



Department of Transportation

Office of Project Development

700 E Broadway Avenue

Pierre, South Dakota 57501-2586 605/773-3268

FAX: 605/773-6608

May 29, 2014

ADDENDUM NO. 1

**RE: Item #2, September 3, 2014 Letting - P TAPR(04), PCN 04QE, Lawrence County
- Shared Use Path**

TO WHOM IT MAY CONCERN:

The following addenda to the plans shall be inserted and made a part of your proposal for the referenced project.

SPECIAL PROVISIONS: Please remove the Special Provisions checklist and replace with attached Special Provisions checklist revised 8/29/14.

Please add the "CITY OF DEADWOOD – GATEWAY PARKING AREA" dated 6/13/14 before the "Special Provision for Fire Plan", dated 5/8/14.

BID ITEM FILE: NO CHANGE

PLANS: NO CHANGE

Sincerely,

Sam Weisgram
Engineering Supervisor

SW/cj

CC: Todd Seaman, Rapid City Region Engineer
Mike Carlson, Rapid City Area Engineer

REV. 8/29/14

SPECIAL PROVISIONS

PROJECT NUMBER(S): P TAPR(04) PCN: 04QE

TYPE OF WORK: SHARED USE PATH

COUNTY: LAWRENCE

The following clauses have been prepared subsequent to the Standard Specifications for Roads and Bridges and refer only to the above described improvement, for which the following Proposal is made. In case of any discrepancy or conflict between said specifications and these Special Provisions, the latter are to govern.

The Contractor's attention is directed to the need for securing from the Department of Environment & Natural Resources, Foss Building, Pierre, South Dakota, permission to remove water from public sources (lakes, rivers, streams, etc.). The Contractor should make his request as early as possible after receiving his contract, and insofar as possible at least 30 days prior to the date that the water is to be used.

Lisa Johnson is the official in charge of the Spearfish Career Center for Lawrence County.

THE FOLLOWING ITEMS ARE INCLUDED IN THIS PROPOSAL FORM:

Special Provision Regarding Triple Combination Bids, dated 8/5/14.

Special Provision for Subletting of Contract and Specialty Items, dated 8/5/14.

CITY OF DEADWOOD – GATEWAY PARKING AREA, dated 6/13/14

Special Provision for Fire Plan, dated 5/8/14.

Special Provision for Contractor Staking, dated 7/2/14.

Special Provision for Contractor Administered Preconstruction Meeting, dated 4/18/13.

Special Provision for Electronic Bidding Requirements, dated 12/18/13.

Special Provision for Fuel Cost Adjustment, dated 7/13/06.

Special Provision for Differing Site Conditions, dated 12/19/13.

Special Provision for Suspension of Work, dated 2/13/04.

Standard Title VI Assurance, dated 7/14/08.

Special Provision For Disadvantaged Business Enterprise, dated 12/19/12.

Special Provision For EEO Affirmative Action Requirements on Federal and Federal-aid Construction Contracts, dated 9/1/97.

Special Provision For Required Contract Provisions Federal-aid Construction Contracts, Form FHWA 1273 (Rev. May/1/12), dated 4/30/13.

Required Contract Provisions Federal-aid Construction Contracts, Form FHWA 1273 (Rev. 5/1/12).

Special Provision Regarding Minimum Wage on Federal-Aid Projects, dated 4/30/13.
Wage and Hour Division US Department of Labor Washington DC.

- US Dept. of Labor Decision Number SD100010, dated 8/30/13.

Supplemental Specification for Errata, dated 3/3/10.

Supplemental Specification to Standard Specifications for Roads and Bridges, dated 3/3/10.

Special Provision for Price Schedule for Miscellaneous Items, dated 9/26/13.

* * * *

SECTION 220110 - BASIC PLUMBING SYSTEM REQUIREMENTS

PART 1 - GENERAL

1.1 SPECIAL NOTE

- A. The AIA Documents A101 and A201, "Standard Form of Agreement Between Owner and Contractor," and "General Conditions of the Contract for Construction," including any Advertisement for Bids, Bidding Requirements, Proposal Form(s), Division 1 Requirements, and Supplementary Conditions, are applicable hereto and made part of Division 22, Mechanical Work.

1.2 DRAWINGS AND MEASUREMENTS

- A. Contract drawings for mechanical work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, ducts, conduits, piping, and approximate sizes and locations of equipment and outlets. Contractor(s) shall follow these drawings in laying out their work, consult general construction drawings to familiarize themselves with all conditions affecting their work, and shall verify spaces in which their work will be installed. Coordinate work with other trades as job conditions reasonably require.
- B. The service clearances, installation details, instructions, and recommendations of the manufacturer of the product used shall form the basis of installation of the products. Contractor shall be responsible for installing products to meet service and maintenance access requirements. Contractor shall not install any item, the positioning of which will restrict service clearance to that item or any other item provided under this or any other section of the specification.
- C. Where job conditions require reasonable changes in indicated sizes, locations and arrangement, such changes shall be made at no increase in the project cost. Contractor shall review such changes with Engineer/Architect before proceeding with the work.
- D. The drawings are not intended to be scaled for roughing in measurements nor to serve as shop drawings.
- E. Equipment shown on the drawings, related supports, concrete pads, electrical requirements, piping, building structures, etc., as well as space requirements, are based on the equipment scheduled. Should selection by the Contractor of approved alternative equipment require revisions, this Contractor shall accept the responsibility for making the necessary changes in the above items to accommodate such equipment. Contractor shall prepare drawing(s) of revision(s) for approval by Architect/Engineer before beginning work. Changes and drawings shall be made at no additional cost to the Owner.

1.3 Substitution Of Materials

- A. Contractor shall provide materials or products specified by name of manufacturer, brand, trade name, or catalog reference, unless changed by an Addendum, prior to bid opening, or a Project Change Order, after bid opening.

SECTION 220111 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Pipe, tube, and fitting materials.
 - 2. Joining materials.
 - 3. Transition fittings.
 - 4. Dielectric fittings.
 - 5. Mechanical sleeve seals.
 - 6. Sleeves.
 - 7. Escutcheons.
 - 8. Grout.
 - 9. Firestopping.
 - 10. Mechanical demolition.
 - 11. Piping system installation - common requirements.
 - 12. Pipe joint construction.
 - 13. Piping connections.
 - 14. Equipment installation - common requirements.
 - 15. Painting.
 - 16. Installation of metal and wood supports and anchorages.
 - 17. Grouting.

1.3 ABBREVIATIONS

- A. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PE: Polyethylene plastic.
 - 4. PVC: Polyvinyl chloride plastic.
 - 5. PEX: Crosslinked polyethylene plastic.
 - 6. PP: Polypropylene plastic.

- B. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.5 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.
- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.3 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
 - 2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
 - 3. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.

- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.5 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Plastic, carbon steel, or stainless steel. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.

- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.8 FIRESTOPPING

- A. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Provide firestop materials, and seal pipe penetrations. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials and installation methods.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS INSTALLATION- COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at code required slopes, or at greater slopes if indicated.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.

- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

- Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- S. Verify final equipment locations for roughing-in.
- T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- U. Mark aboveground and underground piping as specified in Division 23 Section "Mechanical identification."

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. Compression Tool: At Contractor's option, instead of soldering, an electro-hydraulic tool known as ProPress System by Ridge Tool Company can be used for copper pipes ranging from 1/2 to 4 inches. With this process, the Contractor shall use special fittings made by the same Ridge Tool Company.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- C. The service clearances, installation details, instructions, and recommendations of the manufacturer of the product used shall form the basis of installation of the products. Contractor shall be responsible for installing products to meet service and maintenance access requirements. Contractor shall not install any item, the positioning of which will restrict service clearance to that item or any other item provided under this or any other section of the specification.
- D. Equipment shown on the drawings, related supports, concrete pads, electrical requirements, piping, building structures, etc., as well as space requirements, are based on the equipment scheduled. Should selection by the Contractor of approved alternative equipment require revisions, this Contractor shall accept the responsibility for making the necessary changes in the above items to accommodate such equipment. Contractor shall prepare drawing(s) of revision(s) for approval by Architect/Engineer before beginning work. Changes and drawings shall be made at no additional cost to the Owner.

3.5 PAINTING

- A. Painting of mechanical systems, equipment, and components is specified in Division 9 Section "Painting (Consumer Line Products) or Painting (Professional Line Products)."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 INSTALLATION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.7 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 220111

SECTION 220119 - PLUMBING VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following general-duty valves:
 - 1. Bronze ball valves.
 - 2. Bronze gate valves.
 - 3. Bronze globe valves.
 - 4. Bronze check valves.
 - 5. Ductile iron butterfly valves.
 - 6. Resilient-seated, cast-iron, eccentric plug valves.

1.3 DEFINITIONS

- A. The following are standard abbreviations for valves:
 - 1. CWP: Cold working pressure.
 - 2. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 3. BUNA-N: Acrylonitrile-butadiene rubber.
 - 4. PTFE: Polytetrafluoroethylene plastic.
 - 5. SWP: Steam working pressure.
 - 6. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
- B. Maintenance Data: Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairs.

1.5 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.1 for power piping valves and ASME B31.9 for building services piping valves.
 - 1. Exceptions: Domestic hot- and cold-water piping valves unless referenced.

- B. ASME Compliance for Iron Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.
- D. MSS Compliance: Comply with MSS Standard Practice documents referenced.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set gate and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work are limited to the manufacturers specified. Submit alternate manufacturers to the Engineer for review and approval before bidding.
 - 1. Manufacturers for general duty valves when no other manufacturers are specified:
 - a. American Valve, Inc.
 - b. Anvil International Inc., Gruvlok.
 - c. Conbraco Industries, Inc.; Apollo Div.
 - d. Crane Co.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Vietaulic Co.
 - i. Viega Co.
 - j. Watts Industries, Inc.; Water Products Div.
 - k. Or approved equal.

2.2 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Extended Valve Stems: Valves shall have 2" extended handles on insulated piping of non-thermal conductive material. Also provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation.
- C. Bronze Valves: Any size bronze valves shall not have more than 15% zinc content - red brass.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
 - 1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
 - 2. Gear Drive: For quarter-turn valves NPS 8 and larger.
 - 3. Handwheel: For valves other than quarter-turn types.
 - 4. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
 - 5. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
- G. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- H. Valve Grooved Ends: AWWA C606.
 - 1. Solder Joint: With sockets according to ASME B16.18.
 - a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.
 - 2. Threaded: With threads according to ASME B1.20.1.
- I. Valve Bypass and Drain Connections: MSS SP-45.
- J. Ball Valves: Full port stainless steel balls and stems.

2.3 BRONZE BALL VALVES

- A. Bronze Ball Valves, General: MSS SP-110.
- B. Two-Piece, Bronze Ball Valves: Bronze body with full-port, stainless steel ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
- C. Safety-Exhaust, Bronze Ball Valves: Two-piece bronze body with exhaust vent opening, stainless steel ball with vent, blowout-proof stem, locking handle, and working pressure rating for compressed air of at least 125 psig and of 400-psig CWP.

2.4 BRONZE GATE VALVES

- A. Bronze Gate Valves, General: MSS SP-80, with ferrous-alloy handwheel.
- B. Type 1, Class 125, Bronze Gate Valves: Bronze body with nonrising stem and bronze solid wedge.
- C. Type 1, Class 150 and 200, Bronze Gate Valves: Bronze body with nonrising stem and bronze solid wedge and union bonnet.
- D. Type 2, Class 125, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge.
- E. Type 2, Class 150 and 200, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge and union bonnet.
- F. Bronze body with stainless steel disc and union bonnet.

2.5 BRONZE CHECK VALVES

- A. Manufacturers:
 - 1. American Valve, Inc.
 - 2. Cincinnati Valve Co.
 - 3. Crane Co.
 - 4. Milwaukee Valve Company.
 - 5. NIBCO Inc.
 - 6. Powell, Wm. Co.
 - 7. Red-White Valve Corp.
 - 8. Walworth Co.
 - 9. Or approved equal.
- B. Bronze Check Valves, General: MSS SP-80.
- C. Type 2, Class 125, Bronze, Silent Check Valves: Bronze body with nonmetallic disc and bronze seat.
- D. Type 3, Class 125, 150, 200, and 300, Bronze, Swing Check Valves: Bronze body with bronze or TFE disc and seat.

