Forrest City
New City Hall
Forrest City, Arkansas
Volume 2

Prepared for:

CITY OF FORREST CITY
FORREST CITY, ARKANSAS

May, 2018

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SECTION 220100 BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED WORK

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and all other Division 22 and 23 Sections.

1.2 SUMMARY

A. Provide mechanical and plumbing systems indicated on drawings, specified, or reasonably implied, complete. The omission of specific reference to any part of the work necessary for complete systems installation and proper operation shall not be interpreted as relief from providing such parts of the work necessary.

B. Refer to drawings and specifications for Owner-furnished equipment. Provide work indicated and specified to install Owner-furnished items.

1. Provide supplies, stops, and trap for Owner-furnished sinks; verify if faucets, drain, and tailpiece are Owner furnished or shall be furnished and installed by the Contractor.

C. Verify equipment provided under other divisions of the specifications which require mechanical and plumbing connections, and controls.

D. This section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this section to expand the requirements specified in Division 01:

1. Code Requirements, Fees, and Permits
2. Product Substitution Procedures
3. Submittals
4. Drawings
5. Local Conditions
6. Temporary Heat, Cooling and Ventilation
7. Cutting and Patching
8. Rough Ins
9. Quality Assurance
10. Record Documents
11. Operation and Maintenance Manual(s)
12. System Demonstration and Owner’s Instruction

13. Installations
14. Warranties
15. Cleaning

1.3 CODE REQUIREMENTS, FEES, AND PERMITS

A. Provide work in accordance with applicable codes, rules, ordinances, industry standards, utility company regulations, and regulations of local, state and federal governments and other authorities having lawful jurisdiction.

B. Unless otherwise noted, conform to latest editions and supplements of following codes, standards or recommended practices as adopted by the authority having jurisdiction:

1. Arkansas State Plumbing Code
2. Arkansas Mechanical Code
3. International Building Code
4. International Mechanical Code
5. International Plumbing Code
6. AMCA - Air Moving and Conditioning Association
7. ASA - American Standards Association
8. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
9. ASME - American Society of Mechanical Engineers
10. ASTM - American Society of Testing Materials
11. AWWA - American Water Works Association
12. NBS - National Bureau of Standards
13. NEMA - National Electrical Manufacturer's Association NFPA - National Fire Protection Association
14. SMACNA - Sheet Metal and Air Conditioning Contractor's National Association (HVAC Duct Construction Standards)
15. UL - Underwriters' Laboratories, Inc.
16. AGA - American Gas Association Laboratories
17. NSF - National Sanitation Foundation

C. In case of differences between building codes, regulations, laws, local ordinances, industry standards, and utility company regulations, and the Contract Documents, the most stringent governs. Promptly notify Architect in writing of any such difference.

D. Obtain required permits in connection with this work and pay fees in connection therewith. Arrange with the serving utility companies for the connections to utilities and pay charges for same including inspection fees and meters if and when required.

1.4 PRODUCT SUBSTITUTION PROCEDURES

A. Manufacturers of other products than those listed may be considered. Submit substitution request in compliance with Division 01 Sections for "Substitutions & Product Options." All Divisions 22 and 23 substitution requests shall be submitted at least five working days prior to bid. Requests for substitution received by Engineer later than 5 days prior to bid opening may be rejected without review.

1.5 SUBMITTALS

A. The format and quantity of the submittals shall comply with the requirements of Division 1, General Requirements and other Divisions 22 and 23 sections.

B. Refer to individual sections of Divisions 22 and 23 for additional and specific requirements.

C. Product Data:

1. Arrange product data in sets/electronic files with sections corresponding to and in same order as Division 22 and 23 sections.
2. Provide an index of the sections at the front of the submittal listing the section number and the items included in each section.
3. Provide cover sheet for each section, listing each type of material or equipment, designation and model number if any, and the name of the supplier.
4. Clearly indicate sizes, capacities, brand names, motor HP, accessories, options, materials, gages, dimensions, and other pertinent information. Pertinent information shall include items scheduled on the drawings as a minimum. Clearly indicate designations corresponding to drawings and schedules.
5. Provide performance charts and curves, installation instructions, and complete wiring diagrams. Provide pump curves for all pumps indicating operating point and impeller size as a minimum. Provide fan curves for all fans indicating operating point. Provide charts, tables, and data necessary to establish air and water pressure drops for all air and water system components.

D. Submittals failing to meet specified requirements will be returned without review or approval.

1.6 DRAWINGS

A. Drawings show general arrangement of piping, ductwork, and equipment systems. Follow closely as actual building construction and work of other trades will permit.

B. Consider architectural and structural drawings part of this work insofar as these drawings furnish information relating to design and construction of building. These drawings take precedence over mechanical drawings.

C. Due to the small scale of mechanical and plumbing drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves and accessories required to meet the conditions.

D. Record differences between mechanical work as installed and as shown in Contract Documents on a set of Record Documents. Return these prints to Architect at completion of project. Refer to additional information in this section.

E. Do not scale mechanical drawings for dimensions. Accurately lay out work from dimensions indicated on structural and architectural drawings, and as verified in the field.

1.7 LOCAL CONDITIONS

A. Visit site and determine existing local conditions affecting work.

B. No subsequent compensation will be considered for any consequence related to failure to determine site conditions or nature of existing or new construction.

C. Locations and elevations of the various utilities and services included within the scope of this work have been obtained from substantially reliable sources and are offered as a general guide only, without guarantee as to accuracy. Verify the location and elevation of all utilities and their relation to the work.

1.8 CONCRETE BASES

A. Coordinate the size and location of concrete bases with actual equipment provided and the Architectural and Structural Plans.

B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes of the Project.

1. Construct concrete bases of dimensions indicated, but not less than 6 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section, "Cast-in-Place Concrete."

1.9 TEMPORARY HEAT, COOLING AND VENTILATION

A. Comply with requirements of Division 01 Construction Facilities and Temporary Controls.

B. Do not use the permanent heating systems as a temporary source of heat during construction. When the building is substantially complete and only after approval of the Architect may the permanent building systems be utilized.

C. Where advantageous to facilitate installation of finishes and ceiling tile, use of permanent cooling and/or ventilation systems may be permitted, subject to demonstration that construction has progressed to a point where system equipment, ductwork, and controls will not be contaminated with construction material. Use in this case will require written approval of the Architect. Where use is not permitted, provide necessary temporary cooling/dehumidification and/or ventilation at no additional cost to the Owner.

1.10 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, “Structural Welding Code—Steel.”

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, “Welding and Brazing Qualifications.”

1. Comply with provisions in ASME B31 Series, “Code for Pressure Piping.”
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of different electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at the expense of the Contractor. No additional money will be paid due to lack of coordination between the trades. If

minimum energy ratings or efficiencies are specified, the submitted equipment shall comply with the requirements.

1.11 RECORD DOCUMENTS

A. Comply with requirements of Division 01 Section "Administrative Requirements."

B. During the progress of the work, keep an accurate record of all changes and corrections from the Contract Documents. Record of changes shall be kept by accurately making all changes on a set of prints and specifications during the progress of the job.

C. For final submittal, provide reproducible documents.

D. In addition to the requirements of Division 01 Section, "Administrative Requirements,", indicate as a minimum the following:

1. Exact location of underground utility services and their connections to utility mains. Valve locations shall be indicated.
2. Indicate actual inverts of all underground piping.
3. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.
4. Mains and branches of piping systems, with valves and control devices located and numbered, with concealed unions located, and with items requiring maintenance located, including traps, strainers, expansion compensators, and tanks. Provide valve location diagrams, complete with valve tag chart.
5. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
6. Location of access panels.
7. Approved substitutions, contract modifications, and actual equipment and materials installed.
8. Revise mechanical schedules shown on drawings to reflect actual equipment installed. Include actual equipment model numbers.

1.12 OPERATIONS AND MAINTENANCE MANUAL

A. Comply with the requirements of Division 01 Section, "Administrative Requirements."

B. Provide two bound copies of Operations and Maintenance Manual for mechanical systems.

C. Manual shall include tabbed sections for individual systems and equipment with index of sections at the front of the binder. Index shall include name and phone number of nearest supplier and manufacturer's representative.

D. Include the following, as a minimum, in the manual:

1. List of mechanical equipment used indicating name, model, serial number and nameplate data of each item together with number and name associated with each system item.
2. Summary list of mechanical equipment requiring lubrication showing name of equipment, location, and type and frequency of lubrication.
3. Description of equipment and system function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
4. Manufacturer's printed operating procedures to include equipment and system start up, break in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
5. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
6. Provide schematic control diagrams for each system showing location of control devices with correct operating settings marked for each device. Include related electrical devices, including firestats, fuses, interlocks, switches and relays. Provide drawings of each temperature control panel indicating components and their function.
7. Provide copy of valve tag schedule.
8. Provide copies of equipment start-up logs.
9. Provide copy of final Test and Balance report.
10. Provide complete set of approved shop drawings and product data as an appendix to manual.

1.13 SYSTEM DEMONSTRATION AND OWNER'S INSTRUCTIONS

A. Demonstrate to the satisfaction of Owner's representative that mechanical systems and components are operating properly.

B. Utilizing Operation and Maintenance Manual, provide Owner's representative(s) instruction in the operation and maintenance of mechanical systems.

C. Provide minimum of [eight] hours formal instruction balanced as required between classroom type instruction and "hands-on" instruction for each of the following:

1. General mechanical and plumbing systems and equipment.
2. Control system.

D. Provide additional instruction where necessary to fully prepare Owner to operate and maintain mechanical systems and components.

E. Refer to individual Divisions 22 and 23 sections for additional requirements

F. Demonstration and instruction to begin after final Test and Balance report is complete and before final payment.

PART 2 - PRODUCTS - Not Applicable

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 01 Section "Materials and Installation." "CUTTING AND PATCHING." In addition to the requirements specified in Division 01, the following requirements apply

B. Perform cutting, fitting, and patching of electrical equipment and materials required to:

1. Remove existing work not to be reused or reconnected after completion.
2. Uncover Work to provide for installation of ill-timed Work.
3. Remove and replace defective Work.
4. Remove and replace Work not conforming to requirements of the Contract Documents.
5. Remove samples of installed Work as specified for testing.
6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.

C. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.

D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

F. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

1. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers.
2. Patch specified finished surfaces and building components using new materials specified for the original installation and experienced installers.
3. Installers' qualifications refer to the materials and methods required for the surface and building components being patched. Refer to Division 01 Section “Definitions And Standards" for definition of experienced "Installer."

G. Do not endanger or damage installed Work through procedures and processes of cutting and patching.

H. Arrange for repairs required to restore other work, because of damage caused as a result of electrical installations.

I. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

J. Locate, identify, and protect electrical services passing through remodeling or demolition area and serving other areas required to be maintained operational. When transit services must be interrupted, provide temporary services for the affected areas and notify the Owner prior to changeover.

3.2 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to drawings and equipment specifications in Divisions 02 through 23 for rough-in requirements.

3.3 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of plumbing and mechanical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components to allow for plumbing and mechanical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of plumbing and mechanical materials and equipment or efficient flow of the Work. Give particular

attention to large equipment requiring positioning prior to closing in the building.

6. Coordinate the cutting and patching of building components to accommodate the installation of plumbing and mechanical equipment and materials.
7. Where mounting heights are not detailed or dimensioned, install overhead equipment to provide the maximum headroom possible.
8. Coordinate the installation of plumbing and mechanical materials and equipment above ceilings with suspension system, electrical equipment and systems, structural components, and the work of all other trades involved with the project.
9. Coordinate connection of plumbing systems with exterior underground utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service. Do not interrupt electrical or telephone service without Owner's written permission.
10. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
11. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
12. Install plumbing and mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
13. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors" and Division 22 Section "Access to Mechanical Work."
14. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.4 WARRANTIES

A. Refer to the Division 01 Section: Submittals, Materials And Equipment, and Project Closeout for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.

B. Compile and assemble the warranties specified in Division 22 and 23, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item, product, or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

3.5 CLEANING

A. Refer to the Division 01 Section, "Execution & Closeout Procedures": Project Closeout for general requirements for final cleaning.

B. Clean all diffusers prior to final acceptance.

END OF SECTION
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SECTION 220300 ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED WORK

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.

1.2 SUMMARY

A. This section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are specified within the individual equipment specification sections.

C. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

1.3 REFERENCES

A. NEMA Standards MG 1: Motors and Generators.

B. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.

C. NEMA Standard 250: Enclosures for Electrical Equipment.

D. NEMA Standard KS 1: Enclosed Switches.

E. Comply with National Electrical Code (NEC) (NFPA 70).

F. IEEE Standard 112: Tests for Motor Efficiency.

1.4 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.

1.5 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled where standards exist.

PART 2 - PRODUCTS

2.1 MOTORS

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.
   1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
   2. Motor sized shall be large enough so that the driven load will not require the motor to operate in the service factor range.
   3. Two-speed motors shall have two separate windings on poly-phase motors.
   4. Temperature Rating: 40°C environment with maximum 50°C temperature rise for continuous duty at full load (Class A Insulation).
   5. Starting Capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly time spaced starts per hours for manually controlled motors.
   6. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
   7. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
   8. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit specific application.
   9. Bearings:
      a. Ball or roller bearings with inner and outer shaft seals.
      b. Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
      c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
      d. For fractional horsepower, light duty motors, sleeve type bearings are permitted.

   10. Enclosure Type:
      a. Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
      b. Guarded drip-proof motors where exposed to contact by employees or building occupants.
      c. Weather protected Type I for outdoor use, Type II where not housed.

11. Overload Protection: Built-in thermal overload protection and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
12. Noise Rating: "Quiet".
13. Noise Rating: "Quiet" rating for motors located in occupied spaces of building.
14. Efficiency: "Energy Efficient" motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, test method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112, test method B.
15. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

2.2 STARTERS, ELECTRICAL DEVICES, AND WIRING

A. Manual switches shall have:
   1. Pilot lights and extra positions for multi-speed motors.
   2. Overload Protection: Melting alloy type thermal overload relays.

B. Motor Connections: Flexible conduit, except where plug-in electrical cords are specifically indicated.

2.3 DISCONNECT SWITCHES

A. Non-fusible Switches: For equipment two horsepower and smaller, shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment larger than two horsepower, switches shall be the same as fusible type.

PART 3 - EXECUTION - Not Applicable

END OF SECTION
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SECTION 220450 ACCESS TO MECHANICAL WORK

PART 1 - GENERAL

1.1 RELATED WORK

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. This section is a Division 23 Basic Mechanical Materials and Methods section, and is a part of each Division 23 section making reference to access to mechanical work.

C. Section 09 9100; Painting.

D. Section 04 2000; Unit Masonry.

1.2 SUMMARY

A. Extent of access to mechanical work required by this section includes, but is not limited to, providing access panels in ceilings, walls, and floors for dampers, valves, terminal air boxes, filters, and similar equipment which requires periodic adjustment, maintenance, or other access.

B. Where not specifically indicated on the drawing or specified in other sections, but required for access to mechanical work, provide access panels as specified herein.

C. Coordinate locations of access panels with other trades. Obtain approval from Architect for locations of access panels which are not indicated on the drawings.

D. Types of access to mechanical work specified in this section include the following:

1. Access doors in walls, ceilings, and floors.
2. Removable cover plates in walls, ceilings, and floors.

E. Access requirements within mechanical work, to mechanical or electrical components within work, are specified in other Division 23 sections and are not work of this section.

1.3 SUBMITTALS

A. Product Data, Access Units: Submit manufacturer's technical data and installation instructions for each type of access door assembly, including setting drawings,

templates, instructions and directions for installation of anchorage devices. Transmit copy to installer.

B. Source quality-control reports.

C. Field quality-control reports.

D. Operation and Maintenance Manual Data: Submit parts lists for system materials and products. Include this data, product data and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

E. Record Drawings: At project closeout, submit record drawings of installed access assemblies and components, show exact location in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of products for access to mechanical work of sizes, types, ratings, and materials required, whose products have been is satisfactory use in similar service for not less than 5 years.

B. Access Units Fire-Resistance Ratings: Where fire-resistance rating is indicated or required for construction penetrated by access units, provide UL listed-and-labeled units, except for units which are smaller than minimum size requiring ratings as recognized by governing authority.

C. Source Limitations: Obtain each type of access assembly through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section “Substitutions & Product Options.”

PART 2 - PRODUCTS

2.1 ACCESS DOORS

A. General: Where floors, walls and ceilings must be penetrated for access to mechanical work, provide types of access doors indicated, including floor doors if any. Furnish manufacturer's complete units, of type recommended for application in indicated substrate construction, in each case, complete with anchorages and hardware.

PART 3 - EXECUTION

3.1 ACCESS TO MECHANICAL WORK

A. Comply with manufacturer's instructions for installation of access doors, floor doors, and removable access plates. Installation shall be performed by the various trades that normally perform the particular items of work.

B. Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

D. Remove or replace panels or frames which are warped, bowed, or otherwise damaged.

END OF SECTION
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SECTION 220523 VALVES

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Valves furnished as part of factory-fabricated equipment, are specified as part of the equipment assembly in other Division 23 sections.

C. Section 22 1116; Domestic Water Piping.

1.2 SUMMARY

A. Types of valves specified in this section include gate valves, globe valves, drain valves, ball valves, butterfly valves, and swing, wafer, and lift check valves.

1.3 SUBMITTALS

A. Product Data: Submit Manufacturer's Technical Product Data, specifications, installation instructions, and dimensioned drawings for each type of valve. Include pressure drop curve or chart for each type and size of valve.

B. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.

C. Welding Certificates.

D. Source quality-control reports.

E. Field quality-control reports.

F. Operation and Maintenance Manual Data: Submit maintenance data and parts list for each type of valve. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

G. Record Drawings: At project closeout, submit record drawings of installed valves and their exact location in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Firms regularly engaged in the manufacture of valves, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Marking of Valves: Comply with MSS SP-25.

C. Valve Dimensions: For face-to-face and end-to-end dimensions of flanged or welding-end valve bodies, comply with ANSI B16.10.

D. Valve Listing: For valves on fire protection piping, provide listing by UL and Associated Factory Mutual Fire Insurance Companies.

E. Valves Installed in Boiler Rooms: Comply with ASME Boiler and Pressure Vessel Code where applicable.

F. Valve Types: Provide valves of same type by same manufacturer.

G. Welding Qualifications: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Comply with NSF 61, “Drinking Water System Components – Health Effects,” for all components that will be in contact with potable water.

PART 2 - PRODUCTS

2.1 VALVES

A. Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, and connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.

2.2 GATE VALVES

A. Do not use gate valves in any domestic water piping system.

2.3 DRAIN VALVES

A. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

1. Crane
2. Milwaukee
3. Nibco

B. For Low Pressure Drainage Service:
1. Threaded Ends 2" and Smaller: Class 125, bronze body screwed bonnet, rising stem, composition disc, 3/4" hose outlet connection.
2. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed bonnet, rising stem, composition disc, 3/4" hose outlet connection.

2.4 BALL VALVES

A. Select with port area equal to or greater than connecting pipe area, include seat ring designed to hold sealing material.

B. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
1. Crane
2. Milwaukee
3. Nibco

C. Comply with the following standards:
1. Bronze Valves: ASTM B62.
2. Cast-Iron Valves: MSS SP-72.
3. Steel Valves: ANSI B16.34.

D. For Domestic Water Service:
1. Threaded Ends 2" and Smaller: Class 125, bronze 2 piece body, chrome plated brass ball, bronze stem and replaceable Teflon seats and seals.
2. Soldered Ends 2" and Smaller: Class 125, bronze 2 piece body, chrome plated brass ball, bronze stem and replaceable Teflon seats and seals.

2.5 SWING CHECK VALVES

A. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
1. Crane
2. Milwaukee
3. Nibco

B. General: Construct pressure containing parts of valves as follows:
1. Bronze Valves, 125 or 150 psi: ANSI/ASTM B 62.
2. Metallic Seated Bronze Valves, 200 or 300 psi: ANSI/ASTM B 61.
3. Iron Body Valves: ANSI/ASTM A 126, Class B.

C. Comply with MSS SP-80 for design, workmanship, material and testing.

D. Construct valves of pressure castings free of any impregnating materials. Construct valves of bronze, regrinding, with seating angle 40° to 45°, unless composition disc is specified.

E. Provide stop plug as renewable stop for disc hanger, unless otherwise specified. Construct disc and hanger as separated parts, with disc free to rotate. Support hanger pins on both ends by removable side plugs.

F. For Domestic Water Service:
   1. Threaded Ends 2" and Smaller: Class 150, bronze body, screwed cap, horizontal swing, Y-pattern, bronze disc.
   2. Soldered Ends 2" and Smaller: Class ?, bronze body, screwed cap, horizontal swing, Y-pattern, bronze disc.
   3. Flanged Ends 2-1/2" and Larger: Class 125, iron body bronze mounted, bolted cap, horizontal swing, Y-pattern, cast-iron disc.

2.6 VALVE FEATURES

A. Provide valves with features indicated to comply with installation requirements. Comply with ANSI B31.1.

B. Bypass: Comply with MSS SP-45, and except as otherwise indicated, provide manufacturer's standard bypass piping and valving.

C. Drain: Comply with MSS SP-45, and provide threaded pipe plugs complying with Division 22 Section, “Domestic Water Piping.”

D. Flanged: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5, (steel), or ANSI B16.24 (bronze).

E. Valve Ends:
   1. Threaded: Comply with ANSI B2.1.
   2. Butt-Welding: Comply with ANSI B16.25.
   3. Socket-Welding: Comply with ANSI B16.11.
   4. Solder Joints: Comply with ANSI B16.18.

F. Single Flange: Valves including bolt holes dimensioned for mating flanges.

G. Trim: Fabricate pressure-containing components of valve, including stems (shafts) and seats from brass or bronze materials, of standard alloy recognized in valve manufacturing industry.

H. Non-Metallic Disc: Non-metallic material selected for service indicated in accordance with manufacturer's published literature.

I. Renewable Seat: Design seat of valve with removable disc, and assemble valve so disc can be replaced when worn.

J. Extended Stem: Increase stem length by 2" minimum, to accommodate insulation applied over valve.

K. Mechanical Actuator: Factory-fabricated gears, gear enclosure, external chain attachment and chain designed to provide mechanical advantage in operating valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Except as otherwise indicated, comply with the following requirements:
   1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
   2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward for horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Applications Subject to Shock: Install valves with bodies of metal other than cast iron where thermal or mechanical shock is indicated or can be expected to occur.

D. Applications Subject to Corrosion: Do not install bronze valves and valve components in direct contact with steel, unless bronze and steel are separated by dielectric insulator. Install bronze valves in steam and condensate service and in other services where corrosion is indicated or can be expected to occur.

E. Mechanical Actuators: Install mechanical actuators with chain operators where indicated, and where valves 4" and larger are mounted more than 7'-0" above floor in mechanical rooms, boiler rooms; and where recommended by valve manufacturer because of valve size, pressure differential or other operating condition making manual operation difficult.

F. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends or types of pipe/tube connections:
   1. Tube Size 2" and Smaller: Soldered-joint valves.

2. Pipe Size 2" and Smaller: Threaded valves, grooved-end valves, butt-welding valves, socket-welding valves, flanged valves, flangeless valves, or single flanged valves.
3. Pipe Size 2-1/2" and Larger: Grooved-end valves, butt-welding valves, socket-welding valves, flanged valves, wafer valves, single flange valves, hub-and-spigot valves, or mechanical joint end valves.

G. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

H. Non-Metallic Disc: Limit selection and installation of valves with non-metallic disc to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

I. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

J. Fluid Control: Except as otherwise indicated, install ball, globe, and butterfly valves to comply with ANSI B31.1. Where throttling is indicated or recognized as principal reason for valve, install globe or butterfly valves.

K. Installation of Check Valves:
1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.

END OF SECTION
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SECTION 220529 SUPPORTS, ANCHORS & SEALS

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Supports, anchors, and seals furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division 23 sections.

C. Section 03 3000; Cast-In-Place Concrete.

1.2 SUMMARY

A. Extent of support, anchors, and bases required by this section is indicated on drawings and/or specified in other Division 23 sections.

B. Types of supports, anchors, and bases specified in this section include horizontal-piping hangers and supports, vertical-piping clamps, hanger-rod attachments, building attachments, saddles and shields, spring hangers and supports, flashing materials, miscellaneous materials, anchors, and equipment bases.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications, installation instructions and dimensioned drawings for each type of equipment.

B. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.

C. Welding Certificates.

D. Source quality-control reports.

E. Field quality-control reports.

F. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for system materials and products. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

G. Record Drawings: At project closeout submit record drawings of installed systems, show exact locations in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacturer of supports, anchors, and seals, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Substitutions & Product Options."

C. Welding Qualifications: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Code Compliance: Comply with applicable plumbing codes pertaining to product materials and installation of supports, anchors, and seals.

E. UL and FM Compliance: Provide products which are Underwriters Laboratories listed and Factory Mutual approved.

F. Manufacturers Standard Society of the Valve and Fitting Industry, Inc., (MSS) Standard Compliance:
   1. Provide pipe hangers and supports of which materials, design, and manufacturer comply with ANSI/MSS SP-58.
   2. Select and apply pipe hangers and supports, complying with MSS SP-69.
   3. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
   4. Terminology used in this section is defined in MSS SP-90.

PART 2 - PRODUCTS

2.1 HORIZONTAL-PIPING HANGERS AND SUPPORTS

A. Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with ANSI/MSS SP-58, of one of the following MSS types listed, to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems.
   1. Adjustable Steel Clevises: MSS Type 1.
   2. Alloy Steel Pipe Clamps: MSS Type 2.

3. Steel Double Bolt Pipe Clamps: MSS Type 3.
4. Steel Pipe Clamps: MSS Type 4.
5. Pipe Hangers: MSS Type 5.
6. Adjustable Swivel Pipe Rings: MSS Type 6.
7. Adjustable Steel Band Hangers: MSS Type 7.
8. Adjustable Band Hangers: MSS Type 9.
9. Adjustable Swivel Rings, Band Type: MSS Type 10.
10. Split Pipe Rings: MSS Type 11.
11. Extension Split Pipe Clamps: MSS Type 12.
12. U-Bolt: MSS Type 24.
13. Clips: MSS Type 26.
14. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange.
15. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast-iron floor flange.
16. Single Pipe Rolls: MSS Type 41.
17. Adjustable Roller Hangers: MSS Type 43.
18. Pipe Roll Stands: MSS Type 44.
19. Pipe Rolls and Plates: MSS Type 45.
20. Adjustable Pipe Roll Stands: MSS Type 46.

2.2 VERTICAL-PIPING CLAMPS

A. Except as otherwise indicated, provide factory-fabricated vertical-piping clamps complying with ANSI/MSS SP-58, of one of the following types listed, to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.
   1. Two-Bolt Riser Clamps: MSS Type 8.
   2. Four-Bolt Riser Clamps: MSS Type 42.

2.3 HANGER-ROD ATTACHMENTS

A. Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with ANSI/MSS SP-58, of one of the following MSS types listed, to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.
   1. Steel Turnbuckles: MSS Type 13.
   2. Steel Clevices: MSS Type 14.
   3. Swivel Turnbuckles: MSS Type 15.
   4. Malleable Iron Sockets: MSS Type 16.
   5. Steel Weldless Eye Nuts: MSS Type 17.

2.4 BUILDING ATTACHMENTS

A. Except as otherwise indicated, provide factory-fabricated building attachments complying with ANSI/MSS SP-58, of one of the following MSS types listed, to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems.
   1. Concrete Inserts: MSS Type 18.
   2. Top Beam C-Clamps: MSS Type 19.
   3. Side Beam or Channel Clamps: MSS Type 20.
   4. Center Beam Clamps: MSS Type 21.
   5. Welded Attachments: MSS Type 22.
   6. C-Clamps: MSS Type 23.
   7. Top I-Beam Clamps: MSS Type 25.
   8. Side I-Beam Clamps: MSS Type 27.
   9. Steel I-Beam Clamps W/Eye Nut: MSS Type 28.
   10. Steel WF-Beam Clamps W/Eye Nut: MSS Type 29.
   11. Malleable Beam Clamps: MSS Type 30.
   12. Steel Brackets: One of the following for indicated loading:
      a. Light Duty: MSS Type 31.
      b. Medium Duty: MSS Type 32.
      c. Heavy Duty: MSS Type 33.