2.6 DUCTILE IRON BUTTERFLY VALVES

- A. Iron Butterfly Valves, General: MSS SP-67, Type I, for bubble tight shutoff, dead-end service with disc and lining suitable for potable water, unless otherwise indicated.
- B. Wafer, 150, 200, and 250-psig CWP Rating, Cast or Ductile Iron Butterfly Valves: Wafer type with one or two-piece stem.
- C. Lug, 150, 200, and 250-psig CWP Rating, Cast or Ductile Iron Butterfly Valves: Lug type with one or two-piece stem.
- D. Grooved-End, 175 and 300-psig CWP Rating, Ductile Iron Butterfly Valves: Ductile-iron or steel body with grooved or shouldered ends.

2.7 RESILIENT-SEATED, CAST-IRON, ECCENTRIC PLUG VALVES

A. Manufacturers:

1. General Signal; DeZurik Unit.
2. Milliken Valve Company.
3. Olson Technologies; Homestead Div.
4. Pratt, Henry Company.
5. Val-Matic Valve & Mfg. Corp.
6. Or approved equal.

B. Resilient-Seated, Cast-Iron, Eccentric Plug Valves, NPS 2-1/2 and Smaller: Design similar to MSS SP-108, and rated for 175-psig minimum CWP.

1. Resilient Seating Material: Suitable for potable-water service, unless otherwise indicated.

C. Resilient-Seated, Cast-Iron, Eccentric Plug Valves, NPS 3 and Larger: MSS SP-108, and rated for 175-psig minimum CWP.

1. Resilient Seating Material: Suitable for potable-water service, unless otherwise indicated.

2.8 AUTOMATIC FLOW BALANCING VALVES

A. Manufacturers:

1. Bell & Gossett ITT, Div. of ITT Fluid Technology Corp.
2. Delta Auto Touch Component System.
3. Flow Design Inc.
4. Gerand Engineering Co.
5. Griswold Control.
6. Hydronic Components Inc. (HCI) Terminator System.
7. TA-Hydronics/Victaulic.
8. Or approved equal.

B. Manual circuit balancing valves for domestic hot water service shall be ball style valves for precise regulation and control. Bronze valves shall be rated at 240 psi at 250°F.

1. Valves 1/2" to 2" shall be constructed of dezincification resistant brass (DZR) or bronze alloy.
2. Valves 2 1/2" to 12" shall be constructed of iron with ANSI class 125/150 flanged or grooved ends.
3. Each valve shall have two metering/test ports with internal check valves and protective caps. All valves shall be equipped with visual readout and concealed memory stops for repeatable regulation and control.

2.9 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

2.10 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly valves.
 - 2. Throttling Service: Angle, ball, butterfly, or globe valves.
 - 3. Pump Discharge: Spring-loaded, lift-disc check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Hot and cold domestic service water piping:
 - 1. Valves 2 1/2" and smaller:
 - a. Ball Valves: Valves shall be rated 150 psi SWP and 600 psi non-shock WWP and shall have 2-piece cast bronze bodies, (B-584, B-61, or B-62) TFE seats, full or standard port, separate pack nut with adjustable stem packing, anti-blowout stems and stainless steel ball and stem or chrome-plated brass/bronze ball and brass stem. Valve ends shall have full depth ANSI threads or extended solder connections and be manufactured to comply with MSS-SP110. Valves shall be similar to:
 - 1) Standard Port: NIBCO T-580-70-66 (threaded), S-580-70-66 (solder).
 - 2) Full Port: NIBCO T-585-70-66 (threaded), S-585-70-66 (solder).
 - 3) Standard Port: NIBCO T580-70 (threaded), S580-70 (solder).
 - 4) Full Port: NIBCO T585-70 (threaded), S585-70 (solder).

Note: Where piping is insulated, ball valves shall be equipped with 2" extended handles of non-thermal conductive material. Also, provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation. Memory stops, which are fully adjustable after insulation is applied, shall be included. Valves shall be similar to:

- 5) Standard Port: NIBCO T580-7ONS (T580-70-66NS) (threaded), S580-7ONS (S-580-70-66NS) (solder).
 - 6) Full Port: NIBCO T585-7ONS (T-585-70-66NS) (threaded), S585-7ONS (T-585-70-66NS) (solder).
- b. Gate Valves, Rising Stem: Valves shall be Class 125 and 200 psi WWP, rising stem, union bonnet, solid wedge and manufactured in accordance with MSS-SP 80. Body, bonnet, and wedge shall be of bronze ASTM B-62. Stems shall be of dezincification-resistant silicon bronze ASTM B-371 or low-zinc alloy B-99, non-asbestos packing and malleable or ductile iron handwheel. Where higher operating pressures approach 150 psi, Class 150 union bonnet valves of like construction will be used. Valve ends may be threaded or solder-type. Valves shall be similar to:
- 1) Class 125 NIBCO T124 (threaded).
 - 2) Class 150 NIBCO T134 (threaded, S134 (solder).
2. Valves 2 1/2" and larger:
- a. Butterfly Valves: Valves shall be lug or IPS grooved body style manufactured in accordance with MSS-SP67 rated at least 200 psi non-shock cold water working pressure. Body shall have 2" extended neck for insulating and shall be ductile iron. Valve shall have aluminum bronze alloy disc with EPDM rubber seat and seals. Stem shall be 400 series stainless steel and shall not have exposed stem to disc fasteners. Sizes 2 1/2" - 6" shall be lever operated with 10-position throttling plate, sizes 8" and larger shall have weatherproof gear operators. Lug-style shall be capable for use as isolation valves and for dead-end service (no pins or fasteners to be used) at full pressure without the need for downstream flanges. Valves shall be similar to:
- 1) Lug body, aluminum bronze disc NIBCO LD2000-3 (lever operator), LD 2000-5 (gear operator).
 - 2) Grooved body, rubber-coated disc NIBCO GD4765-3 (lever operator),
- b. Pump Discharge: Valves shall be Class 125 and 200 psi WWP, shall be flanged style with stainless steel spring, center guided bronze disc or double disc, body of cast iron ASTM A126 Class B or A48. Valves shall be similar to:
- 1) Spring-actuated flanged type NIBCO F910B.
 - 2) Spring-actuated wafer type NIBCO W910-B (center guided), W-920-W (double disc).
 - 3) Swing-type with outside lever and spring/weight NIBCO F918-BL&S (BL&W).

2.11 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges, and with stem upright and plumb.
 - 3. Lift Check Valves: With stem upright and plumb.
 - 4. Silent Check Valves: In horizontal or vertical position.
- G. Install valves as indicated and according to manufacturer's written instructions. All valves shall be line size.

2.12 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

2.13 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

2.14 VALVE IDENTIFICATION

- A. Identify all valves except valves on radiators, convectors, cabinet unit heaters, blast heaters, and plumbing fixture stops, with valve identification tags.
- B. Tags shall be made of 18-gauge polished brass, 1 1/2 inch diameter, with each tag designating appropriate service, appropriate valve number, room number where valve is located (an "x" shall precede room number if valve is in corridor outside room). Letters and numbers shall be minimum of 3/16 inches high stamped into surface.

- C. Obtain valve number sequence from Owner.
- D. Provide a chart of all valves to include the following items (Chart is to be bound in each maintenance portfolio):
 - 1. Valve Identification Number
 - 2. Location
 - 3. Purpose

END OF SECTION 220119

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 220719 - PLUMBING PIPE INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.3 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Application of protective shields, saddles, and inserts at pipe hangers for each type of insulation and hanger.
 - 2. Attachment and covering of heat trace inside insulation.
 - 3. Insulation application at pipe expansion joints for each type of insulation.
 - 4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Removable insulation at piping specialties and equipment connections.
 - 6. Application of field-applied jackets.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for insulation application.
- C. Coordinate installation and testing of steam or electric heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after testing piping systems and, where required, after installing and testing heat-trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work are limited to the manufacturers specified. Submit alternate manufacturers to the Engineer for review and approval before bidding.

1. Inorganic Glass Fiber Insulation:
 - a. CertainTeed Manson.
 - b. Knauf FiberGlass GmbH.
 - c. Johns Manville Corp.
 - d. Owens-Corning Fiberglas Corp.
 - e. Schuller International, Inc.
 - f. Or approved equal.
2. Cellular-Glass Insulation:
 - a. Pittsburgh-Corning Corp.
 - b. CertainTeed
 - c. Or approved equal.
3. Flexible Elastomeric Thermal Insulation:
 - a. Armstrong World Industries, Inc.
 - b. Rubatex Corp.
 - c. Or approved equal.

2.2 INSULATION MATERIALS

A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:

1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
2. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
4. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
5. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
6. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
7. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

B. Cellular-Glass Insulation: Inorganic, foamed or cellulated glass, annealed, rigid, hermetically sealed cells, incombustible.

1. Preformed Pipe Insulation, without Jacket: Comply with ASTM C 552, Type II, Class 1.
2. Preformed Pipe Insulation, with Jacket: Comply with ASTM C 552, Type II, Class 2.

C. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Adhesive: As recommended by insulation material manufacturer.
2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

D. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.

B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.

C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.

1. Adhesive: As recommended by insulation material manufacturer.
 2. PVC Jacket Color: White or gray.
 - D. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-thick, high-impact, ultraviolet-resistant PVC.
 1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 2. Adhesive: As recommended by insulation material manufacturer.
- 2.4 ACCESSORIES AND ATTACHMENTS
- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd.
 1. Tape Width: 4 inches.
 - B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
 1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
 2. Galvanized Steel: 0.005 inch thick.
 3. Aluminum: 0.007 inch thick.
 - C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.
- 2.5 VAPOR RETARDERS
- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

- 3.1 EXAMINATION
- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - B. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.2 PREPARATION
- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.
- 3.3 GENERAL APPLICATION REQUIREMENTS
- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
 - B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
 - C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
 - D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
 - E. Apply multiple layers of insulation with longitudinal and end seams staggered.
 - F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
 - G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
 - H. Keep insulation materials dry during application and finishing.
 - I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
 - J. Apply insulation with the least number of joints practical.

- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
 - 1. Apply insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
 - 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Circumferential Joints: Cover with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
 - 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
 - 4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 - 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 - 1. Seal penetrations with vapor-retarder mastic.
 - 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 - 3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal metal jacket to roof flashing with vapor-retarder mastic.
- Q. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.
- R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- S. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."
- T. Floor Penetrations: Apply insulation continuously through floor assembly.
 - 1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 MINERAL-FIBER AND CELLULAR-GLASS INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
 - 1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.

2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
 3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
1. Apply preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of insulation of the same thickness as the pipe insulation.
 4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.
- C. Apply insulation to fittings and elbows as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
 3. Cover fittings with standard PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
- D. Apply insulation to valves and specialties as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.
- 3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION
- A. Apply insulation to straight pipes and tubes as follows:
1. Follow manufacturer's written instructions for applying insulation.
 2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- B. Apply insulation to fittings and elbows as follows:
1. Apply mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- C. Apply insulation to valves and specialties as follows:
1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
 2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For

check valves, fabricate removable sections of insulation arranged to allow access to stainer basket.

3. Apply insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.6 FIELD-APPLIED JACKET APPLICATION

- A. Apply glass-cloth jacket, where indicated or required, directly over bare insulation or insulation with factory-applied jackets.
 1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch-thick coats of jacket manufacturer's recommended adhesive.
 3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.
- B. Foil and Paper Jackets: Apply foil and paper jackets where indicated, or required.
 1. Draw jacket material smooth and tight.
 2. Apply lap or joint strips with the same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Apply jackets with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.
- C. Apply PVC jacket where indicated or required, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

3.7 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 1. Fire-suppression piping.

3.8 FIELD QUALITY CONTROL

- A. Inspection: Perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:
 1. Inspect fittings and valves randomly selected by Architect.
 2. Remove fitting covers from 20 elbows or 1 percent of elbows, whichever is less, for various pipe sizes.
 3. Remove fitting covers from 20 valves or 1 percent of valves, whichever is less, for various pipe sizes.
- B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.
- C. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.9 INSULATION APPLICATION SCHEDULE, GENERAL

- A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.
- B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.10 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Domestic hot and recirculated hot water.
 1. Operating Temperature: 60 to 140 deg F.
 2. Insulation Material: Mineral fiber.

3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Copper Pipe, up to 2 inches: 1 inch thick.
 - b. Copper Pipe, Over 2 inches: 1 1/2 inch thick.
 4. Field-Applied Jacket: None.
 5. Vapor Retarder Required: No.
 6. Finish: None.
- B. Service: Domestic cold water.
1. Operating Temperature: 35 to 60 deg F.
 2. Insulation Material: Mineral fiber.
 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Copper Pipe, Up to 2 inches: 1/2 inch thick.
- 3.11 INSULATION THICKNESS AS PROVIDED ABOVE
- A. Thicknesses given are for insulation thermal resistivity in the range of 4.0 to 4.6 h - °F - SF/BTU per inch of thickness on a flat surface at a mean temperature of 75°F. For other insulating values, Contractor shall submit documentation and calculations justifying change in insulation thickness.

END OF SECTION 220719

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes
 - 1. Backflow preventers.
- B. Related Requirements:
 - 1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and calibrated balance valves in domestic water piping.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 and NSF 14.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Conbraco Industries, Inc.
 - c. Febco; a division of Watts Water Technologies, Inc.
 - d. Flomatic Corporation.
 - e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - 2. Standard: ASSE 1013.
 - 3. Operation: Continuous-pressure applications.
 - 4. Pressure Loss: 12 psig maximum, through middle third of flow range.
 - 5. Size and Flow Rate: As indicated on the Drawings.
 - 6. Body: Bronze for NPS 2 and smaller; cast iron or steel with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
 - 7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 - 8. Configuration: As indicated on the Drawings.
 - 9. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.

- b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
- c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
- 10. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; a division of Watts Water Technologies, Inc.
 - c. Flomatic Corporation.
 - d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
- 11. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 - 3. Do not install bypass piping around backflow preventers.
- B. Install water-control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- C. Install balancing valves in locations where they can easily be adjusted.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 221119

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes plumbing fixtures and related components.

1.3 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.4 SUBMITTALS

- A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.
- B. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; about plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about plumbing fixtures for people with disabilities.
- E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- H. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
 - 2. Hand Sinks: NSF 2 construction.
 - 3. Plastic Mop-Service Basins: ANSI Z124.6.
 - 4. Plastic Sinks: ANSI Z124.6.

5. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
 6. Stainless-Steel Fixtures Other Than Service Sinks: ASME A112.19.3M.
 7. Vitreous-China Fixtures: ASME A112.19.2M.
 8. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
 9. Water-Closet, Flushometer Tank Trim: ASSE 1037.
 - I. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
 1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 4. Faucet Hose: ASTM D 3901.
 5. Faucets: ASME A112.18.1M.
 6. Hose-Connection Vacuum Breakers: ASSE 1011.
 7. Hose-Coupling Threads: ASME B1.20.7.
 8. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 9. NSF Materials: NSF 61.
 10. Pipe Threads: ASME B1.20.1.
 11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 12. Supply and Drain Fittings: ASME A112.18.1M.
 - J. Comply with the following applicable standards and other requirements specified for bathtub and shower faucets:
 1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
 2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
 3. Faucets: ASME A112.18.1M.
 4. Hand-Held Showers: ASSE 1014.
 5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
 6. Hose-Coupling Threads: ASME B1.20.7.
 7. Manual-Control Antiscald Faucets: ASTM F 444.
 8. Pipe Threads: ASME B1.20.1.
 9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
 10. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
 - K. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 1. Atmospheric Vacuum Breakers: ASSE 1001.
 2. Brass and Copper Supplies: ASME A112.18.1M.
 3. Manual-Operation Flushometers: ASSE 1037.
 4. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
 5. Tubular Brass Drainage Fittings and Piping: ASME A112.18.1M.
 - L. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 1. Floor Drains: ASME A112.21.1M.
 2. Grab Bars: ASTM F 446.
 3. Hose-Coupling Threads: ASME B1.20.7.
 4. Off-Floor Fixture Supports: ASME A112.6.1M.
 5. Pipe Threads: ASME B1.20.1.
 6. Plastic Toilet Seats: ANSI Z124.5.
 7. Supply and Drain Protective Shielding Guards: ICC A117.1.
- 1.6 COORDINATION
- A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work are limited to the manufacturers specified.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following.
 - 1. China. Kohler, American Standard.
 - 2. Fiberglass. Aqua Glass, Kohler, Clarion, Universal Rundle, Swan.
 - 3. Flush Valves. Sloan, Zurn,
 - 4. Seats. Beneke, Bemis, Church, Centoco, Kohler.
 - 5. Stainless Steel. Elkay, Just,
 - 6. Drinking Fountains shall meet NSF Standard 61 Section 9. Haws, Halsey Taylor, Sunrock, Elkay, Oasis.
 - 7. Under Sink Pipe Protectors. Truebro, Prowrap, Plumberex.
 - 8. Mop Basins: Fiat, Mustee.
 - 9. Shower Valves: Lawler, Powers, Symmons, Speakmen, Leonard.
 - 10. Faucets – Zurn, Chicago, Sloan, American Standard
 - 11. Wall Hydrants – Woodford, Zurn

2.2 GENERAL

- A. The exposed flush, waste, and supply pipes at the fixtures shall be chromium-plated brass pipe, iron pipe size. Fittings and traps for brass pipe shall be cast brass, chromium-plated.
- B. Install chromium-plated brass or stainless steel wall or floor plates with set screw where piping passes through walls or floors.
- C. Where reference is made to chromium-plated brass, same shall mean polished brass, first nickel-plated and finished with chromium plate.
- D. Provide faucets, stops, and traps for all fixtures and equipment.
- E. All lavatories and drinking fountains shall be furnished with 3/8-inch SPS flexible tube supply pipes, 1/2" x 3/8" loose key stops and escutcheons, unless specified otherwise.
- F. All lavatories, drinking fountains, and sinks shall be furnished with 1 1/4-inch tailpiece, 1 1/2-inch cast brass chrome-plated "P" trap with C.O., 17 gauge tubing waste to wall and escutcheons, unless otherwise specified.
- G. All fixtures fitted to the walls or floor shall be ground square and true and be sealed with a non-hardening white silicon caulk bead, with Engineer's approval.
- H. Provide Wade, Zurn, J.R. Smith, or Josam carriers or wall hangers, specified below, to support all wall hung fixtures independent of wall. Carriers shall be secured to structural floor slab with anchor bolts. Carriers shall be designed for chase space allowed on architectural plans.
 - 1. Water Closet. Short foot supports, integral stack fitting, auxiliary inlets and vent connections as required, adjustable to mounting heights indicated. Carriers for single water closets shall have an anchor foot on the back side of carrier in addition to foot supports.
 - 2. Wall hung sinks, urinals. Floor mounted, chrome fixture bolts, hanger and bearing plates for attaching upper back cast iron wall hanger brackets and lower backbolts, etc., steel pipe uprights with block bases.
 - 3. Lavatories (institutional). Floor mounted, chrome fixture bolts, hanger and bearing plates for attaching upper back cast iron wall hanger brackets and lower backbolts, etc., steel pipe uprights with block bases.
- I. The following schedule establishes the standards to which each type of fixture must conform and the plumbing fixture portfolios shall completely illustrate and describe each type. Refer to the drawings for exact quantities of fixtures scheduled in the following.
- J. NOTE: Where there is no standard of quality specified, fixtures shall match identically existing units in the same area. Verify mounting heights from Architectural Details.

2.3 FIXTURES

- A. See the Schedule on the Plans. Not all "P numbers" may appear on each project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water, waste, and vent piping systems. Verify support types, sizes, and actual locations match those required. Verify actual locations and sizes of piping connections before plumbing fixture installation. Use manufacturer's roughing-in data for fixtures provided.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIXTURE INSTALLATION

- A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. For wall-hanging fixtures, install off-floor supports affixed to building substrate.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-hanging fixtures with tubular waste piping attached to supports.
- F. Install counter-mounting fixtures in and attached to casework.
- G. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.
- H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Refer to Division 15 Section "Valves" for general-duty valves.
- I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- K. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- L. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- M. Install toilet seats on water closets.
- N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- O. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.
- P. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- Q. Install shower, flow-control fittings with specified maximum flow rates in shower arms.
- R. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- S. Install disposer in outlet of sinks indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- T. Install escutcheons at piping wall or ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for escutcheons.

- U. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 7 Section "Joint Sealants" for sealant and installation requirements.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.
- D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.
- E. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Verify that installed fixtures are categories and types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers, hot-water dispensers, and controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:
 1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
 2. Adjusting total HVAC systems to provide indicated quantities.
 3. Measuring electrical performance of HVAC equipment.
 4. Setting quantitative performance of HVAC equipment.
 5. Verifying that automatic control devices are functioning properly.
 6. Reporting results of the activities and procedures specified in this Section.

1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.
- C. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- D. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- E. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- F. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.
- G. AABC: Associated Air Balance Council.
- H. AMCA: Air Movement and Control Association.
- I. NEBB: National Environmental Balancing Bureau.
- J. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.4 SUBMITTALS

- A. Quality-Assurance Submittals: Submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.

1.5 QUALITY ASSURANCE

- A. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC, NEBB, or SMACNA.
- B. Instrumentation Type, Quantity, and Accuracy: As described in AABC or NEBB national standards.
- C. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 PROJECT CONDITIONS

- A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

1.7 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.
- B. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
- B. Examine approved submittal data of HVAC systems and equipment. Examine equipment performance data, including fan and pump curves.
- C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
- D. Examine system and equipment test reports.
- E. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- F. Examine the HVAC system and verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Isolating and balancing valves are open and control valves are operational.
- G. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- H. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine strainers for clean screens and proper perforations.
- J. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- L. Examine open-piping-system pumps to ensure absence of entrained air in the suction piping.
- M. Examine equipment for installation and for properly operating safety interlocks and controls.
- N. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices operate by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.

5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 6. Sensors are located to sense only the intended conditions.
 7. Sequence of operation for control modes is according to the Contract Documents.
 8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
 9. Interlocked systems are operating.
 10. Changeover from heating to cooling mode occurs according to design values.
- O. Report deficiencies discovered to the Contractor for correction, and to the Architect. Continue balancing systems after deficiencies have been corrected.

3.2 GENERAL TESTING AND BALANCING PROCEDURES

- A. Perform testing and balancing procedures on each system.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.
- C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

END OF SECTION 230593

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following duct services:
 1. Concealed and exposed supply-air.
 2. Concealed and exposed return-air.
 3. Concealed and exposed, outside-air and mixed-air.
 4. Concealed and exposed, exhaust-air and relief-air.
 5. Outdoor, exhaust-air.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields.
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.
- C. Do not store or install duct insulation materials until the building is enclosed and weather-tight. Use extra-ordinary means to keep insulation clean and dry.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Duct Insulation Schedule," and "Outdoor Duct Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Owens Corning; SOFTR All-Service Duct Wrap.
- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ or FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; Commercial Board.
 - b. Johns Manville; 800 Series Spin-Glas.
 - c. Knauf Insulation; Insulation Board.
 - d. Owens Corning; Fiberglas 700 Series.
- H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 DUCT LINER

- A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.
 - 1. Manufacturers:
 - a. CertainTeed Corp.; Insulation Group.
 - b. Johns Manville International, Inc.
 - c. Knauf Fiber Glass GmbH.
 - d. Owens Corning.
 - 2. Materials: ASTM C 1071; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.
 - a. Thickness: 1 inch having 1-1/2 pound density.
 - b. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.

- c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
- d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
- e. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
 - 1) Tensile Strength: Indefinitely sustain a 50-lb-tensile, dead-load test perpendicular to duct wall.
 - 2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
 - 3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

2.3 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to . Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a 1-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Johns Manville; Super Firetemp M.
- B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; FlameChek.
 - b. Johns Manville; Firetemp Wrap.
 - c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
 - d. Thermal Ceramics; FireMaster Duct Wrap.
 - e. 3M; Fire Barrier Wrap Products.

2.4 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aero seal.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.

- b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - E. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. Speedline Corporation; Polycy VP Adhesive.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 2.5 MASTICS
 - A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.
 - C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 - 3. Service Temperature Range: 0 to 180 deg F.
 - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 5. Color: White.
 - D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 - 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 - 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 - 5. Color: White.
 - E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
 - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: 60 percent by volume and 66 percent by weight.

5. Color: White.

2.6 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 4. Service Temperature Range: 0 to plus 180 deg F.
 5. Color: White.