   13. Side Beam Brackets: MSS Type 34.
   14. Plate Lugs: MSS Type 57.
   15. Horizontal Travelers: MSS Type 58.

2.5 SADDLES AND SHIELDS

A. Except as otherwise indicated, provide saddles for all piping 4" and larger and shields for piping 3" and smaller under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

B. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
   1. Elcen Metal Products Co.
   2. Grinnell

C. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.

D. Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.

E. Thermal Hanger Shields: Constructed of 360° insert of high density, 100 psi, water-proofed calcium silicate, encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation.

2.6 SPRING HANGERS AND SUPPORTS

A. Except as otherwise indicated, provide factory-fabricated spring hangers and supports complying with ANSI/MSS SP-58, of one of the following MSS types listed, to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.

B. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
   1. Elcen Metal Products Co.
   2. Grinnell

C. Hangers and Supports shall be of the type indicated below:
   1. Restraint Control Devices: MSS Type 47.
   2. Spring Cushion Hangers: MSS Type 48.
   3. Spring Cushion Roll Hangers: MSS Type 49.
   4. Spring Sway Braces: MSS Type 50.
   5. Variable Spring Hangers: MSS Type 51; preset to indicated load and limit variability factor to 25%.
   6. Variable Spring Base Supports: MSS Type 52; preset to indicated load and limit variability factor to 25%; include load flange.

2.7 CONSTANT SUPPORTS

A. Provide one of the following types, selected to suit piping system. Include auxiliary stops for erection and hydrostatic test, and field load-adjustment capability.
   1. Horizontal Type: MSS Type 54.
   2. Vertical Type: MSS Type 55.
   3. Trapeze Type: MSS Type 56.

2.8 FLASHING MATERIALS

A. Furnish flashings, as required for the roof/membrane type, for each penetration of mechanical systems through roofs and waterproof membranes to Installer responsible for installation of flashings, as specified in Division 07 Installation; not work of this section.

2.9 MISCELLANEOUS MATERIALS

A. Metal Framing: Provide products complying with NEMA STD ML 1.

B. Steel Plates, Shapes and Bars: Provide products complying with ANSI/ASTM A 36.

C. Heavy-Duty Steel Trapezes: Where several pipes occur at the same elevation, trapeze type hangers may be used. Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

3.2 INSTALLATION OF BUILDING ATTACHMENTS

A. Install building attachments at required locations within concrete for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through opening at top of inserts.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

C. Support fire-protection piping independently of other piping.

D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

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

F. Insulated Piping: Comply with the following installation requirements:
   1. Clamps: Attach clamps, including spacers (if any), to piping with clamps wrapping around the insulation; do not crush the pipe insulation and do not exceed pipe stresses allowed by ANSI B31.
   2. Shields: Where low-compressive-strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields. For pipe 8" and over, install plastic insulation saddles. Wood saddles shall not be used.
   3. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

3.4 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer to loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.5 ADJUSTMENT OF HANGERS AND SUPPORTS

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

END OF SECTION
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SECTION 220553 MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Mechanical identification furnished as part of factory-fabricated equipment, is specified as part of the equipment assembly in other Division 23 sections.

1.2 SUMMARY

A. Extent of mechanical identification work required by this section is indicated on drawings and/or specified in other Division 23 sections.

B. Types of identification devices specified in this section may include painted identification materials, plastic pipe markers, plastic tape, underground-type plastic line market, valve tags, valve schedule frames, engraved plastic-laminate signs and plasticized tags.

1.3 SUBMITTALS

A. Product Data: Submit product specifications and installation instructions for each identification material and device required.

B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.

C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copy for Maintenance Manuals as specified in Division 1.

D. Maintenance Material: Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes. Where stenciled markers are provided, clean and retain stencils after completion of

stenciling and include used stencils in maintenance materials, along with required stock of stenciling paints and applicators.

1.4 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in the manufacture of ? system products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Source Limitations: Obtain each type of label through one source from a single manufacturer.

C. Comply with ANSI Standard A13.1 for lettering size, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 MECHANICAL IDENTIFICATION MATERIALS

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

B. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
   1. Brady Corporation
   2. Seton Identification Products

C. Painted Identification Materials:
   1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 1-1/4" high letters for ductwork, and not less than 3/4" high letters for access door signs and similar operational instructions.
   2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
   3. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

D. Plastic Pipe Markers: Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, color-coded, plastic-sheet pipe markers, complying with ANSI A13.1.

1. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
2. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
   a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
   b. Adhesive lap joint in pipe marker overlap.
   c. Laminated or bonded application of pipe marker to pipe (or insulation).

3. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
   a. Laminated or bonded application of pipe marker to pipe (or insulation).
   b. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

4. Lettering: Manufacturer's standard pre-printed nomenclature which best described piping system in each instance, as selected by Architect in cases of variance with names as shown or specified.
5. Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length. Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

E. Plastic Tape: Manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
   1. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.
   2. Color: Comply with ANSI A13.1, except where another color selection is indicated.

F. Underground-Type Plastic Line Marker: Manufacturer's standard permanent, bright-colored, continuous-printed detectable plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.

G. Valve Tags:
   1. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately 3/16" high letters and sequenced valve numbers approximately 3/8" high, and with 5/32" hole for fastener. Provide 1-1/8" square white tags with black lettering.

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

H. Engraved Plastic-Laminate Signs: Provide engraving stock melamine plastic laminate, complying with Fed. Spec. L-P-387, in the sizes indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
1. 1/16" or1/8" thick, except as otherwise indicated. 1/16" thick for units up to 20 sq. in. or 8" length; 1/8" for larger units.
2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

I. Plasticized Tags: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, or plasticized card stock with matt finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.2 LETTERING AND GRAPHICS

A. Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

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

B. Ductwork Identification: Identify air supply, return, exhaust, intake and relief ductwork with stenciled signs and arrows, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork color).
1. Location: In each space where ductwork is exposed, in occupied areas only, or concealed only by removable ceiling system, locate signs near points

where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50' spacings along exposed runs.

2. Access Doors: Provide stenciled or plastic-laminated type signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.
3. Concealed Doors: Where access doors are concealed above acoustical ceilings or similar concealment, plasticized tags may be installed for identification in lieu of specified signs, at Installer's option.

C. Piping System Identification: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
1. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
2. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
3. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.

D. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, mechanical rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
1. Near each valve and control device.
2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings.

E. Underground Piping Identification: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type, detectable, plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

F. Valve Identification: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated

equipment units, plumbing fixture faucets, convenience and hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

1. Tagging Schedule: Comply with requirements of "Valve Tagging Schedule" at end of this section or per the plans.
2. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

G. Mechanical Equipment Identification: Install engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
2. Meters, gages, thermometers and similar units.
3. Fuel-burning units including boilers, furnaces, heaters, and absorption units.
4. Pumps, compressors, chillers, condensers, and similar motor-driven units.
5. Heat exchangers, coils, evaporators, cooling towers, heat recovery units and similar equipment.
6. Fans, blowers, primary balancing dampers and mixing boxes.
7. Packaged HVAC central-station and zone-type units.
8. Tanks and pressure vessels.
9. Strainers, filters, humidifiers, water treatment systems and similar equipment.

H. Optional Sign Types: Where lettering larger than 1" height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.

I. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 the size of principal lettering.

J. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

K. Optional Use of Plasticized Tags: Operational valves and similar minor equipment items located in non-occupied spaces (including machine rooms) may,

at Installer's option, be identified by installation of plasticized tags in lieu of engraved plastic signs.

END OF SECTION
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SECTION 220700 MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SCOPE

A. Piping System Insulation: Domestic water piping systems,

1.2 RELATED WORK

A. Section 22 0529; Supports, Anchors and Seals.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of insulation products of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer: A firm with at least 3 years successful installation experience on projects with mechanical insulations similar to that required for this project.

C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread rating of 25 or less, and smoke-developed rating of 50 or less, as tested by ANSI/ASTM E 84 (NFPA 255) method.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's specifications and installation instructions for each type of insulation. Include the manufacturer's product number, thickness, thermal conductivity, jackets (both factory and field applied, if any) and furnished accessories for each system requiring insulation.

B. Certifications: Submit manufacturers' certifications to show compliance with these specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

C. Shop Drawings: Submit shop drawings for insulation installations including:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at pipe expansion joints for each type of insulation.
3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

4. Detail removable insulation at piping specialties, equipment connections, and access panels.
5. Detail application of field-applied jackets.
6. Detail application at linkages of control devices.
7. Detail field application for each equipment type.

D. Source quality-control reports.

E. Field quality-control reports.

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.

B. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of products.

C. Protect insulation against dirt, water, chemical or mechanical damage. Do not install damaged insulation.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Supports, Anchors & Seals."

B. Coordinate clearance requirements with piping Installer for piping insulation application, and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
   1. Armstrong World Industries, Inc.
   2. Certainteed
   3. Johns-Manville
   4. Owens-Corning Fiberglas
   5. Pittsburg Corning Corp.
   6. Knauf Fiberglass
   7. Rubatex
   8. Armacell

2.2 PIPE INSULATION MATERIALS

A. Fiberglass Pipe and Pipe Fitting Insulation: Inorganic glass fibers bonded with a thermosetting resin with a density of 10 pounds per cubic foot per ASTM C541 Class I.
   1. Operating Temperature Range: 0 to 850° F per ASTM C411.
   2. Jacket Permeance: 0.02 perms per ASTME 96 Process A.
   3. Thermal Conductivity: k equal to 0.23 BTU·in/hr·ft^2 ·°F at a mean temperature of 75° per ASTM C680.
   4. Jacket Temperature Limitation: -20°F to 150°F per ASTM C1136.
   5. Composite Surface Burning Characteristics: Flame spread of 25 and developed smoke rating of 50 per UL 723 and ASTM E84.
   6. Jacket shall consist of a factory applied fire retardant self-sealing, laminated glass fiber, reinforced vapor barrier.

B. Flexible Elastomeric Pipe Insulation: Flexible expanded closed cell structure with a smooth skin on both sides per ASTM C534.
   1. Thermal Conductivity: 0.25 BTU·in/h· ft^2 ·°F at 75°F and 90°F per ASTM C177 or C518.
   2. Water vapor permeability: 0.05 Perm·in per ASTM E96 Procedure A.
   3. Composite Surface Burning Characteristics: Flame spread of 25 and a developed smoke rating of 50 per ASTM E84.
   4. Water Absorption: 0.2% by volume per ASTM C209.
   5. Do <u>not</u> use for any systems with operating temperatures above 140° F.
   6. Polyolefin shall not be considered an equal and is not allowed for any piping system.
   7. Adhesive: Solvent based contact adhesive as recommended by the manufacturer.

C. PVC Premolded Piping, Fitting and Valve Covers:
   1. Fabricated from one piece polyvinyl chloride plastic (PVC).
   2. Piping covers shall have a minimum thickness of 20 mils.
   3. Fitting and valve covers shall have a minimum thickness of 30 mils.

D. Accessories and Attachments:
   1. Canvas cloth and Tape: Woven canvas fiber fabrics, plain weave, pre-sized a minimum of 8 ounces per square yard. Tape shall be 4" wide.
   2. Aluminum Bands: 3/4" wide, 0.007 inch thick.
   3. Wire: 14 gauge nickel copper alloy, 16 gauge soft-annealed stainless steel or 16 gauge soft-annealed galvanized steel.
   4. Corner Angles: 28 gauge, 1 inch by 1 inch aluminum adhered to 2 inch by 2 inch kraft paper.
   5. Anchor Pins: Capable of supporting 20 pounds each. Provide anchor pins and speed washers of sizes and diameters as recommended by the manufacturer for the insulation type and thickness.

E. ADA Lavatory Piping Protection as indicated on the Plans and the Following:
   1. Lavatory Piping Wrap: Minimum 1/8" thick rigid high impact, stain resistant, white PVC cover with internal reusable fasteners. Piping wrap shall fit all 1-1/4" or 1-1/2" trap configurations and all 3/8" or 1/2" angle stop assemblies and conform to all ADA Requirements. Piping wrap shall be a TrueBro Lav Guard 2 or an engineer approved equivalent.

F. Staples, Bands, Wires, and Cement shall be as recommended by the insulation and/or jacket manufacturer for the applications indicated.

G. Adhesives, Sealers, and Protective Finishes shall be as recommended by the insulation and/or jacket manufacturer for the applications indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

A. Surface Preparation: Clean, dry and remove foreign materials such as rust, scales and dirt.

B. Mix insulating cements with clean potable water. Mix insulating cements that come in contact with stainless steel with de-ionized water only.

3.3 GENERAL

A. Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state.

B. Install vapor barriers on insulated pipes, ducts, and equipment having surface operating temperatures below 65 degrees F.

C. Install insulation on pipe systems subsequent to testing and acceptance of tests.

D. Install insulation continuous through all walls, floors, hangers and supports.

E. Provide saddles, shields, metal protectors and other appurtenances necessary to prevent crushing of insulation at hangers, rollers, supports and anchors. Provide rigid insulation blocks at saddles.

F. Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions.

G. Install insulation with smooth, straight, and even surfaces.

H. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.

I. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.

J. Seal Ends: Except for flexible elastomeric insulation, taper ends at 45 degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.

K. Apply adhesives and coating at manufacturer's recommended coverage-per-gallon rate.

L. Keep insulation materials dry during application and finishing.

M. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
   1. Fibrous glass ducts; metal ducts with duct liner, factory-insulated flexible ducts; factory-insulated plenums, casings, terminal boxes, and filter boxes and sections; testing laboratory labels and stamps; nameplates and data plates; access panels and doors in air distribution systems; sanitary drainage and vent piping, unless indicated otherwise; drainage piping located in crawl spaces, unless indicated otherwise; below grade piping, unless indicated otherwise; chrome-plated plumbing pipes and fittings from face of wall to fixture, except

for plumbing fixtures for the disabled; piping specialties including air chambers, unions, strainers, check vales, plug valves, flow regulators, hot piping within radiation enclosures or unit cabinets, cold piping within unit cabinets provided piping is located over drain pan.

3.4 PLUMBING PIPING SYSTEM INSULATION

A. Cold Piping: Insulate domestic cold water piping. Insulate with 1" thick fiberglass with factory applied vapor barrier or 1/2" thick flexible unicellular insulation.