2.7 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: Aluminum.
 6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: White.
 6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.

2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lb force/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lb force/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lb force/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 488 AWF.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - c. Compac Corporation; 120.
 - d. Venture Tape; 3520 CW.
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lb force/inch in width.

2.11 SECUREMENTS

- A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide.
 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide.
- B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, of diameter shank, length to suit depth of insulation indicated.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, of diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
 3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & F Wire.

2.12 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- B. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation below roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation,

- install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."
- 3.5 APPLICATION OF DUCT LINER IN RECTANGULAR DUCTS
- A. Duct dimensions indicated on the drawings are internal sizes after the duct lining has been applied. Increase the duct dimensions as required to keep the internal duct dimensions equal to those indicated on the drawings.
 - B. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 - C. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 - D. Butt transverse joints without gaps and coat joint with adhesive.
 - E. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 - F. In rectangular ducts, do not apply liner using longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
 - G. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
 - H. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 - I. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 1. Fan discharges.
 2. Intervals of lined duct preceding unlined duct.
 3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm or where indicated.
 - J. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

1. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
- K. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.
- 3.6 INSTALLATION OF MINERAL-FIBER INSULATION
- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.9 FINISHES

- A. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

- A. Tests and Inspections:

1. The Architect may inspect ductwork insulation by directing removal of field-applied jacket and insulation in layers in reverse order of their insulation. The extent of inspection shall be as required to determine compliance with requirements. Re-insulation shall be completed at the Contractor's expense.
 - B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.
- 3.11 DUCT INSULATION SCHEDULE, GENERAL
- A. Ducts Requiring Insulation:
 1. Concealed and exposed supply-air.
 2. Concealed and exposed return-air.
 3. Concealed and exposed, outside-air and mixed-air.
 4. Concealed and exposed, exhaust-air and relief-air.
 5. Outdoor exhaust air.
 - B. Items Not Insulated:
 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 2. Factory-insulated flexible ducts.
 3. Factory-insulated plenums and casings.
 4. Flexible connectors.
 5. Vibration-control devices.
 6. Factory-insulated access panels and doors.
- 3.12 DUCT INSULATION SCHEDULE
- A. Supply Air Ducts: Round, concealed and exposed, other than factory insulated double wall ducts.
 1. Material: Mineral-fiber blanket.
 2. Thickness: 1-1/2 inches.
 3. Number of Layers: One.
 4. Field-Applied Jacket: Foil and paper.
 5. Vapor Retarder Required: Yes.
 6. Density: 1 lb.
 7. R-Value: 5.6.
 - B. Supply Air Ducts: Rectangular, concealed and exposed:
 1. Material: Mineral-fiber blanket.
 2. Thickness: 1-1/2 inches.
 3. Number of Layers: One.
 4. Field-Applied Jacket: Foil and paper.
 5. Vapor Retarder Required: Yes.
 6. Density: 1 lb.
 7. R-Value: 5.6.
 - C. Return Air Ducts: Rectangular, concealed and exposed:
 1. Material: Duct Liner.
 2. Thickness: 1 inch.
 3. Number of Layers: One.
 4. Field-Applied Jacket: None, but glass fiber surfaces exposed to the air stream shall be coated to prevent erosion of the material.
 5. Vapor Retarder Required: No.
 6. Density: 1-1/2 lb.
 - D. Outside Air and Combustion Air Ducts: Rectangular, concealed and exposed:
 1. Material: Mineral-fiber board.
 2. Thickness: 2 inches.
 3. Number of Layers: One.
 4. Field-Applied Jacket: Foil and paper.
 5. Vapor Retarder Required: Yes.
 6. Density: 3 lb.

7. R-Value: 8.7.
- E. Outside Air and Combustion Air Ducts: Round, concealed and exposed:
 1. Material: Mineral-fiber blanket.
 2. Thickness: 2 inches.
 3. Number of Layers: One.
 4. Field-applied Jacket: Glass cloth.
 5. Vapor Retarder Required: Yes.
 6. Density: 3 lb.
 7. R-Value: 8.7.
- F. Mixed air ducts: Rectangular exposed
 1. Material: Mineral-fiber board.
 2. Thickness: 1 inch.
 3. Number of Layers: One.
 4. Field-Applied Jacket: Foil and Paper
 5. Vapor Retarder Required: Yes.
 6. Density: 3 lb.
 7. R-Value: 4.3.
- G. Service: Rectangular and round, dishwasher exhaust, relief and general exhaust ducts, concealed - maximum 15 feet from roof or louver opening including drip pans and louver plenums.
 1. Material: Mineral-fiber board.
 2. Thickness: 2 inches.
 3. Number of Layers: One.
 4. Field-Applied Jacket: Foil and paper.
 5. Vapor Retarder Required: No.
 6. Density: 3 lb.
 7. R-Value: 8.7.

END OF SECTION 230713

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 231123 - NATURAL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes natural gas piping, specialties, and accessories within the building.

1.3 PROJECT CONDITIONS

- A. Low Pressure Gas Piping System: One pressure range. Operating pressure is 0.5 psig or less.
- B. Medium Pressure Gas Piping System: Operating pressure is more than 0.5 psig but not more than 2.0 psig.
- C. High Pressure Gas Piping System: Operating pressure is more than 2.0 psig but not more than 5.0 psig.
- D. Design values of fuel gas supplied for these systems are as follows:
 - 1. Nominal Heating Value: 1000 Btu/cu. ft.
 - 2. Nominal Specific Gravity: 0.6.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 2. Pressure regulators. Include pressure rating, capacity, and settings of selected models.
- B. Shop Drawings: For natural gas piping. Include plans and attachments to other Work.
 - 1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- D. Maintenance Data: For natural gas specialties and accessories to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

- A. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ANSI Standard: Comply with ANSI Z223.1, International Fuel Gas Code, and the current edition of the Minnesota Fuel Gas Code.
- C. FM Standard: Provide components listed in FM's "Fire Protection Approval Guide" if specified to be FM approved.
- D. IAS Standard: Provide components listed in IAS's "Directory of A. G. A. and C. G. A Certified Appliances and Accessories" if specified to be IAS listed.
- E. UL Standard: Provide components listed in UL's "Gas and Oil Equipment Directory" if specified to be UL listed.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.

1.7 COORDINATION

- A. New Utilities: Contact the local gas company and make all arrangements to provide gas service and meter to the locations indicated on the drawings. Include any fees from the gas company in the Mechanical Contractor's bid.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work are limited to the manufacturers specified. Submit alternate manufacturers to the Engineer for review and approval before bidding.
1. Appliance Connector Valves:
 - a. American Valve.
 - b. Brass Craft Manufacturing Co.
 - c. Conbraco Industries, Inc.; Apollo Div.
 - d. E. M. Plastic and Electric Products, Ltd.; Neo Valve Div.
 - e. Jomar International, Ltd.
 - f. Legend Valve and Fitting, Inc.
 - g. McDonald: A. Y. McDonald Mfg. Co.
 - h. Mueller Co.; Mueller Gas Products Div.
 - i. Watts Industries, Inc.; Water Products Div.
 - j. Or approved equal.
 2. Gas Valves, NPS 2 and Smaller:
 - a. Crane Valves.
 - b. Flow Control Equipment, Inc.
 - c. Grinnell Corp.
 - d. Jomar International, Ltd.
 - e. Legend Valve and Fitting, Inc.
 - f. McDonald: A. Y. McDonald Mfg. Co.
 - g. Milwaukee Valve Co., Inc.
 - h. Mueller Co.; Mueller Gas Products Div.
 - i. National Meter.
 - j. Nibco, Inc.
 - k. Nordstrom Valves, Inc.
 - l. Watts Industries, Inc.; Water Products Div.
 - m. Or approved equal.
 3. Plug Valves, NPS 2-1/2 and Larger:
 - a. Flow Control Equipment, Inc.
 - b. Milliken Valve Co., Inc.
 - c. Nordstrom Valves, Inc.
 - d. Olson Technologies, Inc.; Homestead Valve Div.
 - e. Walworth Co.
 - f. Or approved equal.
 4. Electrically Operated Gas Valves:
 - a. Atkomatic Valve Co., Inc.
 - b. Automatic Switch Co.
 - c. Eclipse Combustion Inc.
 - d. Goyen Valve Corp.
 - e. Magnatrol Valve Corp.
 - f. Parker Hannifin Corp.; Climate & Industrial Controls Group; Skinner Valve Div.
 - g. Or approved equal.
 5. Service Pressure Regulators:
 - a. American Meter Co.
 - b. Equimeter, Inc.
 - c. Fisher Controls International, Inc.
 - d. National Meter.

- e. Richards Industries, Inc.; Jordan Valve Div.
- f. Schlumberger Industries; Gas Div.
- g. Or approved equal.
- 6. Line Pressure Regulators:
 - a. American Meter Co.
 - b. Equimeter, Inc.
 - c. Fisher Controls International, Inc.
 - d. Maxitrol Co.
 - e. National Meter.
 - f. Richards Industries, Inc.; Jordan Valve Div.
 - g. Schlumberger Industries; Gas Div.
 - h. Or approved equal.
- 7. Appliance Pressure Regulators:
 - a. Canadian Meter Co., Inc.
 - b. Eaton Corp.; Controls Div.
 - c. Harper Wyman Co.
 - d. Maxitrol Co.
 - e. SCP, Inc.
 - f. Or approved equal.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS

- A. Steel Pipe: ASTM A 53; Type E or S; Grade B; Schedule 40; black.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
 - 2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
 - 3. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
 - 4. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
 - 5. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
 - 6. Joint Compound and Tape: Suitable for natural gas.
 - 7. Steel Flanges and Flanged Fittings: ASME B16.5.
 - 8. Gasket Material: Thickness, material, and type suitable for natural gas.
- B. Copper Tube: Copper tubing shall comply with ASTM B 88, Type K or L.
 - 1. Copper Fittings: ASME B16.22, wrought copper, streamlined pattern.
 - 2. Brazing Filler Metals: AWS A5.8, Silver Classification BAg-1. Filler metal containing phosphorus is prohibited.
 - 3. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.
 - 4. Gasket Material: Thickness, material, and type suitable for natural gas.
- C. Transition Fittings: Type, material, and end connections to match piping being joined.
- D. Common Joining Materials: Refer to Division 23 Section "Basic Mechanical Materials and Methods" for joining materials not in this Section.

2.4 PROTECTIVE COATING

- A. Furnish pipe and fittings with factory-applied, corrosion-resistant polyethylene coating for use in corrosive atmosphere.

2.5 PIPING SPECIALTIES

- A. Flexible Connectors: ANSI Z21.24, copper alloy.
- B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

- C. Strainers: Y pattern, full size of connecting piping. Include stainless-steel screens with 3/64-inch perforations, except where other screens are indicated:
 - 1. Pressure Rating: 125-psig minimum steam or 175-psig WOG working pressure, except where otherwise indicated.
 - 2. 2-inch NPS and Smaller: Bronze body with threaded ends conforming to ASME B1.20.1.
 - 3. 2 1/2-inch NPS and Larger: Cast-iron body with flanged ends.
 - 4. Screwed screen retainer with centered blow-down and pipe plug.

2.6 SPECIALTY VALVES

- A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
- B. Valves, NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
- C. Appliance Connector Valves: ANSI Z21.15 and IAS listed.
- D. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.
- E. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating.
 - 1. Tamperproof Feature: Include design for locking.
- F. Plug Valves, NPS 2-1/2 and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating.
 - 1. Tamperproof Feature: Include design for locking.
- G. General-Duty Valves, NPS 2-1/2 and Larger: ASME B16.38, cast-iron body, suitable for fuel gas service, with "WOG" indicated on valve body, and 125-psig pressure rating.
 - 1. Gate Valves: MSS SP-70, OS&Y type with solid wedge.
 - 2. Butterfly Valves: MSS SP-67, lug type with lever handle.
- H. Electrically Operated Gas Valves: UL 429, bronze, aluminum, or cast-iron body solenoid valve; 120-V ac, 60 Hz, Class B, continuous-duty molded coil. Include NEMA ISC 6, Type 4, coil enclosure and electrically opened and closed dual coils. Valve position shall normally be closed. FM approved.

2.7 SERVICE METERS

- A. Service Meters: Shall be provided by the owner if needed.

2.8 PRESSURE REGULATORS

- A. Description: Single stage and suitable for natural gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.
 - 1. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
 - 2. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
 - 3. Service Pressure Regulators: ANSI Z21.80. Inlet pressure not less than system service pressure.
 - 4. Line Pressure Regulators: ANSI Z21.80 with 10-psig inlet pressure rating, unless otherwise indicated.
 - 5. Appliance Pressure Regulators: ANSI Z21.18. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction. Inlet pressure not less than system pressure with capacity and pressure setting to match that of the appliance.
- B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

2.9 CONCRETE BASES

- A. Description: Precast, reinforced concrete base, made of 3000-psi-minimum, 28-day compressive strength concrete, and measuring 4 inches thick and 4 inches larger in each dimension than supported item, unless otherwise indicated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.
- B. Comply with ANSI Z223.1, "Prevention of Accidental Ignition" Paragraph.

3.2 SERVICE ENTRANCE PIPING

- A. Extend natural gas piping and connect to natural gas distribution for service entrance to building.
 - 1. Exterior natural gas distribution system piping, service pressure regulator, and service meter will be provided by the local utility company.

3.3 CONCRETE BASE INSTALLATION

- A. Locate bases at service meters and service regulators.
- B. Excavate earth and make level beds to support bases. Set bases level with top surface projecting approximately 3 inches above grade.

3.4 PIPING APPLICATIONS

- A. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.
- B. Natural Gas Piping, 0.5 psig or Less: Use the following:
 - 1. NPS 1/2 and Smaller: NPS 3/4 steel pipe, malleable-iron threaded fittings, and threaded joints.
 - 2. NPS 1/2 and Smaller: Corrugated, stainless-steel tubing system and threaded joints.
 - 3. NPS 3/4 and NPS 1: Steel pipe, malleable-iron threaded fittings, and threaded joints.
 - 4. NPS 3/4 and NPS 1: Hard copper tube, copper fittings, and brazed joints.
 - 5. NPS 3/4 and NPS 1: Corrugated, stainless-steel tubing system and threaded joints.
 - 6. NPS 1-1/4 to NPS 2: Steel pipe, steel welding fittings, and welded joints.
 - 7. NPS 2-1/2 to NPS 4: Steel pipe, steel welding fittings, and welded joints.
- C. Natural Gas Piping, 0.5 to 2 psig: Use the following:
 - 1. All Pipe Sizes: Steel pipe, steel welding fittings, and welded joints.
- D. Natural Gas Piping 2 to 5 psig: Use the following:
 - 1. All Pipe Sizes: Steel pipe, steel welding fittings, and welded joints.
- E. Underground Fuel Gas Piping: Steel pipe, steel welding fittings, and welded joints. Encase in containment conduit.
- F. Containment Conduits: Steel pipe, steel welding fittings, and welded joints.
- G. Gas Service Piping at Meters and Regulators, Above 5 psig: Steel pipe, steel welding fittings, and welded joints.

3.5 VALVE APPLICATIONS

- A. Appliance Shutoff Valves for Pressure 0.5 psig or Less: Appliance connector valve or gas stop.
- B. Appliance Shutoff Valves for Pressure 0.5 to 2 psig: Gas stop or gas valve.
- C. Piping Line Valves, NPS 2 and Smaller: Gas valve.
- D. Piping Line Valves, NPS 2-1/2 and Larger: Plug valve or general-duty valve.
- E. Valves at Service Meter, NPS 2 and Smaller: Gas valve.
- F. Valves at Service Meter, NPS 2-1/2 and Larger: Plug valve.

3.6 PIPING INSTALLATION

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements.
 - B. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.
 - 1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
 - 2. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls.
 - a. Exception: Tubing passing through partitions or walls.
 - 3. In Walls: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in masonry walls, subject to approval of authorities having jurisdiction.
 - 4. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - a. Exception: Accessible above-ceiling space specified above.
 - C. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
 - D. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, unless indicated to be exposed to view.
 - E. Install natural gas piping at uniform grade of 0.1 percent slope upward toward risers.
 - F. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
 - G. Connect branch piping from top or side of horizontal piping.
 - H. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
 - I. Install corrugated, stainless-steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.
 - J. Install strainer on inlet of each control valve, line pressure regulator, electrically operated valve, and elsewhere as indicated.
 - K. Install dielectric fittings (unions and flanges) with ferrous and brass or bronze end connections, separated by insulating material, where piping of dissimilar metals is joined.
 - L. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.
 - M. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.
- 3.7 JOINT CONSTRUCTION
- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
 - B. Use materials suitable for natural gas.
 - 1. Brazed Joints: Make with brazing alloy with melting point greater than 1000 deg F. Brazing alloys containing phosphorus are prohibited.
- 3.8 VALVE INSTALLATION
- A. Install valves in accessible locations, protected from damage. Tag valves with metal tag indicating piping supplied. Attach tag to valve with metal chain.

1. Refer to Division 23 Section "Mechanical Identification" for valve tags.
- B. Install gas valve upstream from each gas pressure regulator. Where 2 gas pressure regulators are installed in series, valve is not required at second regulator.
- C. Install pressure relief or pressure-limiting devices so they can be readily operated to determine if valve is free; test to determine pressure at which they will operate; and examine for leakage when in closed position.

3.9 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 23 Section "Hangers and Supports" for pipe hanger and support devices.
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
- C. Install hangers for horizontal hard copper tubing with the following maximum spacing and minimum rod sizes:
 1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
 2. NPS 1/2 and NPS 5/8: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 3. NPS 3/4 and NPS 7/8: Maximum span, 84 inches; minimum rod size, 3/8 inch.
 4. NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.10 CONNECTIONS

- A. Drawings indicate general arrangement of natural gas piping, fittings, and specialties.
- B. Install piping adjacent to appliances to allow service and maintenance.
- C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.
- D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.
- E. Ground equipment.
 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
 2. Do not use gas pipe as grounding electrode.

3.11 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator, and specialty valve.
 1. Text: In addition to name of identified unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
 2. Refer to Division 23 Section "Mechanical Identification" for nameplates and signs.

3.12 PAINTING

- A. Use materials and procedures in Division 9 Section "Painting," "Exterior Paint Schedule" Article, "Ferrous Metal" Paragraph, "Full-Gloss, Alkyd-Enamel Finish" Subparagraph.
- B. Paint exterior service meters, pressure regulators, and specialty valves.
 1. Color: Gray.

3.13 FIELD QUALITY CONTROL

- A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging," and requirements of authorities having jurisdiction.
- B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.
- C. Report test results promptly and in writing to Architect and authorities having jurisdiction.
- D. Verify capacities and pressure ratings of service meters, pressure regulators, valves, and specialties.
- E. Verify correct pressure settings for pressure regulators.
- F. Verify that specified piping tests are complete.

3.14 ADJUSTING

- A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

END OF SECTION 231123

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg. Metal ducts include the following:
 1. Sheet metal materials.
 2. Sealant materials.
 3. Hangers and supports.
 4. Rectangular ducts fabrication.
 5. Round and oval duct and fitting fabrication.
 6. Firestopping.
 7. Duct applications.

1.3 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.

1.4 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 SUBMITTALS

- A. Welding certificates.
- B. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports, AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members, and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. NFPA Compliance:
 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- C. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work are limited to those listed. Submit alternate manufacturers to the Engineer for review and approval before bidding.

2.2 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A 653/A 653M and having G90 (Z275) coating designation. Factory-applied PVC coatings shall be 4 mils thick on sheet metal surfaces of ducts and fittings exposed to corrosive conditions and 2 mils thick on opposite surfaces.
- D. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.
- E. Stainless Steel: ASTM A 480/A 480M, Type 304, and having a No. 2D finish for concealed ducts and No. 4 for exposed ducts.
- F. Aluminum Sheets: ASTM B 209 (ASTM B 209M), alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- G. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- H. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
- B. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
- C. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.
- D. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- E. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.4 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 3. Do not use power actuated or mechanical fasteners in post-tensioned concrete slabs where the cable locations are unknown. Fasteners shall not exceed 3/4-inch embedment.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
 - 1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - 2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
 - 3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
 - 4. Stainless Steel: All ductwork and accessories exposed to the aquatic environment shall be supported using stainless steel devices.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Fasteners shall not project more than 1/4 inch into the air stream.

- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
 - 3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.
- 2.5 RECTANGULAR DUCT FABRICATION
- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
 - 1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 - 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
 - B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
 - 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Nexus Inc.
 - c. Ward Industries, Inc.
 - C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
 - 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Lockformer.
 - 2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
 - 3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.
 - D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.
- 2.6 ROUND AND OVAL DUCT AND FITTING FABRICATION
- A. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
 - B. Duct Joints:
 - 1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
 - 2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
 - 3. Ducts Larger than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
 - 4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
 - a. Manufacturers:
 - 1) Lindab Inc.
 - C. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
 - D. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

- E. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
 2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
 - a. Ducts 3 to 36 Inches in Diameter: 22 gauge.
 - b. Ducts 37 to 50 Inches in Diameter: 20 gauge.
 - c. Ducts 52 to 60 Inches in Diameter: 18 gauge.
 - d. Ducts 62 to 84 Inches in Diameter: 16 gauge.
 3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
 - a. Ducts 3 to 26 Inches in Diameter: 22 gauge.
 - b. Ducts 27 to 50 Inches in Diameter: 20 gauge.
 - c. Ducts 52 to 60 Inches in Diameter: 18 gauge.
 - d. Ducts 62 to 84 Inches in Diameter: 16 gauge.
 4. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
 5. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
 6. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
 7. Round Elbows Larger than 14 Inches in Diameter: Fabricate gored elbows unless space restrictions require mitered elbows.
 8. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures: 20 gauge with 2-piece welded construction.
 9. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
 10. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 26 gauge.
- F. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:
1. Round Elbows 4 to 8 Inches in Diameter: Two piece, die stamped, with longitudinal seams spot welded, bonded, and painted with PVC aerosol spray.
 2. Round Elbows 9 to 26 Inches in Diameter: Standing-seam construction.
 3. Round Elbows 28 to 60 Inches in Diameter: Standard gored construction, riveted and bonded.
 4. Other Fittings: Riveted and bonded joints.
 5. Couplings: Slip-joint construction with a minimum 2-inch insertion length.

2.7 FIRESTOPPING

- A. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials and installation methods.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Supply Ducts Connected to Furnaces and Constant Volume Air Handling Units: 2-inch wg.
 2. Supply Ducts Connected to VAV Air Handling Units (before Air Terminal Units): 4-inch wg.
 3. Supply Ducts Connected to VAV Air Handling Units (after Air Terminal Units): 2-inch wg.
 4. Return Ducts (Negative Pressure): 2-inch wg.
 5. Exhaust Ducts (Negative Pressure): 2-inch wg.
- B. All ducts shall be galvanized steel except as follows:
1. Commercial Range Hood Exhaust Ducts: Comply with NFPA 96.
 - a. Concealed: Carbon-steel sheet.
 - b. Exposed: Type 304, stainless steel with finish to match kitchen equipment and range hood.
 - c. Weld and flange seams and joints.
 2. Dishwasher Hood Exhaust Ducts:
 - a. Type 304, stainless steel with finish to match kitchen equipment and range hood.
 - Weld and flange seams and joints.
 3. Underground Ducts: Concrete-encased PVC-coated galvanized steel with thicker coating on duct exterior.