B. Hot Piping: Insulate domestic hot water piping, domestic hot water recirculating piping, and exposed drains with 1" thick fiberglass for pipe sizes up to and including 6", 1-1/2” thick fiberglass for pipe sizes over 6”, or 1" thick flexible unicellular for pipe sizes up to and including 2" (largest size permitted).

3.5 INSTALLATION OF PIPING INSULATION

A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to testing and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

G. Extend piping insulation without interruption through walls, floors, hangers, supports and similar piping penetrations, except where otherwise indicated.

H. Install protective metal shields and insulated inserts wherever needed to prevent compression of insulation.

I. Insulation joints: For hot pipes, apply 3 inch wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 inch wide vapor barrier tape or band.

J. Provide a PVC jacket on all insulated pipe below 9’-0” above the finish floor where exposed in occupied spaces.

3.6 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION
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SECION 221116 DOMESTIC WATER PIPING SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 22 0519; Meters and Gages.

C. Section 22 0529; Supports, Anchors and Seals.

D. Section 22 0540; Expansion Compensation.

E. Section 22 0553; Mechanical Identification.

F. Section 22 0700; Mechanical Insulation.

G. Section 22 1119; Piping Specialties.

H. Trenching and backfill required in conjunction with exterior water piping is specified in applicable Division 02 sections.

I. Trenching and backfill required in conjunction with domestic water piping inside of building foundations is specified in applicable Division 02 sections.

1.2 SUMMARY

A. Extent of domestic water piping systems work is indicated on drawings and schedules and by requirements of this section.

B. Applications for domestic water piping systems include the following:
   1. Domestic cold-water piping.
   2. Domestic hot-water piping.
   3. Exterior water piping.
   4. Domestic recirculating-water piping.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications, installation instructions and dimensioned drawings for each type of piping and fitting.

B. Shop Drawings: Submit shop drawings for piping layouts, showing piping materials, sizes and locations. Show interface and spatial relationship between piping and approximate structures.

C. Welding Certificates.

D. Source quality-control reports.

E. Field quality-control reports.

F. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for piping system materials and products. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

G. Record Drawings: At project closeout, submit record drawings of installed piping systems, show exact location and route in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of piping materials products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with work similar to that required for this project.

C. Source Limitations: Obtain each type of piping material through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Substitutions & Product Options."

E. Plumbing Code Compliance: Comply with applicable portions of The International Plumbing Code pertaining to plumbing materials, construction and installation of products.

F. Source Quality-Control Reports.
   1. PEX piping:
      a. The PEX tubing and fitting manufacturer shall maintain a third party listing of the tubing and fittings. The tubing and fittings shall be certified in accordance with ANSI/NSF 14/61 to verify suitability to transport potable water. The tubing and fittings shall have the mark

"NSF-pw", "cNSF® us pw-G", or "NSF 61" permanently marked on the product to verify the material listing.

b. The manufacturer of the PEX tubing and fittings shall maintain a quality control program in accordance with ISO 9001 or NSF International in the manufacturing plant to assure that the tubing and fittings are continually being produced to the required standard. The tubing and fittings shall be certified as complying with NSF 14.

G. ANSI Compliance: Comply with applicable American National Standards pertaining to products and installation of domestic water piping systems.

H. Comply with NSF 61, "Drinking Water System Components - Health Effects," for all components that will be in contact with potable water.

I. Welding Qualifications: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

J. PDI Compliance: Comply with applicable Plumbing and Drainage Institute standards pertaining to products and installation of soil and waste piping systems.

K. Local Utility Compliance: Comply with requirements of the local utility company(ies).

PART 2 - PRODUCTS

2.1 DOMESTIC WATER PIPING MATERIALS AND PRODUCTS

A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by the installer to comply with the installation requirements. Provide sizes and types matching piping and equipment connections. Provide fittings of materials which match pipe materials used in domestic water piping systems unless noted otherwise. Where more than one type of materials or products are indicated, the selection is the installer's option.

2.2 BASIC IDENTIFICATION

A. Provide identification complying with Division 22 Section, "Mechanical Identification," in accordance with the following listings:
1. Domestic Water Piping: Plastic pipe markers.
2. Domestic Water Valves: Valve tags.
3. Water Service: Underground-type plastic line markers.

2.3 BASIC PIPE, TUBE, AND FITTINGS: Provide pipe, tube, and fittings complying with the following:

A. Above Grade Domestic Water Piping:
   1. Tube Size 4" and Smaller: Copper tube and fittings per ASTM B88 and ASME B16.22.
      a. Wall Thickness: Type L, hard-drawn temper.
      b. Fittings: Wrought-copper, solder-joints.

B. Below Grade Water Piping:
   1. Tube Size 4" and Smaller: Copper tube and fittings per ASTM B88 and ASME B16.22.
      a. Wall Thickness: Type K soft-annealed temper or Type K hard drawn copper tube.
      b. Fittings: Wrought-copper fittings with silver brazed joints. Silver brazing shall be equal to SIL-FOS 2 or FOS FLO 7.

   2. 1 ½” - 3”, SDR-21, PVC pipe per ASTM D2241, Class 200, Bell and Spigot with rubber gasketed joints and matching fittings. Provide concrete blocking at all tees and elbows.

2.4 BASIC PIPING SPECIALTIES

A. Provide piping specialties complying with Division 22 Section, "Piping Specialties," in accordance with the following listing:
   1. Pipe escutcheons.
   2. Low-pressure Y-type pipeline strainers.
   3. Dielectric unions.
   4. Drip pans.
   5. Pipe sleeves.
   6. Sleeve seals.

B. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
   1. Amtrol, Inc.
   2. Smith (Jay R.) Mfg. Co.
   3. Wade Div.
   4. Tyler Pipe.
   5. Zurn.
   6. Sioux Chief.

C. Water Hammer Arresters: Provide piston-type water hammer arresters, type L copper tube body with a poly piston with two EPDM O-rings, MIP thread fitting, pressure rated for 250 psi, tested and certified in accordance by ASSE to

the ANSI/ASSE 1010 Standard. Sizes shall be in accordance with Plumbing and Drainage Institute Standard WH-201.

2.5 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

B. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.

C. Piping Connectors for Dissimilar Non-Pressure Pipe: Fernco, Inc., or an engineer approved equivalent; elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.

2.6 BASIC SUPPORTS, ANCHORS, AND SEALS

A. Provide supports, anchors, and seals complying with Division 22 Section, "Supports, Anchors, and Seals," in accordance with the following listing:
   1. Adjustable steel clevises, adjustable roller hangers, and adjustable pipe roll stands for horizontal piping hangers and supports.
   2. Two-bolt riser clamps for vertical piping supports.
   3. Concrete inserts, C-clamps, and steel brackets for building attachments.
   4. Protection shields for insulated piping support in hangers.
   5. Copper flashings for piping penetrations through exterior surfaces.

2.7 BASIC VALVES

A. Provide valves complying with Division 22 Section, "Valves," in accordance with the following listing:
   1. Sectional Valves:
      a. 4" and Smaller: Ball Valves.

   2. Shutoff Valves:
      a. 4" and Smaller: Ball Valves.

   3. Drain Valves:
      a. 4" and Smaller: Ball Valves.

   4. Check Valves: Swing Check Valves, all sizes.

2.8 SPECIAL VALVES

A. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
   1. Bell & Gossett
   2. ITT Fluid Handling Div.
   3. Hammond Valve Corp.
   4. American Air Filter Co.
   5. Milwaukee Valve Co., Inc.
   6. Sarco Co.
   7. Taco, Inc.
   8. Griswold Controls Co.

B. Auto-flow Control Valves
   1. General Specifications
      a. Automatic flow control valve cartridges shall automatically control flow rates with ±5% accuracy over an operating pressure differential range of at least 14 times the minimum required for control. Four operating pressure ranges shall be available with the minimum range requiring less than 3 PSID to actuate the mechanism.
      b. Valve internal control mechanism shall consist of a stainless steel one-piece cartridge with segmented port design and full travel linear coil spring.
      c. Manufacturer shall be able to provide certified independent laboratory tests verifying accuracy of performance. (Consult the factory for details).
      d. All flow control valve cartridges shall be warranted by the manufacturer for five years from date of sale.

   2. Isolator Series Valve
      a. Isolator series valves, sizes 1/2" through 1-1/2", shall have a ASTM brass alloy body, rated at no less than 400PSI/250°F. Isolator series valves, sizes 1-1/2" Large through 3", shall have a CAST brass alloy body, rated at no less than 275PSI/250°F. These sizes shall be constructed in a one-piece body to include a handle ball valve, a flow control cartridge assembly, dual pressure or pressure/temperature test valves for verifying accuracy of flow performance for all sizes combined with a manual air vent, and a union end which will accept various end pieces. The IY shall include a removable 20 mesh stainless steel strainer. Available flow rates shall be from 0.25 GPM to 160.0 GPM. Refer to the plans for the required flow rates.
      b. The body design shall allow inspection or removal of cartridge or strainer without disturbing piping connections.
      c. The body design shall allow inspection or repair of handle operated stem without disturbing piping connections. The repairable stem shall

include two Teflon seals and one EPDM o-ring for protection against chemicals and modulating temperature.

d. The valve shall come fully assembled and be permanently marked to show direction of flow; shall have a body tag to indicate flow rate and model number.

C. Hydrants and Hose Bibbs: Provide products complying with Division 22 Section, “Plumbing Equipment & Fixtures.”

2.9 BASIC PUMPS

A. Provide inline booster pumps, for hot water recirculating, complying with Division 23 Section, "Pumps."

2.10 BACKFLOW PREVENTERS

A. The double check valve assembly shall consist of two positive seating check modules with captured springs and rubber seat discs. The check module seats and seat discs shall be replaceable. Service of all internal components shall be through a single access bronze or stainless steel access cover secured with stainless steel bolts. The assembly shall also include two resilient seated isolation valves and four top mounted resilient seated test cocks. The assembly shall meet the requirements of: ASSE Std. 1015 and AWWA Std. C510.

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
   a. FEBCO
   b. Ames
   c. Watts Regulator Co.

2.11 BASIC EXPANSION COMPENSATION

A. Provide expansion compensation products complying with Division 22 Section, “Expansion Compensation," in accordance with the following listing:

1. Expansion compensators for hot water and hot water recirculating piping.
2. Pipe alignment guides.

2.12 BASIC METERS AND GAGES

A. Provide meters and gages complying with Division 22 Section, "Meters and Gages" in accordance with the following listing:

1. Pressure gages.
2. Glass thermometers.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.

B. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

C. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

3.2 INSTALLATION

A. General: Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" misalignment tolerance. Comply with ANSI B30 Code for Pressure Piping.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations, or if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent-enclosure elements of building; limit clearance to 1/2" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1.0" clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.

C. Electrical Equipment Spaces: Do not run piping above electric panels or through transformer vaults and other electrical or electronic equipment spaces and enclosures.

D. Piping System Joints: Provide joints of type indicated in each piping system.
   1. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where

recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

2. Weld pipe joints in accordance with recognized industry practice and as follows:
   a. Weld pipe joints only when ambient temperature is above 0°F where possible. Bevel pipe ends at a 37.5° angle, smooth rough cuts, and clean to remove slag, metal particles and dirt.
   b. Use pipe clamps or tack-weld joints with 1" long welds; 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
   c. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.
   d. Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.
   e. At Installer's option, install forged branch-connection fittings wherever branch pipe of size smaller than main pipe is indicated; or install regular "T" fitting.

3. Weld pipe joints of steel water pipe in accordance with AWWA C206.
4. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

E. Install gray and ductile cast-iron water mains and appurtenances in accordance with ANSI/AWWA C603.

3.3 INSTALLATION OF EXTERIOR WATER PIPING

A. Install exterior water service piping system in compliance with local governing regulations.

B. Street Main Connection: Obtain the required permits in connection with the required work and coordinate with the Utility Company for the installation of the water service as shown on the plans.

C. Water Service Piping: Extend water service piping from meter of size and in location indicated to water service entrance at building. Provide a sleeve in the foundation wall for water service entry; make entry watertight. Provide valve at water service entry inside building; refer to the plans for information.

D. Copper Tube: Install in accordance with recommended procedures of the Copper Development Association.

E. Sterilization: At completion of water service line installation, flush and sterilize in conformance with AWWA C-601 to satisfaction of local authorities having jurisdiction.

3.4 CLEANING, FLUSHING, INSPECTING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items. Inspect pressure piping in accordance with procedures of ANSI B30.

B. Disinfect water mains and water service piping in accordance with AWWA C601.

3.5 PIPING TESTS

A. Notify Architect at least 24 hours before performing leak test.

B. Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is installed wherever feasible, and remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time. Required test periods is 2 hours. Test each piping system at 150% of operating pressure indicated, but not less than 25 psi test pressure. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.

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

D. Drain test water from piping systems after testing and repair work has been completed.

3.6 INSTALLATION OF BASIC IDENTIFICATION

A. Install mechanical identification in accordance with Division 22 Section, “Mechanical Identification.”

3.7 INSTALLATION OF PIPING SPECIALTIES

A. Install piping specialties in accordance with Division 22 Section, "Piping Specialties."

B. Water Hammer Arresters: Install in upright position, in locations and of sizes in accordance with PDI Standard WH-201, and elsewhere as indicated.

3.8 INSTALLATION OF SUPPORTS, ANCHORS, AND SEALS

A. Install supports, anchors, and seals in accordance with Division 22 Section, “Supports, Anchors, and Seals."

3.9 INSTALLATION OF VALVES

A. Install valves in accordance with Division 22 Section, "Valves."

B. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves two or more plumbing fixtures or equipment connections, and elsewhere as indicated.

C. Shutoff Valves: Install on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated.

D. Drain Valves: Install on each plumbing equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain domestic water piping system.

E. Check Valves: Install on discharge side of each pump and elsewhere as indicated.

F. Balance/Automatic Flow Control Valves: Install in each hot water recirculating loop and elsewhere as indicated.

3.10 INSTALLATION OF PUMPS

A. Install pumps in accordance with Division 23 Section, "Pumps.”

B. Provide the following controls for each hot water recirculating pump. Refer to Division 26 section for wiring of controls; not work of this section.
   1. Time clock for continuous operation during occupied hours, coordinate with the electrical contractor for the time clock specifications.
   2. Immersion aquastat to start pump at 130°F (54°C) and stop pump at 140°F (60°C). Seven-day time clock and separate on-auto-off switch.

3. Relays required for above.

3.11 INSTALLATION OF BACKFLOW PREVENTERS

A. Install backflow preventers where indicated and where required by the codes. If required, pipe relief outlet to nearest floor drain.

3.12 INSTALLATION OF METERS AND GAGES

A. Install meters and gages in accordance with Division 22 Section, "Meters and Gages."

3.13 EQUIPMENT CONNECTIONS

A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated but in no case smaller than required by The International Plumbing Code.

B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated, and comply with equipment manufacturer's installation instructions. Provide shutoff valve and union for each connection. Provide drain valve on drain connection.

3.14 SPARE PARTS

A. Furnish to Owner, with receipt, one valve key for each key operated hydrant, bibb, or faucet installed.

END OF SECTION
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SECTION 221119 PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Piping specialties furnished as part of factory-fabricated equipment, are specified as part of the equipment assembly in other Division 22 sections.

C. Section 22 1116; Domestic Water Piping Systems.

D. Section 22 4200; Plumbing Equipment and Fixtures.

1.2 SUMMARY

A. Extent of piping specialties required by this section is indicated on drawings and/or specified in other Division 22 sections.

B. Types of piping specialties specified in this section include pipe escutcheons, pipeline strainers, dielectric unions, drip pans, sleeves, and sleeve seals.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data, specifications, and installation instructions for each type of manufactured piping specialty. Include pressure drop curve or chart for each type and size of pipeline strainer. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.

B. Shop Drawings: Submit for fabricated specialties, indicating details of fabrication, materials, and method of support.

C. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for each required piping specialty. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing the contents.

D. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.

E. Welding Certificates.

F. Source Quality-Control Reports.

G. Field Quality-Control Reports.

H. Record Drawings: At project closeout, submit record drawings of installed specialties, show exact location in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of piping specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with piping specialties work similar to that required for this project.

C. Source Limitations: Obtain each type of piping specialty through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Substitutions & Product Options."

E. Welding Qualifications: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA.

G. Comply with NSF 61, "Drinking Water System Components – Health Effects," for all components that will be in contact with potable water.

PART 2 - PRODUCTS

2.1 MANUFACTURED PIPING SPECIALTIES

A. Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections.

B. Pipe Escutcheons
   1. Description: Manufactured wall and ceiling escutcheons and floor plates, with an inside diameter closely fitting pipe outside diameter, or outside of

pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.

a. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide solid, non-hinged cast brass or sheet brass escutcheons.
b. Pipe Escutcheons for Dry Areas: Provide steel solid, non-hinged escutcheons with a set screw.

2. One-Piece, Brass, Deep-Pattern Type: Piping with fitting or sleeve protruding from wall.
3. One-Piece, Cast-Brass Type: With a set screw: Polished Chrome-plated (finished spaces); Rough brass (unfinished service spaces).
4. One-Piece, Floor-Plate Type: Cast-iron floor plate.

C. Y-Type Pipeline Strainers:

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
   a. Armstrong.
   b. Sarco.
   c. Metraflex.

2. Strainers shall comply with FCI 73-1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Provide 125 psi working pressure strainers for all services with Type 304 stainless steel screens, with 0.045" perforations.
   a. Threaded Ends, 2" and Smaller" Cast-iron body, screwed screen retainer with centered blowdown fitted with pipe plug.
   b. Threaded Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.
   c. Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.

D. Dielectric Unions:

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
   a. FMC Corp.
   b. PSI Industries
   c. Stockham Valves and Fittings.

2. Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.

E. Vacuum Breaker: Provide a vacuum breaker to prevent back-siphonage of

potentially contaminated water into the domestic water piping for each plumbing fixture or piece of equipment having a submerged inlet or attached hose end as required by any local and state health authorities.

2.2 FABRICATED PIPING SPECIALTIES

A. Drip Pans: Provide ABS plastic drip pans or drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over 1/4" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drain line connection.

B. Pipe Sleeves: Provide pipe sleeves of one of the following:
   1. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gages: 3" and smaller, 20 gage; 4" to 6", 16 gage; over 6", 14 gage.
   2. Steel-Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
   3. Iron-Pipe: Fabricate from cast-iron or ductile-iron pipe with plain ends and an integral water stop, unless otherwise indicated.
   4. Plastic-Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.

C. Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade, or in exterior walls, of one of the following:
   1. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation. Unit shall be equal to a unit manufactured by Thunderline.

2.3 PIPE SPECIALTIES

A. Unions:
   1. 2” and smaller copper pipe shall be brass solder joints rated for 150 psi working pressure.
   2. 2” and smaller steel pipe shall be screwed, malleable iron brass to steel joints for 150 psi working pressure.

B. Flanges:
   1. Flanges shall be forged steel rated for 150 psi working pressure per ANSI B16.5. Bolts for flanges shall be made of bolt steel and shall have clean cut threads with upset square heads and semi-flush hexagonal cold pressed nuts.

   2. Flange connections shall be constructed of high pressure graphite 1/16” sheet packing or rubber, both rated for temperatures of up to 200°F per ANSI B16.21.

PART 3 - EXECUTION

3.1 INSTALLATION OF MANUFACTURED PIPING SPECIALTIES

A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration thru floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and in flush with adjoining surface.

B. Y-Type Strainers: Install Y-type strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff valve in strainer blow down connection, full size of connection, except for strainers 2" and smaller installed ahead of control valves feeding individual terminals. Provide drain line from shutoff valve to plumbing drain, full size of blow down connection. Locate y-type strainers in supply line ahead of pumps, and elsewhere as indicated, if integral strainer is not included in equipment.

C. Dielectric Unions: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.

3.2 INSTALLATION OF FABRICATED PIPING SPECIALTIES

A. Drip Pans: Locate drip pans under piping passing over or within 3' horizontally of electrical equipment. Provide drip pans under each fan coil unit and duct coil installed above finished ceiling in addition to factory drain pan furnished with unit or coil. Provide drip pans elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection, and run to nearest plumbing drain or elsewhere as indicated.

B. Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members except as detailed on drawings, or as reviewed by Architect. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than 2 pipe sizes larger than piping run. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves 1/4" above level floor finish, and 3/4" above floor finish sloped to drain. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves. Install sheet-metal sleeves at interior partitions and ceilings other than suspended ceilings. Install iron-pipe sleeves at exterior penetrations, both above and below grade. Install steel-pipe or plastic-pipe sleeves except as otherwise indicated.

C. Sleeve Seals: Install with mechanical sleeve seals. Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.

END OF SECTION
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SECTION 221123 NATURAL GAS PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 09 9100; Painting.

C. Section 22 0529; Supports, Anchors and Seals.

D. Section 22 0553; Mechanical Identification.

E. Section 22 1119; Piping Specialties.

1.2 SUMMARY

A. Extent of natural gas piping system work is indicated on drawings and schedules and by requirements of this section.

B. Gas Pressure and Definitions

1. Low-Pressure Gas Piping System: Operating at pressure of 13” W.C. or 1/2 psi, or as indicated on drawings.
2.
3. Gas Service: Pipe from the gas main to the building being served. Service includes gas service valves, pressure regulator and meter.
4. Gas Piping System: Pipe within the building that conveys gas from point of delivery to points of usage. Piping includes dielectric fitting and gas valve immediately downstream from point of delivery.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications and installation instructions for fuel gas piping systems materials and products.

B. Welding Certificates.

C. Source quality-control reports.

D. Field quality-control reports.

E. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for gas piping system materials and products. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

F. Record Drawings: At project closeout, submit record drawings of installed gas piping systems, show exact location and route of the piping in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of natural gas piping products of types, materials, and sizes required whose products have been in satisfactory use in similar service for not less than 5 years.

B. ANSI Code Compliance: Comply with applicable provisions of ANSI B31.2 "Fuel Gas Piping."

C. National Fuel Gas Code Compliance: Comply with applicable provisions of NFPA 54 (ANSI Z223.1) "National Fuel Gas Code" and ANSI Z223.1a "Supplement to National Fuel Gas Code."

D. Local Utility Compliance: Comply with requirements of local utility.

PART 2 - PRODUCTS

2.1 NATURAL GAS PIPING MATERIALS AND PRODUCTS

A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated. Provide materials and products complying with ANSI B31.2 where applicable; base pressure rating on natural gas piping system maximum design pressures. Provide sizes and types matching piping and equipment connections. Provide fittings of materials which match pipe materials used in gas piping systems.

2.2 BASIC IDENTIFICATION

A. Provide identification complying with Division 22 Section, "Mechanical Identification," in accordance with the following listing:

1. Building Distribution Piping: Pipe markers.
2. Gas Valves: Valve tags.

2.3 BASIC PIPE, TUBE, AND FITTINGS

A. Provide pipe, tube, and fittings complying with the following listing:

1. Gas Service Piping:

   a. All Pipe Sizes: Black steel pipe, Schedule 40, wrought-steel butt-welded fittings. Machine wrap pipe using 50% overlay wrap, with polyvinyl chloride tape. Hand wrap fittings using 90% overlay wrap extending 6" beyond fitting onto wrapped pipe. Comply with tape manufacturer's installation instructions.
   b. Pipe Sizes ½” Through 12”: Polyethylene plastic gas pressure pipe, tubing and fittings complying with ASTM D2513.

2. Building Distribution Piping:

   a. Low pressure (1/2 psi or less) Gas Systems:

      (1) Above Grade Piping:

         (a) Pipe size 2” and smaller: black steel pipe, schedule 40, malleable iron threaded fittings and joints in ducted return plenums only, provide wrought steel butt-welded fittings and joints in return air plenums.
         (b) Pipe size 2-1/2” and larger: Black steel pipe, schedule 40, with wrought steel butt-welded fittings and joints.

2.4 BASIC PIPING SPECIALTIES

A. Provide pipe escutcheons, pipe sleeves, and sleeve seals complying with Division 22 Section, "Piping Specialties."

B. Underground Transition Risers shall be a schedule 40 steel with an epoxy coated case complying with ASTM D 2513.

2.5 BASIC SUPPORTS, ANCHORS, AND SEALS

A. Provide supports, anchors, and seals complying with Division 22 Section, "Supports, Anchors, and Seals."

PART 3 - EXECUTION

3.1 INSTALLATION OF BASIC IDENTIFICATION

A. Install mechanical identification in accordance with Division 22 Section, "Mechanical Identification."

3.2 INSTALLATION OF NATURAL GAS PIPING

A. Install natural gas distribution piping in accordance with the following requirements and in accordance with applicable codes and local utility requirements.

B. Obtain the required permits in connection with the required work and coordinate with the utility company for the installation of the gas service as shown on the plans.

C. Use sealants on metal gas piping threads which are chemically resistant to natural gas. Use sealants sparingly, and apply to only male threads of metal joints.

D. Remove cutting and threading burrs before assembling piping.

E. Do not install defective piping or fittings. Do not use pipe with threads which are chipped, stripped or damaged.

F. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping or equipment connections are completed.

G. Ground gas piping electrically and continuously within project and bond tightly to grounding connection.

H. Install drip-legs in gas piping where required by code or regulation.

I. Install "Tee" fitting with bottom outlet plugged or capped at bottom of pipe risers.

J. Use dielectric unions where dissimilar metals are joined together.

K. Install piping with 1" drop in 60' pipe run (0.14%) in direction of flow.

L. Install piping parallel to other piping, but maintain minimum of 12" clearance between gas piping and steam or hot water piping above 200°F(93°C)

M. For piping buried in building substrate, or below floor slabs, install in welded conduit, ventilated to outdoors on both ends, and tested to same requirements as gas piping.

N. All exterior gas piping shall be painted. Refer to Division 09 Section “Painting.” Paint all gas piping on the roof OSHA Safety Yellow, all other above grade piping shall be painted gray.

3.3 INSTALLATION OF PIPING SPECIALTIES

A. Install piping specialties in accordance with Division 22 Section, "Piping Specialties."

3.4 INSTALLATION OF SUPPORTS, ANCHORS, AND SEALS

A. Install supports, anchors, and seals in accordance with Division 22 Section, "Supports, Anchors, and Seals."

3.5 PIPING TESTS

A. Test natural gas piping in accordance with ANSI B31.2.

B. Use only leak detector solution for detecting leaks in piping. Dish soap or window cleaner shall not be used.

3.6 SPARE PARTS

A. Furnish to Owner, with receipt, two valve wrenches for each type of gas valve installed.

END OF SECTION
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SECTION 221316 SOIL & WASTE PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 22 0529; Supports, Anchors and Seals.

C. Section 22 0553; Mechanical Identification.

D. Section 22 0700; Mechanical Insulation.

E. Section 22 1119; Piping Specialties.

F. Section 22 4200; Plumbing Equipment and Fixtures.

G. Section 33 3100; Sanitary Utility Sewerage Piping.

1.2 SUMMARY

A. Extent of building soil, waste and drain piping system work, is indicated on drawings and schedules, and by requirements of this section.

B. Applications for soil, waste and drain piping systems include the following:
   1. Above ground soil, waste, drain and vent piping within buildings including soil stacks, vent stacks, horizontal branches, traps, and connections to fixtures and drains.
   2. Underground building drain piping including mains, branches, traps, connections to fixtures and drains, and connections to stacks, terminating as indicated on the drawings.

C. Exterior sanitary sewer system is specified in applicable Division 33 Section, “Sanitary Utility Sewerage Piping,” and is included as work of this section.

D. Trenching and backfilling required in conjunction with underground building drain piping is specified in the applicable portions of the following, Division 02, and Division 31 Section, “Earthwork,” and is included as work of this section.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data, specifications, installation instructions and dimensioned drawings for each type of piping and fitting.

B. Source Quality-Control Reports

C. Field Quality-Control Reports

D. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for system materials and products. Include this data, product data, and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing the contents.

E. Record Drawings: At project closeout, submit record drawings of installed waste and vent piping systems, show exact location of associated equipment and piping runs in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Firms regularly engaged in manufacturer of system products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with systems work similar to that required for this project.

C. Source Limitations: Obtain each type of pipe and fittings through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Substitutions & Product Options."

E. Plumbing Code Compliance: Comply with applicable portions of International Plumbing Code pertaining to plumbing materials, construction and installation of products.

F. ANSI Compliance: Comply with applicable American National Standards pertaining to products and installation of soil and waste piping systems.

G. PDI Compliance: Comply with applicable Plumbing and Drainage Institute Standards pertaining to products and installation of soil and waste piping systems.