3.2 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Duct dimensions indicated on the drawings are internal sizes after the duct insulation has been applied. Increase the duct dimensions as required to keep the internal dimensions equal to those indicated on the drawings.
- C. Install round ducts in lengths not less than 12 feet unless interrupted by fittings.
- D. Install ducts with fewest possible joints.
- E. Install fabricated fittings for changes in directions, size, and shape and for connections.
- F. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- G. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- J. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- K. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- L. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- M. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- N. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- O. Fire-Rated Partition Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at duct penetrations. Provide firestop materials and seal duct penetrations. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials and installation methods. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories".
- P. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

- 3.3 PVC-COATED DUCT, SPECIAL INSTALLATION REQUIREMENTS
- A. Repair damage to PVC coating with manufacturer's recommended materials.
- 3.4 UNDERSLAB DUCTS, SPECIAL INSTALLATION REQUIREMENTS
- A. Verify undamaged condition of ducts before enclosure with fill or encasement.
 - B. Protect ducts from damage by equipment used in placing fill materials and concrete on or around ducts.
 - C. Protect duct openings from damage and prevent entrance of foreign materials.
- 3.5 RANGE HOOD EXHAUST DUCTS, SPECIAL INSTALLATION REQUIREMENTS
- A. Install ducts to allow for thermal expansion through 2000 deg F temperature range.
 - B. Install ducts without dips or traps that may collect residues unless traps have continuous or automatic residue removal.
 - C. Install access openings at each change in direction and at intervals defined by NFPA 96; locate on sides of duct a minimum of 1-1/2 inches from bottom; and fit with grease-tight covers of same material as duct.
 - D. Do not penetrate fire-rated assemblies except as permitted by applicable building codes.
- 3.6 SEAM AND JOINT SEALING
- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.
 - 1. For pressure classes lower than 2-inch wg, seal transverse joints.
 - B. Seal ducts before external insulation is applied.
- 3.7 HANGING AND SUPPORTING
- A. Hanging devices shall be of the same material and construction as the ductwork being supported.
 - B. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
 - C. Support vertical ducts at maximum intervals of 16 feet and at each floor.
 - D. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
 - E. Install concrete inserts before placing concrete.
 - F. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- 3.8 CONNECTIONS
- A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."
 - B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.
- 3.9 FIELD QUALITY CONTROL
- A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
 - 1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
 - 3. Determine leakage from entire system or section of system by relating leakage to surface area of test section.
 - a. Allowable Leakage, Supply Duct Systems: 3 percent of design airflow.

- b. Allowable Leakage, Return Duct Systems: 4 percent of design airflow.
 - c. Allowable Leakage, Exhaust Supply Duct Systems: 4 percent of design airflow.
 - d. Allowable Leakage, Supply Duct Systems, Terminals to Air Outlets: 3 percent of design airflow.
4. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg.
 5. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.10 CLEANING NEW SYSTEMS

1. Clean the exterior of exposed ducts of oils and grease or other foreign material to allow painting under **Division 9**.

END OF SECTION 233113

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes ceiling, floor and wall-mounted diffusers, registers, and grilles.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Anemostat Products.
 - 2. Krueger Manufacturing Co.
 - 3. Price Industries.
 - 4. Titus.
- B. General: Refer to Drawings and Schedules. Provide air diffusers of the type, size, shape and capacity; and constructed of materials and with the components and accessories indicated.
- C. Performance: Provide air diffusers with performance characteristics equal to the scheduled products. Performance shall include minimum and maximum CFM, static pressure drop, velocity profiles, air throw and drop, and sound performance. Performance shall be compared with the performance of the scheduled product as described in the current manufacturer's product data.
- D. Mounting Compatibility: Provide air diffusers with frame and border styles that are compatible with the surface on which they are installed. Refer to Architectural Drawings and Specifications for ceiling types and applications.
 - 1. Lay-in Ceilings: Provide air diffusers specifically manufactured for the ceiling type indicated with accurate fit and adequate support.
 - 2. Surface-Mounted: Provide air diffusers with a flush perimeter frame and gasket to seal tight against the mounting surface. Provide accurate fit and adequate support.
 - 3. Attachments: Attach to surfaces without the use of visible fasteners.
 - 4. Linear Diffusers: Provide means to join diffuser sections with hairline butt joints without the use of visible fasteners. Provide end terminations on diffusers. Provide blank-off panels as indicated.
- E. Adjustable Air Pattern: Provide air diffusers with field adjustable air pattern devices, capable of changing the air pattern from full horizontal to full vertical down air flow, and for directional air flows as indicated on the Drawings.
- F. Adjustable Air Volume: Provide air diffusers with field adjustable air volume devices, accessible from the face of the diffuser. The air volume device may be omitted where a diffuser is the only outlet downstream of an accessible duct air damper.
- G. Materials and Finishes: Provide air diffusers with the materials and finishes scheduled.
- H. Air Plenums: Provide diffuser air plenums as indicated on the Drawings. Refer to "Air Plenums" Article in this Section.

2.2 REGISTERS AND GRILLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Anemostat Products.
 - 2. Krueger Manufacturing Co.
 - 3. Price Industries.
 - 4. Titus.
 - 5. Tuttle & Bailey.
 - 6. Metal-Aire
- B. General: Refer to Drawings and Schedules. Provide air registers and grilles of the type, size, shape and capacity; and constructed of materials and with the components and accessories indicated.
- C. Performance: Provide registers and grilles with performance characteristics equal to the scheduled products. Performance shall include minimum and maximum CFM, static pressure drop, velocity profiles, air throw and drop, and sound performance. Performance shall be compared with the performance of the scheduled product as described in the current manufacturer's product data.
- D. Mounting Compatibility: Provide registers and grilles with frame and border styles that are compatible with the surface on which they are installed. Refer to Architectural Drawings and Specifications for ceiling types and applications.
 - 1. Lay-in Ceilings: Provide registers and grilles that are compatible with the ceiling type indicated with accurate fit and adequate support.
 - 2. Surface-Mounted: Provide registers and grilles with a flush perimeter frame and gasket to seal tight against the mounting surface. Provide accurate fit and adequate support.
 - 3. Attachments: Attach to surfaces without the use of visible fasteners, if possible. Visible fasteners for registers and grilles, if used, shall be oval head screw fasteners in countersunk holes provided in the device frame. Fasteners shall be the same color and finish as the device and shall be furnished by the device manufacturer.
- E. Adjustable Air Pattern: Provide registers and grilles with field adjustable air pattern devices, capable of changing the air pattern from full horizontal to full vertical down air flow, and for directional air flows as indicated on the Drawings.
- F. Adjustable Air Volume: Provide registers and grilles with field adjustable air volume devices, accessible from the face of the register or grille. The air volume device may be omitted where the register is the only outlet downstream of an accessible duct air damper.
- G. Air Plenums: Provide register and grille air plenums as indicated on the Drawings. Refer to "Air Plenums" Article in this Section.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb. Install diffusers, registers, and grilles in perfect alignment with ceiling lines.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final

locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 235400 - FURNACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 1. Gas-fired, condensing furnaces and accessories complete with controls.
 2. Air filters.
 3. Refrigeration components.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each of the following:
 1. Furnace.
 2. Thermostat.
 3. Air filter.
 4. Refrigeration components.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each furnace to include in emergency, operation, and maintenance manuals for each of the following:
 1. Furnace and accessories complete with controls.
 2. Air filter.
 3. Ultraviolet germicidal light.
 4. Humidifier.
 5. Refrigeration components.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Disposable Air Filters: Furnish two complete sets.
 2. Fan Belts: Furnish one set(s) for each furnace fan.
 3. Disposable Humidifier Media: Furnish one set(s).

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

- D. Comply with NFPA 70.
- 1.8 COORDINATION
- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
 - B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."
- 1.9 WARRANTY
- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:
 - 1. Warranty Period, Commencing on Date of Substantial Completion:
 - a. Furnace Heat Exchanger: 10 years.
 - b. Integrated Ignition and Blower Control Circuit Board: Five years.
 - c. Draft-Inducer Motor: Five years.
 - d. Refrigeration Compressors: Five years.
 - e. Evaporator and Condenser Coils: Five years.

PART 2 - PRODUCTS

- 2.1 GAS-FIRED FURNACES, CONDENSING
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - B. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Carrier Corporation; Div. of United Technologies Corp.
 - 2. Lennox Industries Inc.
 - 3. Rheem Manufacturing Company; Air Conditioning Division.
 - 4. Ruud Air Conditioning Division.
 - 5. Trane.
 - 6. York International Corp.; a division of Unitary Products Group.
 - C. General Requirements for Gas-Fired, Condensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3, "Gas-Fired Central Furnaces," and with NFPA 54.
 - D. Cabinet: Steel.
 - 1. Cabinet interior around heat exchanger shall be factory-installed insulation.
 - 2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
 - 3. Factory paint external cabinets in manufacturer's standard color.
 - 4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 - E. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.
 - 1. Fan Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 2. Special Motor Features: Variable speed with internal thermal protection and permanent lubrication controlled by integrated furnace/blower control.
 - F. Type of Gas: Natural.
 - G. Heat Exchanger:
 - 1. Primary: Aluminized steel.
 - 2. Secondary: Stainless steel.
 - H. Burner:
 - 1. Gas Valve: 100 percent safety two-stage main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
 - 2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.

- I. Gas-Burner Safety Controls:
 - 1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
 - 2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
 - 3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.
- J. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.
- K. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; terminals for connection to accessories; diagnostic light with viewport.
- L. Accessories:
 - 1. Combination Combustion-Air Intake and Vent: PVC plastic fitting to combine combustion-air inlet and vent through roof.
 - 2. CPVC Plastic Vent Materials.
 - a. CPVC Plastic Pipe: Schedule 40, complying with ASTM F 441/F 441M.
 - b. CPVC Plastic Fittings: Schedule 40, complying with ASTM F 438, socket type.
 - c. CPVC Solvent Cement: ASTM F 493.
 - 1) CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2) Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3) Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 THERMOSTATS AND HUMIDISTATS

- A. Controls shall comply with requirements in ASHRAE/IESNA 90.1, "Controls."
- B. Solid-State, Combination Thermostat: Wall-mounting, programmable, microprocessor-based unit with automatic switching from heating to cooling, preferential rate control, seven-day programmability with minimum of four temperature presets per day, and battery backup protection against power failure for program settings.
- C. Control Wiring: Unshielded twisted-pair cabling.
 - 1. No. 24 AWG, 100 ohm, four pair.

2.3 AIR FILTERS

- A. Disposable Filters: 1-inch- (25-mm-) thick fiberglass media with ASHRAE 52.2 MERV rating of 6 or higher, in sheet metal frame.

2.4 REFRIGERATION COMPONENTS

- A. General Refrigeration Component Requirements:
 - 1. Refrigeration compressor, coils, and specialties shall be designed to operate with CFC-free refrigerants.
 - 2. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."
- B. Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with ARI 210/240, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment." Match size with furnace. Include condensate drain pan with accessible drain outlet complying with ASHRAE 62.1.

1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.
- C. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, sealed, and with suction line insulated. Provide in standard lengths for installation without joints, except at equipment connections.
 1. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I, 1 inch (25 mm) thick.
- D. Refrigerant Piping: Comply with requirements in Section 232300 "Refrigerant Piping."
- E. Air-Cooled, Compressor-Condenser Unit:
 1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
 2. Compressor: Hermetically sealed scroll type.
 - a. Crankcase heater.
 - b. Vibration isolation mounts for compressor.
 - c. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - d. Two-speed compressor motors shall have manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - e. Refrigerant: R-407C or R-410A.
 3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
 4. Heat-Pump Components: Reversing valve and low-temperature air cut-off thermostat.
 5. Fan: Aluminum-propeller type, directly connected to motor.
 6. Motor: Permanently lubricated, with integral thermal-overload protection.
 7. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
 8. Mounting Base: Polyethylene.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for gas piping systems to verify actual locations of piping connections before equipment installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.
- B. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
- C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.
 1. Anchor furnace to substrate to resist code-required seismic acceleration.
- D. Controls: Install thermostats and humidistats at mounting height of 60 inches (1500 mm) above floor.
- E. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

- F. Install ground-mounted, compressor-condenser components on 4-inch- (100-mm-) thick, reinforced concrete base; 4 inches (100 mm) larger on each side than unit. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

3.3 CONNECTIONS

- A. Gas piping installation requirements are specified in Section 231123 "Facility Natural-Gas Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Vent and Outside-Air Connection, Condensing, Gas-Fired Furnaces: Connect plastic piping vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt.
 - 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - 3. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - c. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - d. Requirements for Low-Emitting Materials:
 - 1) CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2) PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3) Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 4) Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 - 4. Slope pipe vent back to furnace or to outside terminal.
- D. Connect ducts to furnace with flexible connector. Comply with requirements in Section 233300 "Air Duct Accessories."
- E. Connect refrigerant tubing kits to refrigerant coil in furnace and to air-cooled, compressor-condenser unit.
 - 1. Flared Joints: Use ASME B16.26 fitting and flared ends, following procedures in CDA's "Copper Tube Handbook."
 - 2. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
 - 3. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Comply with requirements in Section 232300 "Refrigerant Piping" for installation and joint construction of refrigerant piping.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:

1. Perform electrical test and visual and mechanical inspection.
 2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
 4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
- 3.5 STARTUP SERVICE
- A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 1. Inspect for physical damage to unit casings.
 2. Verify that access doors move freely and are weathertight.
 3. Clean units and inspect for construction debris.
 4. Verify that all bolts and screws are tight.
 5. Adjust vibration isolation and flexible connections.
 6. Verify that controls are connected and operational.
 - B. Adjust fan belts to proper alignment and tension.
 - C. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.
 - D. Measure and record airflows.
 - E. Verify proper operation of capacity control device.
 - F. After startup and performance test, lubricate bearings.
- 3.6 ADJUSTING
- A. Adjust initial temperature and humidity set points.
 - B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.
- 3.7 CLEANING
- A. After completing installation, clean furnaces internally according to manufacturer's written instructions.
 - B. Install new filters in each furnace within 14 days after Substantial Completion.
- 3.8 DEMONSTRATION
- A. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 235400

SECTION 260000 - ELECTRICAL SPECIFICATIONS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplemental Conditions and Division 1 section, apply to this section.