H. Local Utility Compliance: Comply with requirements of the local utility company(ies).

PART 2 - PRODUCTS

2.1 SOIL & WASTE PIPING MATERIALS AND PRODUCTS

A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated. Where not indicated, provide proper

selection as determined by the installer to comply with the installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in soil and waste piping systems. Unless noted otherwise where more than one type of materials or products are indicated, the selection is the installer's option.

2.2 BASIC IDENTIFICATION

A. Provide identification complying with Division 22 Section, "Mechanical Identification," in accordance with the following listing:
   1. Above Ground Soil, Waste, and Vent Piping: Plastic pipe markers.
   2. Underground Building Drain Piping: Underground-type plastic line markers.

2.3 BASIC PIPE, TUBE & FITTINGS

A. Provide pipe, tube, and fittings complying with the following

B. Above Ground Piping Within Buildings:
   1. Pipe Size 8" and smaller: Polyvinyl chloride plastic pipe (PVC) shall not be installed in air plenums, unless wrapped with an appropriate insulation, per Division 22 Section "Mechanical Insulation".
      a. Wall Thickness: Schedule 40 solid core per ASTM D2665. Cellular core PVC pipe shall not be an acceptable substitution for solid core PVC pipe.
      b. Fittings: DWV Socket type, solvent cemented joints per ASTM D2466.

   2. Pipe Size 10" and Smaller: Hubless cast-iron soil pipe for use in return air plenums. All cast iron pipe soil pipe and fittings shall be marked with the trademark of the Cast Iron Soil Pipe Institute (CISPI).
      a. Pipe Class: Service weight per CISPI 301.
      b. Fittings: Hubless cast-iron soil pipe fittings, no-hub joints, with rubber gaskets per ASTM C564 and stainless steel, cast iron, or FM-type heavy duty couplings.

C. Underground Building Drain Piping:
   1. Pipe Size 8" and Smaller: Polyvinyl chloride plastic pipe (PVC).
      a. Wall Thickness: Schedule 40 solid core per ASTM D2665. Cellular core PVC pipe shall not be an acceptable substitution for solid core PVC pipe.
      b. Fittings: DWV socket type solvent cemented joints per ASTM D2466.

2.4 BASIC PIPING SPECIALTIES

A. Provide piping specialties complying with Division 22 Section, "Piping Specialties," in accordance with the following listing:

   1. Pipe Escutcheons.
   2. Pipe Sleeves.

3. Sleeve Seals.

2.5 BASIC SUPPORTS, ANCHORS & SEALS

A. Provide supports, anchors, and seals complying with Division 22 Section, "Supports, Anchors and Seals," in accordance with the following listing:
   1. Adjustable steel clevises, steel pipe clamps, and pipe saddle supports for horizontal piping hangers and supports.
   2. Two-bolt riser clamps for vertical piping supports.
   3. Concrete inserts, C-clamps, and steel brackets for building attachments.
   4. Copper flashings for piping penetrations.

2.6 DRAINAGE PIPING PRODUCTS

A. Provide factory-fabricated drainage piping products of size and type indicated below and complying with Division 22 Section, "Plumbing Equipment & Fixtures."

B. Cleanout Plugs: Cast-bronze or brass, threads complying with ANSI B2.1, countersunk head.

C. Floor Cleanouts: Cast-iron body and frame; cleanout plug; adjustable threaded housing round top.
   1. Nickel Bronze Top: Manufacturer's standard cast unit of the pattern specified, with recess to receive 1/8" thick floor finish, standard non-slip scored or abrasive satin finish top, or a carpet flange and carpet marker as required by the plans, locations and finishes.
   2. Cast Iron Top for Mechanical Spaces Only: Manufacturer's standard cast unit of patter specified, exposed flush type with a standard non-slip scored or abrasive finish.

D. Wall Cleanouts: Cast-iron body adaptable to pipe with cast-bronze or brass cleanout plug; stainless steel cover including screws.

E. Flashing Flanges: All roof drains and plumbing piping passing through the roof membrane shall be flashed under Division 07 Section, "Flashing & Sheet Metal." The contractor shall insure that all building envelope penetrations are properly flashed and made weather tight.

F. Manufacturer, Subject to compliance with requirements, shall be one of the following or an engineer approved equivalent:
   1. Josam Mfg. Co.
   2. Smith (Jay R.) Mfg. Co.
   3. Wade Div.
   4. Tyler Pipe
   5. Zurn Industries
   6. Hydromechanics Div.

2.7 FLOOR DRAINS

A. Provide floor drains of size as indicated on the plans and complying with the plumbing fixture schedule and Division 22 Section, “Plumbing Equipment & Fixtures.”

B. All floor drains shall be by the same manufacturer.

C. Furnish and install a deep seal “P” trap at each floor drain.

2.8 TRAPS

A. All fixtures having waste connection shall be trapped with the water seal located as close as possible to the fixture. Provide all required traps including traps not furnished in combination with the fixture or equipment.

B. Traps for lavatories or sinks shall be chrome plated 17 gauge brass unless noted otherwise on the plans.

2.9 BACKWATER VALVES

A. The backwater valve shall have a cast iron body with backwater valve and threaded cast iron cover.

B. Install components in accordance with manufacturer's instructions and approved product data submittals.

C. Set plumb, level, and rigid.

PART 3 - EXECUTION

3.1 INSTALLATION OF BASIC IDENTIFICATION

A. Install mechanical identification in accordance with Division 22 Section, “Mechanical Identification.”

3.2 ɪNSTALLATION OF SOIL & WASTE ABOVE GROUND PIPING

A. Install soil and waste piping in accordance with The International Plumbing Code.

3.3 INSTALLATION OF BUILDING STORM, WASTE, OR DRAIN PIPING

A. Install underground building drains as indicated and in accordance with International Plumbing Code. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clean interior of piping of dirt and

other superfluous materials as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

B. Install soil and vent piping pitched to drain at minimum slope of 1/4" per foot (2%) for piping 3" and smaller, and 1/8" per foot (1%) for piping 4" and larger unless noted otherwise or a greater slope is required by the applicable code(s).

C. The size of the storm, waste, drain and vent stacks shall be as indicated on the drawings, but shall not be less than required by any applicable code.

D. All below grade piping shall be continuously bedded with depressions for hubs on compacted sand or gravel to undisturbed soil for a minimum depth of 6” under pipe. All trenches for under-slab piping shall be backfilled with gravel up to the bottom elevation of the slab.

E. Connections to soil, waste and drain stacks shall be at 45 degrees; those to vent stack may be at 45 degrees or 90 degrees except vent stacks shall be connected at 45 degrees to soil, waste or drain stack.

F. Connections to stack and sewers shall be arranged so that operation of any fixture will not cause fluctuation of water level in traps of other fixtures.

G. All thread joints shall be made up with Teflon-bearing pipe joint compound applied to male thread only. Threads exposed after joints are made up shall be painted with red lead to prevent rust. Teflon tape may be used at Contractor’s option.

H. Junctions of screwed pipe to bell and spigot cast iron shall be made with ring or half coupling screwed to end of galvanized pipe to form spigot end.

I. Junctions in all drainage lines shall be made with “Y” branches or 1/8 bends, unless closeness of connection prevents it, in which case, where direction of flow is from horizontal to vertical, sanitary tees may be used upon the approval of the Engineer’s superintendent.

J. Do not install pvc piping in air-handling ceiling spaces, unless wrapped with an appropriate insulation, Per Division 22 Section “Mechanical Insulation”.

3.4 INSTALLATION OF PIPING SPECIALTIES

A. Install piping specialties in accordance with Division 22 Section, “Piping Specialties.”

3.5 INSTALLATION OF SUPPORTS, ANCHORS & SEALS

A. Install supports, anchors, and seals in accordance with Division 22 Section, “Supports, Anchors & Seals.”

3.6 INSTALLATION OF DRAINAGE PIPING PRODUCTS

A. Cleanouts:
   1. Install in above-ground piping and below grade building drain/waste piping as indicated and as required by The International Plumbing Code; and at each change in direction of piping greater than 45°; at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping; including the vertical component of the piping. Install floor and wall cleanout covers for concealed piping, select type to match adjacent building finish.
   2. A cleanout shall be provided at no more than two feet above the base of each vertical storm, waste, or drain stack.
   3. Provide additional cleanouts as may be required for adequate rodding of the complete system.
   4. Cleanouts shall be flush with the surrounding wall or floor finish.
   5. Unless otherwise noted cleanouts shall not be installed in the center of corridors.
   6. Carpet markers shall be installed in all carpeted areas.

B. Flashing Flanges: Install flashing flange and clamping device with each stack and cleanout passing through waterproof membranes.

C. Vent Flashing Sleeves: Install on stacks passing through roof, secure over stack flashing in accordance with manufacturer's instructions.

3.7 INSTALLATION OF FLOOR DRAINS

A. Install floor drains in accordance with manufacturer’s written instructions and in locations indicated.

B. Coordinate with building waste and drain piping as necessary to interface floor drains with drainage piping systems.

C. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.

D. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

E. Position drains so that they are accessible and easy to maintain and coordinate the location with the architectural plans.

3.8 INSTALLATION OF BACKWATER VALVES

A. Install backwater valves in building waste and drain piping as indicated on the plans and as required by The International Plumbing code. For interior installations provide a cleanout cover flush with the floor, centered over the valve,

and of adequate size to remove the backwater valve cover for service.

3.9 INSTALLATION OF VENTS

A. All plumbing fixtures shall be vented to prevent siphoning of traps. Venting as shown on the plans is the minimum required. Vents and vent stacks shall be increased in size and/or number and relocated as required, to prevent trap siphoning and to comply with applicable codes, ordinances, statutes, regulations of all governmental bodies, without increase in contract price.

B. A vent stack shall be run parallel to each soil or waste stack to receive branch vents from fixtures and traps. Each vent stack shall originate from a soil or waste pipe at its base. Each soil or waste stack and each vent stack shall be carried through the roof. Where possible, soil, waste, or vent stacks shall be combined before passing through the roof so as to have as few roof openings as possible. Pipes running close to walls shall be offset away from such walls before passing through the roof to permit proper flashing. All vent pipes passing through the roof shall be sized as indicated on the drawings, and shall extend 12” above the roof.

C. All horizontal vent pipes shall grade to meet the requirements of all local and state codes.

D. Vent risers and branches shall connect to the soil and waste risers above the waste connection of the highest fixture.

E. Air admittance valve shall be used in lieu of venting <u>only</u> where shown on the plans and only where prior approval is granted by the local code enforcement authority.

3.10 EQUIPMENT CONNECTIONS

A. Provide soil and waste piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by The International Plumbing Code. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.11 PIPING TESTS

A. Test soil and waste piping system in accordance with the requirements of The International Plumbing Code.

END OF SECTION
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SECTION 223300 ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 22 1116; Domestic Water Piping.

1.2 SUMMARY

A. This Section includes the following electric water heaters:
   1. Storage type Domestic Water Heaters.

B. Compression tanks.

C. Water heater accessories.

1.3 SUBMITTALS

A. Product Data: Submit Manufacturer's Technical Product Data, Specifications, and Installation Instructions for each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Submit shop drawings showing piping connection configurations, power diagrams, and signal and control wiring.

C. Wiring Diagrams: Submit shop drawings detailing the manufacturer's electrical requirements for power supply wiring for water heaters. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Certificates of Shop Inspections and Data Reports: For each type of commercial water heater required to have an ASME label, signed by product manufacturer.

E. Source quality-control test reports.
   1. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
   2. Hydrostatically test commercial water heater storage tanks before shipment to minimum of one and one-half times pressure rating.
   3. Prepare test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: Submit maintenance data and parts lists for each water heater. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing the contents.

H. Record Drawings: At project closeout, submit record drawings of installed water heater systems, show the exact location and piping configuration in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of water heaters of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with water heaters similar to that required for this project.

C. Source Limitations: Obtain each type of water heater through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on the specific system indicated. Refer to Division 01 Section "Substitutions & Product Options."

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

G. ASME Compliance:
   1. Where ASME-code construction is indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

H. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

1.5 COORDINATION

A. Coordinate size and location of concrete bases with the actual equipment provided, and the Architectural and Structural Plans.

1.6 WARRANTY

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

B. Failures include, but are not limited to, the following:
   1. Structural failures including storage tank and supports.
   2. Faulty operation of controls.
   3. Deterioration of metals, metal finishes, and other materials beyond normal use.

C. Warranty Period(s): From date of Substantial Completion:
   1. Electric Water Heaters:
      a. Electric heating coil: Five years.
      b. Controls and Other Components: One year.

   2. Compression Tanks: One year.

PART 2 - PRODUCTS

2.1 STORAGE TYPE ELECTRIC HEATERS

A. Commercial, dual element, dual thermostat, Electric Water Heaters: Comply with UL 174 and ASHRAE/IESNA 90.1.
   1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
      a. AO Smith.
      b. Bradfford White.
      c. Rheem.

   2. Description: Dual elements with dual thermostats, diffuser dip tube for tank cleaning, CFC foam insulation, anode rod and a glass coated tank.
   3. Construction:
      a. Glass lined tank with two anode rods with and ASME rated T&P relief valve and a maximum working pressure of 150 psi.
      b. Incoloy stainless steel lower element.
      c. Connections shall be ¾” threaded connections.

2.2 COMPRESSION TANKS

A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
   1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
      a. AMTROL Inc.
      b. Armstrong Pumps, Inc.
      c. Taco, Inc.
      d. Watts Regulator Co.

   2. Construction:
      a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
      b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      c. Air-Charging Valve: Factory installed.

   3. Capacity and Characteristics: Refer to drawings.

2.3 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select each relief valve with sensing element that extends into storage tank.
   1. Water Heaters: ANSI Z21.22/CSA 4.4.

B. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand/skid for floor mounting and stacking units, and capable of supporting water heater and water.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/ IESNA 90.1-2004.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install water heaters on 4” high concrete bases.

B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

C. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section, "Piping Specialties," for hose-end drain valves.

E. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section, "Meters and Gages," for thermometers.

F. Install pressure gage(s) on inlet and outlet piping of commercial, water heater piping. Refer to Division 22 Section, "Meters and Gages," for pressure gages.

G. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

H. Fill water heaters with water.

I. Charge compression tanks with air.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Division 26 Section "Grounding."

D. Connect wiring according to Division 26 Section "Wiring and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
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SECTION 224200 PLUMBING EQUIPMENT AND FIXTURES

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 22 1116; Domestic Water Piping.

C. Section 22 1119; Piping Specialties.

D. Section 22 1316; Soil and Waste Piping Systems.

E. Division 26; Electrical connections to plumbing equipment and fixtures.

1.2 SUMMARY

A. Provide plumbing equipment, fixtures and trim, specified, shown on the plans and as required for a complete installation.

B. Provide scald protection devices as required for all fixtures required to have protection per the applicable codes.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data, specifications, installation instructions and dimensioned drawings for each type of fixture or piece of equipment. Include faucets, carriers, mixing valves, seats and any accessories for each item.

B. Wiring Diagrams: Submit shop drawings detailing the manufacturer's electrical requirements for power supply wiring for plumbing equipment and fixtures where required. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

C. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.

D. Source quality-control reports.

E. Field quality-control reports.

F. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for fixtures and equipment. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

G. Record Drawings: At project closeout, submit record drawings of installed components showing locations in accordance with the requirements of Division 01. Plumbing equipment, fixtures and trim, including catalog cut of each fixture type and trim item furnished, roughing-in dimensioned drawings, templates for cutting substrates, fixture carriers, installation instructions, start-up instructions, capacity and ratings, with selection points clearly indicated.

H. Shop Drawings: Submit assembly type shop drawings indicating dimensions, weights, required clearances, and methods of assembly of all components.

I. Wiring Diagrams: Submit ladder-type wiring diagrams for all components, clearly indicating all required field electrical connections.

J. Maintenance Data: Submit maintenance data and parts lists for each item of plumbing equipment, fixture type and trim item, including instructions for care of finishes, "trouble shooting" maintenance. Include this data in maintenance manual.

1.4 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in the manufacture of fixtures and equipment types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer’s Qualifications: Firm with at least 3 years of successful installation experience on projects with work similar to that required for this project.

C. Source Limitations: Obtain fixtures and equipment through one source from a single manufacturer where at all possible.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section “Substitutions & Product Options.”

E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

F. Comply with NSF 61, "Drinking Water System Components - Health Effects," for all components that will be in contact with potable water. Plumbing Fixture Standards: Comply with applicable portions of International Plumbing Code for installation of plumbing fixtures.

G. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems, and bath tub units.

H. ANSI Standards: Comply with ANSI A171.1 standard pertaining to plumbing fixtures for handicapped.

I. PDI Compliance: Comply with standards established by Plumbing and Drainage Institute pertaining to plumbing fixture supports.

J. Federal Standards: Comply with applicable Fed. Spec. WW-P-541/-Series sections pertaining to plumbing fixtures.

K. NAHB Label: Provide fiberglass bath tub units and shower stalls which have been tested and labeled by the National Association of Home Builders (NAHB) Research Foundation Inc.

L. UL Labels: Provide water coolers which have been listed and labeled by Underwriters Laboratories.

M. ARI Labels: Provide water coolers which are rated and certified in accordance with applicable Air-Conditioning and Refrigeration Institute standards.

N. UL and NEMA Compliance: Provide electric motors and electrical components required as part of plumbing equipment, which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.

O. NEC Compliance: Comply with National Electrical Code (ANSI/NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of plumbing equipment.

P. ANSI Compliance: Comply with ANSI Z223.1 (NFPA 54) "National Fuel Gas Code", as applicable to installation of gas-fired water heaters.

Q. AGA and NSF Labels: Provide water heaters which have been listed and labeled by American Gas Association and National Sanitation Foundation.

R. ASME Code Symbol Stamps: For the following equipment, comply with ASME Boiler and Pressure Vessel Code for construction, and stamp with ASME Code symbol:
   1. Commercial water heaters.
   2. Water softener pressure vessel.
   3. Water tanks.

S. ASME Relief Valve Stamps: Provide water heaters with safety relief valves bearing ASME valve markings.

T. Mineral Standards: Provide mineral products for water softeners, acceptable under state and local public health control regulations.

U. AWWA Compliance: Comply with applicable American Water Works Association standards pertaining to steel water tanks.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver plumbing equipment and fixtures individually wrapped in factory-fabricated containers.

B. Handle plumbing equipment and fixtures carefully to prevent breakage, chipping and scoring the fixture finish. Do not install damaged plumbing equipment or fixtures; replace and return damaged units to equipment manufacturer.

1.6 COORDINATION

A. Coordinate the size and location of concrete bases with the actual equipment provided and the Architectural and Structural Plans.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

A. Manufacturers, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:
1. Water Closets: Eljer, Kohler, American Standard, Toto, and Zurn.
2. Urinals: Eljer, Kohler, American Standard, Toto, and Zurn.
3. Lavatories: Eljer, Kohler, American Standard, Toto, and Zurn.
4. Lavatory Faucets: American Standard, Delta, Kohler, Moen, Toto and Zurn.
5. Sinks: Just, Advance Tabco, and Elkay.
6. Sink Faucets: Kohler, American Standard, Toto, Moen, and Zurn.
7. Garbage Disposals: In-Sink-Erator, Kitchenaid, Hobart, and Whirlpool.
8. Service Sinks: Stern-Williams, Kohler, American Standard, Fiat, and Zurn.
9. Water Coolers: Elkay, Oasis, and Halsey Taylor.
10. Floor Drains: Wade, Josam, Watts, Toto, and Zurn.
11. Cleanouts: Wade, Zurn, Josam, Jay R. Smith Mfg. Co., and Watts.
12. Wall Hydrants: Woodford, and Zurn.
13. Toilet Seats: Church, Bemis, Olsonite, Zurn and Toto.
14. Carriers: Wade, Zurn, Josam, Jay R. Smith Mfg. Co., and Watts
15. Trim: McGuire, Chicago Faucet, Dearborn Brass, Zurn, Engineered Brass Co. (EBC)

2.2 EQUIPMENT

A. Manufacturers, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

1. Water Heaters: Rheem, Lochinvar, Bradford-White, A.O. Smith, and State.
2. Backwater Valves: Wade, Jay R. Smith, Josam, and Zurn.

3. Back Flow Preventers: Refer to Division 22 Section, "Domestic Water Piping Systems."
4. Thermostatic Mixing Valves:
   a. Point of Use Tempering Valve: Apollo, Watts, and Leonard.

B. Fixture Carriers: Jay R. Smith Mfg. Co., Watts, Josam, and Zurn.

2.3 FIXTURES AND TRIM

A. Whenever possible all fixtures, trim, faucets, etc. specified as part of the project shall be of the same manufacturer's products.

B. Where manufacturer's numbers for a complete assembly are specified, the assembly shall be modified as required to meet the project requirements.

C. All fixtures shall be furnished complete as specified with brass piping, fittings, stops, trim and brackets. All exposed brass piping and fittings shall be chrome plated.
   1. Traps shall be 17 gauge chrome plated brass.
   2. Stops shall be chrome plated quarter-turn brass ball valves with chrome plated brass tubing and braided flexible stainless steel risers with a chrome–plated steel escutcheon.

D. Each fixture shall have an air gap connection or vacuum breaker on the domestic water connection as required by the local authority having jurisdiction and by all local and state health departments.

E. Water connection sizes are specified as a minimum size and shall be increased as required by the equipment or fixture manufacturer.

2.4 CARRIERS

A. Drinking fountains/water coolers, urinals, and water closets] shall be supported by a floor mounted carrier. Where urinals are mounted to a (minimum 6" thick) masonry wall the carrier may be omitted.
   1. Urinal carriers shall be equal to Zurn Model Z1217 selected to match the fixture. Verify the wall thickness and installation requirements prior to submitting and furnishing the carrier.

B. Carriers shall be selected for the particular fixture, piping arrangement and conditions at each location.

C. Special sinks, where wall mounted, shall be supported with a carrier designed for the fixture.

2.5 HANDICAPPED ACCESSIBLE WATER CLOSETS

A. For handicapped accessible water closets the flush handle shall be located on the wide side of the stall. Tank type water closets shall be furnished with the handle on the correct side of the tank. Flush valves shall be installed with the valve handle on the correct side.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION

A. Examine roughing-in work of domestic water and waste piping systems to verify actual locations of piping connections prior to installing equipment and fixtures. Also examine floors and substrates, and conditions under which fixture or equipment work is to be accomplished. Correct any incorrect locations of piping, and other unsatisfactory conditions for installation of plumbing fixtures and equipment. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install plumbing equipment and fixtures of types indicated where shown and at specified heights; in accordance with manufacturer's written instructions, roughing-in drawings, and with recognized industry practices. Ensure that plumbing equipment and fixtures comply with requirements and serve intended purposes. Comply with applicable requirements of the International Plumbing Code pertaining to installation of plumbing equipment and fixtures.

B. Fasten plumbing equipment and fixtures securely to indicated supports or building structure; and insure that they are level and plumb. Secure plumbing supplies behind or within wall construction so as to be rigid, and not subject to pull or push movement.

C. Fixtures intended to meet ADA requirements shall be installed at the recommended heights and with the required clearances.

D. Sinks and lavatories intended to meet ADA requirements shall be installed with offset tailpieces and insulated traps and supplies.

E. Fixtures that could present a scalding hazard to the building occupants shall be protected by a thermostatic mixing valve or other approved anti-scald device (i.e. all hand sinks supplied by a water heater stored at 140 deg. F).

F. Wall Hydrants shall be provided with the depth as required for proper installation due to the wall thickness, insulation thickness and structure. The contractor shall provide varying lengths of hydrants as required by the job site conditions.

3.3 OWNER FURNISHED FIXTURES AND/OR EQUIPMENT

A. Provide rough-ins and final connections to all owner furnished equipment including valves, piping, traps, vacuum breakers, pressure regulators, solenoid valves, etc. Required for connection of the fixture or equipment for a complete installation.

B. Install all faucets, drains, tailpieces, overflows, etc. furnished with owner provided fixtures and equipment for a complete installation.

C. All visible exposed piping and fittings for owner furnished fixtures and equipment shall be chrome plated brass. Exposed piping supports and braces shall be chrome plated.

D. All service lines to owner furnished fixtures and equipment shall be appropriately valved, capped, plugged and protected until connections are made.

3.4 CLEAN AND PROTECT

A. Clean plumbing equipment and fixtures of dirt and debris upon completion of installation.

B. Protect installed equipment and fixtures from damage during the remainder of the construction period.

3.5 FIELD QUALITY CONTROL

A. Upon completion of installation of plumbing equipment and fixtures and after units are water pressurized when required, test units to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

B. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove and replace with new unit. Feasibility and match to be judged by Architect. Remove damaged, cracked, or dented units and replace with new units.

3.6 EXTRA STOCK

A. Furnish special wrenches and other devices necessary for servicing plumbing equipment, fixtures, and trim to Owner with receipt. Furnish one device for every 10 units.

END OF SECTION
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SECTION 23 0500 COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED WORK

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other Division 23 sections.

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Grout.
7. HVAC demolition.
8. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
10. Concrete bases.
11. Supports and anchorages.

1.3 CODE REQUIREMENTS, FEES, AND PERMITS

A. Provide work in accordance with applicable codes, rules, ordinances, industry standards, utility company regulations, and regulations of local, state and federal governments and other authorities having lawful jurisdiction.

B. Unless otherwise noted, conform to latest editions and supplements of following codes, standards or recommended practices as adopted by the authority having jurisdiction:

1. Arkansas Mechanical Code
2. Arkansas Plumbing Code
3. Arkansas Fuel Gas Code
4. Arkansas Fire Prevention Code
5. Arkansas Energy Code
6. ASA - American Standards Association
7. ASME - American Society of Mechanical Engineers
8. ASTM - American Society of Testing Materials

9. NBS - National Bureau of Standards
10. NEMA - National Electrical Manufacturer's Association
11. NFPA - National Fire Protection Association
12. UL - Underwriters' Laboratories, Inc.
13. NSF - National Sanitation Foundation
14. Occupational Safety and Health Act of 1970
15. Life Safety Code, N.F.P.A. No. 101
16. N.F.P.A. 17/17A, 72, 72B, 54 and 96.

C. In case of differences between building codes, regulations, laws, local ordinances, industry standards, and utility company regulations, and the Contract Documents, the most stringent governs. Promptly notify Architect in writing of any such difference.

D. Obtain required permits in connection with this work and pay fees in connection therewith. Coordinate with the serving utility companies for the connections to utilities and pay charges for same, including inspection fees and meters if and when required.

1.4 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and within chases.

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

1.5 PRODUCT SUBSTITUTION PROCEDURES

A. Manufacturers’ of other products than those listed may be considered. Submit substitution request in compliance with Section 01 2500 “Substitutions &

Product Options." All Divisions 22 and 23 substitution requests shall be submitted at least five working days prior to bid. Requests for substituion received by Engineer later than 5 days prior to bid opening may be rejected without review.

1.6 SUBMITTALS

A. The format and quantity of the submittals shall comply with the requirements of Division 01 General requirements and other Divisions 22 and 23 Sections.

B. Refer to the individual sections of Divisions 22 and 23 for additional and/or specific requirements.

C. Arrange product data in sets/electronic files with sections corresponding to and in the same order as Division 22 and 23 sections.

D. Provide an index of the sections at the front of the submittal listing the section number and items included in each section.

E. Provide cover sheet for each section, listing each type of material or equipment, designation and model number if any, and the name of the supplier.

F. Clearly indicate sizes, capacities, brand names, motor HP, accessories, options, materials, gages, dimensions, and other pertinent information. Pertinent information shall include items scheduled on the drawings as a minimum. Clearly indicate designations corresponding to drawings and schedules.

G. Provide performance charts and curves, installation instructions, and complete wiring diagrams.

H. Submittals failing to meet specified requirements will be returned without review or approval.

1.7 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 01 Section Project Management and Coordination, to a scale of 1/4"=1'0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of major mechanical systems, equipment, and materials. Include the following:

a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
b. Exterior wall and foundation penetrations.
c. Fire-rated wall and floor penetrations.
d. Equipment connections and support details.
e. Sizes and location of required concrete pads and bases.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
4. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, and other ceiling-mounted devices.

B. Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the work, including, but not necessarily limited to, the following:

1. Equipment Room Layouts: Specific equipment installations, including, but not limited to the following:

a. Furnaces.
b. Water Heaters.