1.2 DRAWINGS AND MEASUREMENTS

- A. The drawings are not intended to be scaled for roughing-in measurements or to serve as shop drawings. The Contractor shall consult the architectural, structural, mechanical, or equipment drawings for dimensions, obstructions and location of equipment of other trades.
- B. Outlet devices, switches, panels, cabinets, fixtures and special equipment are shown on the drawings only in a schematic manner and not necessarily in their specific location. The Contractor shall be responsible for exact locations of the outlets to form a functional and aesthetic installation either by careful review of all architectural elevations, tile patterns, surface finishes, and equipment arrangements or by consultation with the Engineers and/or other trades involved.

1.3 ORDINANCES AND CODES

- A. All work shall be executed in accordance with the current edition of the City Electrical Ordinances, State Electrical Laws and Statutes and National Electrical Code (NEC) and be subject to the inspection of these departments. All fees, permits, licenses, etc., necessary in order to complete the work of this section shall be paid by this Contractor.

1.4 WORKMANSHIP

- A. The installation work included in this specification shall be performed in a neat workmanlike manner by persons experienced and skilled in the Electrical trade. Only the best quality workmanship will be accepted. All exposed parts of the electrical wiring systems such as exposed conduits, flush plates, cabinet trim, fixtures, etc., shall be square and true with the building construction.

1.5 GUARANTEE

- A. This Contractor shall assume responsibility for any defects which may develop in any part of his work caused by faulty workmanship, material or equipment, and agrees to replace, repair, or alter, at his expense, any such faulty workmanship, material or equipment that has been brought to his attention during a period of one year from the date of substantial completion. Acceptance of the work shall not waive this guarantee.

1.6 QUALITY ASSURANCE

- A. All materials and equipment shall be new and of best quality, of the type best suited for the purpose intended. All electrical materials used in this work shall be listed by the Underwriter's Laboratories, Inc., where testing is provided and shall bear their label.

1.7 SHOP DRAWINGS

- A. Shop drawing submittals shall be furnished in accordance with the requirements in Division 1, each labeled with the proper name of the project, equipment, or material descriptive names and manufacturer's name and address. Drawings shall indicate catalog number, dimension, voltage and current characteristics, wire sizes, construction rough-in data of all materials to be used. Shop drawings shall be submitted for all major pieces of equipment.
- B. Shop drawings are required on the items listed below:
 - 1. Panelboards
 - 2. Wiring Devices
 - 3. Lighting Fixtures

1.8 EQUIPMENT IDENTIFICATION

- A. All electrical equipment shall be provided with identification indicating its use or function. Equipment to be identified shall include panelboards. Identification shall be by means of a permanently attached, engraved, plastic laminated label. Junction boxes and empty conduits provided for future use shall also be identified by handwritten permanent marker on the conduits and on the junction box cover.
- B. Available Fault Current Warning: "WARNING – ARC FLASH AND SHOCK HAZARD – APPROPRIATE PPE REQUIRED – AVAILABLE FAULT CURRENT: (Value calculated by Contractor) – INSTALLATION DATE: (Date)."

1.9 CLEANUP

- A. All electrical equipment must be kept completely protected from weather elements, painting, etc., until the building is substantially completed. Damage from rust, paint, scratches, etc., shall be corrected as directed by the A/E.

1.10 CUTTING AND PATCHING

- A. In existing construction this Contractor shall perform all cutting required and all necessary patching after completion to restore the surface to its original condition, unless otherwise indicated. Should any cutting of walls, floors, ceilings, partitions, etc., be made necessary on account of this Contractor's failure to coordinate with other trades, such cutting shall be done at his own expense, restoring the work to its original condition. This Contractor shall not endanger the stability of the structure by cutting, digging or otherwise, and shall not any anytime cut or alter work of any other Contractor.

1.11 ELECTRICAL SERVICE ENTRANCE

- A. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- B. This Contractor shall make contact with the Power Company to obtain from them any and all charges for the electrical service installation, and shall include these charges in his bid, and pay the utility.

1.12 GROUNDING

- A. Ground all electrical systems and equipment per NEC and by special requirements as described in this section and other sections. Provide insulated equipment grounding conductor in all raceways (feeders and branch circuits).

1.13 ELECTRICAL EQUIPMENT MOUNTING

- A. Wherever electrical panelboards, etc., are indicated mounted on wall surfaces, this Contractor shall first install a 3/4" Type BD plywood panel of sufficient size for mounting all equipment. Plywood panels shall be cleanly cut, without burrs or splinters, square, and painted two coats of gray fire retardant preservative on both sides.
- B. Plywood shall be anchored to walls by means of toggle or expansion anchors. Equipment shall be attached to plywood by means of wood screws.

1.14 MOTOR AND EQUIPMENT WIRING

- A. The Electrical Contractor shall furnish and install all motor starters except in package or prewired units as shown on drawings. All motors will be furnished and installed by Mechanical Contractor, but shall be connected by the Electrical Contractor. Single phase fractional horsepower motors shall have manual thermal element starters. It shall be the Electrical Contractor's responsibility to see that all motors have the proper thermal overload protection.

1.15 NOT USED

1.16 TRENCHING

- A. This Contractor shall perform all excavation to the depths required. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from trench to prevent slides or cave ins. All excavated materials not required or usable for backfilling shall be removed from site. Backfilling shall be done to finished grades and restore the surface to its original condition. Prior to any excavation, determine whether underground installations will be encountered. Contact the appropriate Entity.

1.17 CONNECTIONS TO EQUIPMENT

- A. Special equipment is hereby defined as all equipment that is not specified under this contract, but requires connections by this Contractor, as indicated on the Drawings. Such connections shall be performed by this Contractor. This Contractor shall verify the locations of such connections by securing the equipment supplier's templates, detail drawings, and roughing in

measurements. Unless otherwise specified, the Contractor responsible for furnishing such equipment is also responsible for setting the equipment in place.

PART 2 – PRODUCTS

2.1 RACEWAYS AND FITTINGS

- A. Rigid Metal Conduit (RMC): Heavy wall conduit shall be hot-dip galvanized alloy steel with the U.L. label. Heavy wall, galvanized steel conduit shall be used in all runs where required for mechanical protection.
- B. Electrical Metallic Tubing (EMT): EMT may be used in furred ceiling areas and interior partitions, surface mounted in equipment rooms and in concrete slabs above grade when installed with approved wrench tight, ring compression, watertight steel fittings. Steel set screw fittings may be used in dry locations. EMT shall not be used in slab on grade or where exposed to moisture or earth. Indenter fitting shall not be used.
- C. Flexible Metal Conduit: Flexible metal conduit shall be used for connections to motors, fixed appliances, and recessed luminaires where required. In areas of high moisture content, liquid-tight conduit with liquid-tight fittings shall be used.
- D. Rigid Non-Metallic Conduit: PVC conduit shall be used only where allowed by code and shall be Schedule 40 rigid conduit, UL listed for use above ground, underground direct burial, and concrete encased. Connections shall be made by solvent welding. Provide expansion joints where crossing expansion joints or where wide temperature differential exists. Heavy wall, galvanized steel conduit shall be used for all elbows which penetrate concrete floor slabs or finish grade. This elbow shall extend above floor or finish grade.
- E. Fittings: On all conduit systems the connector fitting shall be of the insulated throat type. Where rigid conduit is connected to a threadless box, double locknut method shall be used. All conduit fittings shall be of steel construction. Malleable iron and die-cast aluminum fittings shall not be used on any conduits.
- F. General Installation: Conduits shall be sized as noted or as required by NEC for number and size of conductors installed except that 3/4 inch shall be minimum size for branch circuit home runs. All conduit and raceways shall be securely positioned by galvanized steel straps, clamps, and hangers with suitable fastenings. Galvanized tie wires are not considered an acceptable support. Caddy fasteners as manufactured by Erico Products are acceptable support devices where applied according to manufacturer's recommendations. Exposed conduits shall be run parallel to and at right angles to building lines and neatly grouped and supported with approved conduit hangers or channel supports. All conduit runs shall be fastened within 3 feet of any bend or offset. Conduits embedded in or below slabs shall be RMC or RNC with PVC-coated RMC elbows. Change from RNC to RMC with PVC-coated RMC elbows before rising above the floor.

2.2 BOXES:

- A. Outlet boxes shall be at least 1-1/2 inches deep, or gang style type of size to accommodate devices noted. Outlet boxes on exposed conduit runs in unfinished areas and equipment rooms shall be 4 inch square. Exterior outlet boxes shall be cast aluminum type with cast-aluminum weatherproof cover. All outlet boxes shall be concealed except where shown or noted otherwise. This Contractor shall verify type and depth of finished surface so that outlet will be flush.

2.3 WIRE AND CABLE:

- A. All wire and cable for feeder and branch circuits shall conform to the requirements of the current edition of the NEC and shall meet all relevant ASTM specifications. Conductors shall be 600 volt rated, coated copper and unless otherwise noted, shall have type THWN or THHN insulation. Minimum conductor size shall be No. 12 AWG, unless otherwise noted. All conductors No. 10 and smaller shall be solid. Conductors larger than No. 10 AWG shall be stranded. Splices shall be made with solderless-tapeless, mechanical wire connectors with spring action to maintain constant pressure on the conductors. All connections shall guarantee a good electrical and mechanical connection with conductor to conductor contact. No intermediary current path (material between conductors) is allowed. Connections shall be made using twist-on type connectors such as IDEAL INDUSTRIES connector brands WIRE-NUT®, WING NUT®, OR TWISTER®. Quick connect “stab-in” connectors will not be allowed.
- B. All multi-wire branch circuits shall use dedicated neutrals for each phase circuit. Do not use combined neutral conductors.

2.4 PANELBOARDS:

- A. Shall be rated for voltage and phase as noted on drawings, dead front construction. Circuit breakers shall be bolt on thermal magnetic type, quick-make, quick-break, A.C. rated with a trip indication different from the on or off position. Bus bars shall be hard-drawn copper, 98% conductivity. Panels shall be service entrance rated as required. Panels shall be similar to Square D, Type NQOD, or equal by General Electric, Siemens, or Cutler Hammer.
- B. Calculations of maximum available fault current: Calculate the maximum available short-circuit current in amperes rms symmetrical at service equipment of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit. Coordinate available fault current from the serving Utility, transformer impedance, installed conductor length, etc for actual values. Label per Equipment Identification.

2.5 SAFETY SWITCHES:

- A. Shall be heavy duty 600 or 250 volt as required, quick make, quick break operation, horsepower rated, non-fused unless noted fused, and of the size shown on the drawings or as required by code, with appropriate NEMA rating. Safety switches shall be of the same manufacturer as panelboards and where shown as weatherproof shall have a NEMA 3R enclosure.

2.6 FUSES:

- A. All motors shall be protected by dual-element fuses able to carry 500% of rating for a minimum of 10 seconds, and sized at 125% of the actual name plate ampere rating. Fuses shall be Bussman-Fusetron, FRN (250V), FRS (600V), or approved equal.

2.7 WIRING DEVICES:

- A. Duplex receptacles shall be specification grade, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Receptacles shall be equal to Hubbell HBL5362. Tamper resistant receptacles shall be equivalent to Hubbell HBL8300SGA.
- B. Each switch outlet shall be equipped with a toggle switch, 20 amp capacity, 120/277 volt, A.C. rated, quiet type. Switches shall be equal to Hubbell HBL1221L Series.

- C. Ground fault interrupter receptacles shall be 20 AMPS, 120 volt, A.C., 4-6 milliampere trip, straight blade, feed-through type and equal to Hubbell No. GF5362A. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped. Weatherproof plates shall be wet-location, weatherproof cover plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with “while-in-use”, gasketed, lockable cover. Covers shall be Hubbell #WP26M series, or equivalent.
- D. Device color shall be gray.
- E. All outlet plates in finished areas shall be stainless steel 302 style with openings for devices intended. Plates in unfinished areas or on surface outlets may be cadmium plated steel.

2.8 MOTOR CONTROL DEVICES:

- A. All starters for single-phase motors not requiring overload protection shall be Sierra Series No. 5011. All starters requiring overload protection shall be Square D, Class 2510, or approved equal, NEMA I, or flush mounted with stainless steel plate, in all finished spaces.

2.9 LIGHTING FIXTURES:

- A. Fluorescent fixtures shall be rigidly supported with metal bar hangers secured to structural members. Special mounting requirements shall be as noted.

2.10 BALLASTS:

- A. Fluorescent ballasts shall be programmed-rapid start, electronic, energy-saving type compatible with energy-saving lamps. Ballasts shall be General Electric GEX32-MVPS-N or equivalent by Philips-Advance, or Osram-Sylvania.
 - 1. Minimum Power Factor: 90 percent. Ballast factor: 0.85-0.90. Max THD: 10%.
 - 2. Third harmonic content of ballast input current shall be less than 33 percent.
 - 3. Input Watts:
 - a. 33 or less watts when operating one F32T8 lamp
 - b. 62 or less watts when operating two F32T8 lamps
 - c. 95 or less watts when operating three F32T8 lamps
 - d. 114 or less watts when operating four F32T8 lamps
 - 4. Parallel lamp circuits.

2.11 LAMPS:

- A. Fluorescent lamps shall be high efficiency, energy saving T8, similar to General Electric Ecolux series, 2950 initial lumens (4-foot), 86 CRI, and 4000K, or equivalent by Osram-Sylvania or Philips.

END OF SECTION 260000

- B. Before the bid opening, interested parties may request approval of substitute materials. Such requests shall be made in writing and be delivered to the Engineer no later than 6 working days before receipt of bids. All substitutions approved will be listed in an Addendum.
- C. After the award of the contract, requests for value engineering substitutions may be made in writing by the Contractor (not material supplier or subcontractor) through the shop drawing submittal. Such requests shall be accompanied by a transmittal that states the name of the product specified, the name of the product proposed, complete shop drawings on the product proposed for substitution, the reason for requesting the substitution, and the deduct in contract amount resulting from the substitution. Any changes required of other trades as a result of use of the substitution material or equipment shall be stated in the written request for substitution. Costs of these changes shall be included in deduct in contract amount requested above.
 - 1. No such substitution shall be made until an appropriate contract modification document has been issued and approved.
 - 2. The cost of any changes of other trades as a result of use of the substitution material or equipment shall be borne by the Contractor submitting such material or equipment.

1.4 LIST OF MATERIALS/SUPPLIERS/MANUFACTURERS

- A. Comply with Material/Supplier/Manufacturer Listing requirements.

1.5 SHOP DRAWINGS

- A. Comply with Shop Drawings requirements for all major equipment where required in each specification article.
- B. Shop Drawings must first be checked by the Contractor for space conformance and for performance characteristics established by Plans and/or Specifications, and so stamped or stated on the transmittal sheet. Contractor's stamp or statement shall include name and address of Contractor, specification paragraph, and the following statement: "Item(s) has (have) been checked for compliance with specification requirements and space limitations and will meet these conditions; checked by; Date."
- C. Shop Drawings not stamped as specified will be returned to the Contractor without action.
- D. Contractor must submit a minimum of 6 sets of complete drawings to Engineer.
 - 1. 2 - Architect's and Engineer's record.
 - 2. 2 - Contractor to include in maintenance and operating instruction for Owner.
 - 3. 1 - Contractor's job site file.
 - 4. 1 - Contractor's use (Contractors shall determine if additional copies are required for their use.)
- E. Shop drawings are required even if the Contractor plans to use the same equipment by the same manufacturer as specified on the drawings.

1.6 Project Record Documents

- A. Maintain at the job site one complete set of all Contract Documents, Change Orders, and Shop Drawings. Mark up the documents to show all modifications that occur during the course of construction. Locations of concealed utilities shall be carefully noted. Turn this set of documents over to the A/E project coordinator at completion of project.

1.7 ORDINANCES, PERMITS, AND CODES

- A. All work shall be executed in accordance with the local, state, and other attending rules and regulations applicable to the trade affected and be subject to the inspection of these departments.
- B. Obtain all permits and licenses required for work performed under Division 22 and pay all fees in connection with same.
- C. Where work required by the drawings and specification is above the standard required by local regulations, it shall be done as shown and/or specified.
- D. All equipment, final assemblies, electrical materials, etc., associated with Division 22, used under this contract, shall be listed by Underwriters Laboratories, Inc., or approved testing laboratory, and shall bear their label. All work shall be in accordance with the latest edition of the National Electrical Code.

1.8 OPERATION AND MAINTENANCE MANUALS

- A. Comply with Operation and Maintenance Manuals requirements.
- B. Prepare two portfolios, each with a complete set of copies of shop drawings used in the erection of mechanical system, testing, cleaning, and maintenance instructions, list of materials for maintenance, parts list, wiring diagrams, and name and address of authorized service organization.
- C. Information shall be folded, if necessary, and bound in 8 1/2" x 11" hard cover, indexed, loose-leaf, three-ring binder. Multiple binders shall be used if required to contain material. All material shall be properly identified with job name, date, name and address of Contractor, Architect, and Engineer.
- D. The index of the manual shall be in sequential order of the mechanical specification sections. Combining sections shall not be permitted.
- E. Portfolio shall be submitted to the engineer for review of material and completeness before the final observation, and when approved by Engineer, portfolio will be turned over to the Owner at the time of final observation.

1.9 OWNER INSTRUCTION

- A. Contractor shall instruct Owner's personnel in the operation and maintenance procedures of all equipment and systems.

- B. Contractor shall arrange in writing with the Owner, before the final observation, a date to instruct the Owner and/or his designated representative in the operation of all systems. Provide Architect and Engineer with copies of correspondence.
- C. The Owner shall respond in writing if date is acceptable and provide a list of those who are to attend. Contractor shall provide, at the time of final observation, written verification that the Owner has been instructed to his satisfaction.

1.10 PROTECTIVE DEVICES

- A. All sheaves, belts, gears, couplings, and moving parts shall be protected by OSHA approved permanent guards, casings, or railings.
- B. Double inlet fan guards must be faced with expanded mesh for minimum restriction.
- C. Pressure or temperature or combination P & T relief valves, serving boilers, water heaters, etc., shall have their discharge piped full size within 6 inches of floor or drain, securely anchored at top elbow. Boilers shall also have discharge pipe securely anchored at base.
 - 1. Verify with local code enforcement officials the discharge point of boiler relief before installation.

1.11 PROTECTIVE COVERING FOR EQUIPMENT

- A. Provide covering and shielding for all equipment provided under Division 22, existing equipment in proximity to construction, and equipment furnished by Owner for installation under Division 22 to protect from mortar, paint, debris, etc., during construction. A polyethylene covering tied securely around the equipment will be acceptable for this purpose.

1.12 CLEANING AND PAINTING

- A. Clear away all debris, surplus materials, etc., resulting from Mechanical Contractor's work or operations, leaving the job and equipment in a clean condition. All existing areas in which work is performed shall be cleaned periodically and restored to their original condition upon completion of the project.
- B. All surfaces of all coils, fans, air units, air filters, etc., shall be wiped clean or washed if required. All plumbing fixtures shall be thoroughly cleaned of all foreign matter, including stickers. Clean all items furnished, such as floor drains, pumps, motors, condensers, traps, etc., leaving the entire installation in a first-class condition.
- C. Equipment and material provided under Division 22 will be painted by others except where specified otherwise. However, any mechanical equipment that has sustained damage to the manufacturer's prime and finish coats of paint shall be restored, by this Contractor, to the original condition and appearance before application of finish paint.
 - 1. Restore damaged galvanized piping, tank, housing, etc., with ZRC cold galvanizing compound manufactured by ZRC Chemical, Quincy, Massachusetts.

1.13 Substantial Completion Observation

- A. Upon completion of all work, the Contractor shall submit for approval the following data as applicable.
 - 1. Balance reports.
 - 2. Maintenance Manuals.
 - 3. Boiler startup certification.
 - 4. Temperature control system startup and checkout certification.
 - 5. Sprinkler test and acceptance certification.
 - 6. Certifications of any Contractor-provided equipment.
 - 7. Certified chemical analysis of the hydronic system glycol solution.
 - B. After receiving approval of the above, the Contractor shall contact the Owner and/or Engineer and make arrangements for a final observation. See AIA Document A201, Article 9.7, regarding list of items remaining to be completed.
 - C. At the time of final observation, the Contractor shall present the following as applicable.
 - 1. List of items requiring completion or correction.
 - 2. Confirmation of Owner instruction.
 - 3. Sill cock, plumbing fixture keys, and fire department box keys.
 - 4. Special tools required for cabinet unit heaters, thermostats, etc.
 - 5. Extra sets of pump seals.
 - 6. Provide extra sets of air filters.
 - D. After the final observation is made, the Contractor shall review the list of items requiring adjustment, correction, replacement, or completion, with Owner and Engineer/Architect. An additional list may be issued.
 - E. The Contractor shall comply with all the listed requirements within 30 days of final observation.
 - F. Before release of final payment, Contractor shall provide fully executed copies of AIA Documents G706 and G707.
- 1.14 TEMPORARY HEATING OF BUILDING
- A. Temporary heating of the building during construction will be provided as specified in the General Conditions and Supplemental General Conditions of this Specification.
- 1.15 COST BREAKDOWN
- A. Comply with **Section 01300** Schedule of Values requirements. This Contractor shall submit to the A/E an itemized cost breakdown of the various portions of the work, including separation of labor and materials provided under Division 22, for each item, within 5 working days of notification of proposal acceptance. The breakdown shall be divided so as to facilitate the Engineer's analysis of the various costs for the purpose of approval of the payment requests unless requested otherwise by the Owner. The following are recommended categories for the cost breakdown.
 - 1. Special Mechanical Conditions
 - 2. Insulation
 - 3. Plumbing Fixtures and Equipment
 - 4. Plumbing Piping
 - 5. Heating Equipment

6. Heating Piping
7. Ventilation Equipment
8. Ventilation - Air Distribution

B. Contractor shall use AIA Form G703.

1.16 SITE OBSERVATIONS

- A. Periodic job site observations will be made throughout the construction to review applications for payment, observe methods and materials of construction, and review requirements of the Contract Documents.
- B. Contractor shall notify the A/E and arrange for observation of installation before backfill or concealing of systems listed herein, or as agreed upon by Contractor, Architect/Engineer, and City Officials/Inspectors. These systems shall include the following:
 1. Outside Utilities (Natural Gas, Drain, etc.)
 2. Waste, Vent, Storm, or Water Piping
 3. Ductwork (Supply, Return or Exhaust)
- C. Arrangements for observation shall be made in advance of the scheduled date of backfill or concealment to allow a site visit to be scheduled. Contractor shall, to the maximum extent practicable, schedule work to allow the observation of systems listed in groups instead of individual items.

1.17 DEFINITIONS OF TERMS USED IN DIVISION 22 SPECIFICATIONS

- A. Provide. Under this contract, Contractor shall furnish and install item or items specified. Contractor shall perform all labor and furnish all materials and equipment necessary so that specified item or system will be complete and operational in every respect.
- B. Furnish. Under this contract, Contractor shall deliver to the site item(s) specified, as well as additional specialized materials and/or accessories necessary for the use and operation of item or items specified.
- C. Install. Under this contract, Contractor shall set in position, connect (including sub-assemblies furnished), and adjust for use. Contractor shall furnish miscellaneous specialty items such as hangers, valves, unions, piping, sheet metal, etc., as obviously necessary for a complete and operating installation.
- D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- E. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- F. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- G. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

- H. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

END OF SECTION 220110

THIS PAGE INTENTIONALLY LEFT BLANK