1.8 PLANS

A. Plans show general arrangement of fixtures and equipment systems. Follow closely as actual building construction and work of other trades will permit.

B. Consider architectural and structural plans part of this work insofar as these plans furnish information relating to design and construction of building. These plans take precedence over the Mechanical Plans.

C. Due to the small scale of the Mechanical Plans, it is not possible to indicate all offsets, fittings and accessories which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings and accessories required to meet the conditions.

D. Record difference between mechanical work as installed and as shown in Contract Documents on a set of Record Documents. Return these prints to Architect at completion of project.

E. Do not scale mechanical drawings for dimensions. Accurately lay out work from dimensions indicated on structural and architectural drawings, and as verified in the field.

1.9 LOCAL CONDITIONS

A. Visit site and determine existing local conditions affecting work.

B. No subsequent compensation will be considered for any consequence related to failure to determine site conditions or nature of existing or new construction.

C. Locations and elevations of the various utilities and services included within the scope of this work have been obtained from substantially reliable sources and are offered as a general guide only, without guarantee as to accuracy. Verify the location and elevation of all utilities and their relation to the work.

1.10 CONCRETE BASES

A. Coordinate the size and location of concrete bases with actual equipment provided and the Architectural and Structural Plans.

B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes of the Project.

1. Construct concrete bases of dimensions indicated, but not less than 6 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section, “Cast-in-Place Concrete.”

1.11 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code-Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Certify that each welder has passed ASW qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of different electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at the expense of the Contractor. No additional money will be paid due to lack of coordination between the trades.

1.12 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Store products in either environmentally controlled spaces or supply sufficient electric heat internally to prohibit degradation from condensation.

1.13 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 01 Section Execution and Closeout Procedures. In addition to the requirements specified in Division 01, indicate installed conditions for:

1. Major mechanical systems, size and location, for both exterior and interior; and locations of control devices.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

B. Engage the services of a Land Surveyor or Professional Engineer registered in the state in which the project is located as specified in Division 01 Section Execution and Closeout Procedures to record the locations of underground installations.

1.14 OPERATION AND MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 01 Section Execution and Closeout Procedures. In addition to the requirements specified in Division 01, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

1.15 SYSTEM DEMONSTRATION AND OWNER'S INSTRUCTIONS

A. Demonstrate to the satisfaction of Owner's representative that mechanical systems and components are operating properly.

B. Utilizing Operation and Maintenance Manual, provide Owner's representative(s) instruction in the operation and maintenance of systems.

C. Provide minimum of 8 hours formal instruction balanced as required between classroom type instruction and "hands-on" instruction for each of the following:

1. Plumbing Systems and Equipment.
2. Mechanical Systems and Equipment.

D. Provide additional instruction where necessary to fully prepare Owner to operate and maintain systems and components.

E. Refer to individual Division 26 sections for additional requirements.

F. Demonstration and instruction to begin after Substantial Completion and before final payment.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series or BAg1, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: 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 Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

F. 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.

2.4 SLEEVES

A. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gages: 3" and smaller, 20 gage; 4" to 6", 16 gage; over 6", 14 gage.

B. Steel-Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

C. Iron-Pipe: Fabricate from cast-iron or ductile-iron pipe with plain ends and an integral water stop, unless otherwise indicated.

D. Plastic-Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.

E. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.5 MECHANICAL SLEEVE SEALS

A. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation. Unit shall be equal to a unit manufactured by Thunderline.

B. Fire Protection Mechanical Sleeve Seals: 3-hour fire rated modular mechanical type, consisting of interlocking fire-resistant silicone rubber links shaped to continuously fill the annular space between the pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when bolts are tightened, providing watertight and fire resistant seal. Units to be submitted for approval before installation.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.

1. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide solid, non-hinged cast brass or sheet brass escutcheons.
2. Pipe Escutcheons for Dry Areas: Provide steel solid, non-hinged escutcheons with a set screw.

B. One-Piece, Brass, Deep-Pattern Type: Piping with fitting or sleeve protruding from wall.

C. One-Piece, Cast-Brass Type: With a set screw: Polished Chrome-plated (finished spaces); Rough brass (unfinished service spaces).

D. One-Piece, Floor-Plate Type: Cast-iron floor plate.

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.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

A. Refer to Division 01 Sections for cutting and patching requirements and Division 02 Sections for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping that shall be removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping that shall be abandoned in place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts that shall be removed: Remove portion of ducts indicated to be removed and seal remaining ducts airtight with same or compatible ductwork material.
4. Ducts that shall be abandoned in place: Cap or seal ducts airtight with same or compatible ductwork material.
5. Equipment that shall be removed: Disconnect and cap services and remove equipment.
6. Equipment that shall be removed and reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment that shall be removed and salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

N. 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.

O. 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.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Sections for penetration firestopping materials information.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections for interior painting and exterior painting information.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Sections for metal fabrication information for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.9 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pumps 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
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SECTION 23 0513 COMMON MOTOR REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED WORK

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

1.2 SUMMARY

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

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are specified within the individual equipment specification sections.

C. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

1.3 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.

1.4 REFERENCES

A. NEMA Standards MG 1: Motors and Generators.

B. Comply with National Electrical Code (NEC) (NFPA 70).

C. IEEE Standard 112: Tests for Motor Efficiency.

1.5 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

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

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

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

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION
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SECTION 23 0529 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 23 0700; HVAC Insulation.

C. Section 23 2300; Refrigerant Piping.

1.2 SUMMARY

A. Section Includes:

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

B. Performance Requirements

1. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
2. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
3. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications, installation instructions and dimensioned drawings for each type of support. Include fabrication and installation details for each support.

B. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.

C. Welding Certificates.

D. Source quality-control reports.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with support systems work similar to that required for this project.

B. Source Limitations: Obtain each type of support equipment through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Substitutions & Product Options."

D. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

E. Pipe Welding Qualifications: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for Intended location and application.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

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

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

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

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 EQUIPMENT SUPPORTS

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

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Cleaning and Touchup painting of field welds, bolted connections and abraded areas of shop paint on miscellaneous metal as specified in Division 09 Painting sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION
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SECTION 230553 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED WORK

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Warning tags.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's specifications, installation instructions and dimensioned drawings for each type of identification.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of system products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Source Limitations: Obtain each type of identification product through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Substitution & Product Options."

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number,

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Near major equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
5. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Refrigerant Piping:

   a. Background Color: Yellow.
   b. Letter Color: Black.

2. Natural Gas Piping:

a. Background Color: Yellow
b. Letter Color: Black

3.4 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION
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SECTION 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED WORK

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

1.2 SUMMARY

A. Balancing of Air Systems:

1. Constant-volume air systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

A. Qualification Data: Within 45 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

G. Operation and Maintenance Manual Data: Submit a copy of the final approved Test & Balance report in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.

B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS - Not Applicable

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, engage one of the following:

1. Airetech Corporation – Little Rock, AR (501) 280-0404.
2. Powers of Arkansas – North Little Rock, AR (501) 374-5420.
3. Harrison Energy Partners – Little Rock, AR (501 661-0621.

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Sections and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine operating safety interlocks and controls on HVAC equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Temperature-control systems are operational.
3. Equipment and duct access doors are securely closed.
4. Balance, smoke, and fire dampers are open.
5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

6. Windows and doors can be closed so indicated conditions for system operations can be met.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance"; ASHRAE 111; NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP)] units.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is sealed as specified in Division 23 Sections.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

   a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

   a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

   a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.8 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering and leaving air temperatures.

C. Record compressor data.

3.9 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.10 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.

3.11 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.12 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.

8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Settings for supply-air, static-pressure controller.
    g. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Terminal units.
4. Balancing stations.
5. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.

c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Cooling-coil static-pressure differential in inches wg.
g. Heating-coil static-pressure differential in inches wg.
h. Outdoor airflow in cfm.
i. Return airflow in cfm.
j. Outdoor-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..

h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Refrigerant expansion valve and refrigerant types.
i. Refrigerant suction pressure in psig.
j. Refrigerant suction temperature in deg F.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.

f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following report data:

1. System and air-handling-unit number.
2. Location and zone.
3. Traverse air temperature in deg F.
4. Duct static pressure in inches wg.
5. Duct size in inches.
6. Duct area in sq. ft..
7. Indicated air flow rate in cfm.
8. Indicated velocity in fpm.
9. Actual air flow rate in cfm.
10. Actual average velocity in fpm.
11. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

K. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.

b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.13 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

   a. Measure airflow of at least 10] percent of air outlets.
   b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
   c. Verify that balancing devices are marked with final balance position.
   d. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect/Engineer].
3. Architect/Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.14 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION
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SECTION 230700 HVAC INSULATION

PART 1 - GENERAL

1.1 SCOPE

A. Piping System Insulation: Condensate drain piping systems in unconditioned spaces and Refrigerant piping systems.

B. Ductwork System Insulation: Dual temperature ductwork, andAir plenums and equipment housings.

1.2 RELATED WORK

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

B. Section 22 0700; Mechanical Insulation.

C. Section 23 3000; Air Distribution.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of insulation products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with insulation systems similar to that required for this project.

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

D. Product Options: Drawings and specifications indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Substitutions & Product Options."

E. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's specifications and installation instructions for each type of insulation. Include the manufacturer's product number, thickness, thermal conductivity, jackets (both factory and field applied, if any) and furnished accessories for each system requiring insulation.

B. Certifications: Submit manufacturers' certifications to show compliance with these specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

C. Shop Drawings: Submit shop drawings for insulation installations including:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
3. Detail removable insulation at piping specialties, equipment connections, and access panels.
4. Detail application of field-applied jackets.

D. Source quality-control reports.

E. Field quality-control reports.

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.

B. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of products.

C. Protect insulation against dirt, water, chemical or mechanical damage. Do not install damaged insulation.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Grade 1, Type I for tubular materials and Type II for sheet materials. Polyolefin is not an approved substitution and shall not be utilized.

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

a. Aeroflex USA Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

F. Flexible Elastomeric Exterior Sheet Insulation: Flexible expanded closed cell structure with a smooth skin on the interior side and a UV and damage resistant 12 mil laminated membrane on the exterior side. The insulation shall comply with ASTM C 534 for Grade 1, Type II sheet material. The puncture resistant embossed surface and seal tape shall provide a weatherproof seal that doesn't require painting. A 10 year membrane warranty shall be provided by the manufacturer.

1. Manufacturer, subject to compliance with the requirements, shall be the following or an Engineer approved equivalent:

a. Armacell LLC; AP Armatuff.

G. Fiberglass Wrap 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. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Duct Wrap.
d. Owens Corning; All-Service Duct Wrap.

H. Rigid Fiberglass Insulation Board: 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 FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equal:

a. CertainTeed Corp.; Commercial Board.
b. Johns Manville; 800 Series Spin-Glas.
c. Knauf Insulation; Insulation Board.
d. Owens Corning; Fiberglas 700 Series.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

   a. Johns Manville; Micro-Lok.
   b. Knauf Insulation; 1000 Pipe Insulation.
   c. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 541, Class I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Flexible Elastomeric Pipe Insulation: Flexible expanded closed cell structure with a smooth skin on both sides per ASTM C534.

1. Thermal Conductivity: 0.25 BTU·in/h· ft^2 ·°F at 75°F and 90°F per ASTM C177 or C518.
2. Water vapor permeability: 0.05 Perm·in per ASTM E96 Procedure A.
3. Composite Surface Burning Characteristics: Flame spread of 25 and a developed smoke rating of 50 per ASTM E84.
4. Water Absorption: 0.2% by volume per ASTM C209.
5. Do <u>not</u> use for any systems with operating temperatures above 140° F.
6. Polyolefin shall not be considered an equal and is not allowed for any piping system.
7. Adhesive: Solvent based contact adhesive as recommended by the manufacturer.

K. PVC Premolded Piping, Fitting and Valve Covers:

1. Fabricated from one piece polyvinyl chloride plastic (PVC).
2. Piping covers shall have a minimum thickness of 20 mils.
3. Fitting and valve covers shall have a minimum thickness of 30 mils.

L. Aluminum Premolded Piping, Fitting and Valve Covers:

1. Constructed of 0.016” (minimum) thick aluminum alloy conforming to ASTM B209.
2. Fitting and valve covers shall be formed to fit from the manufacturer.
3. Lined with a 3 mil thick moisture retarder, laminated with heat and pressure.
4. Finish shall be a smooth bare mill finish.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates

and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with ASTM E 84.

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

   a. Aeroflex USA Inc.; Aeroseal.
   b. Armacell LCC; 520 Adhesive.
   c. Foster Products Corporation, H. B. Fuller Company; 85-75.
   d. RBX Corporation; Rubatex Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mineral-Fiber Adhesive: Comply with ASTM C 916, Type I.

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

   a. Carlisle HVAC Products;
   b. Childers Products, Division of ITW; CP-82.
   c. Foster Products Corporation, H. B. Fuller Company; 85-20.
   d. Marathon Industries, Inc.; 225.
   e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ Adhesive, and FSK and PVC Jacket Adhesive: Comply with ASTM C 916 for bonding insulation jacket lap seams and joints.

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

   a. Childers Products, Division of ITW; CP-82.
   b. Foster Products Corporation, H. B. Fuller Company; 85-20.
   c. Marathon Industries, Inc.; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

    a. Dow Chemical Company (The); 739, Dow Silicone.
    b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    c. P.I.C. Plastics, Inc.; Welding Adhesive.
    d. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 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 and outdoor use on below ambient services.

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

    a. Childers Products, Division of ITW; CP-35.
    b. Foster Products Corporation, H. B. Fuller Company; 30-90.
    c. Marathon Industries, Inc.; 590.
    d. Mon-Eco Industries, Inc.; 55-40.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

a. Childers Products, Division of ITW; CP-76-8.
b. Foster Products Corporation, H. B. Fuller Company; 95-44.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire and water resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

a. Childers Products, Division of ITW; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 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.

2.6 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. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto PVC Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

   a. Sheet and roll stock ready for shop or field sizing.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

d. Factory-Fabricated Fitting Covers:

(1) Same material, finish, and thickness as jacket.
(2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
(3) Tee covers.
(4) Flange and union covers.
(5) End caps.
(6) Beveled collars.
(7) Valve covers.
(8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
b. Compac Corp.; 104 and 105.
c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
b. Compac Corp.; 110 and 111.
c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.

3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
   d. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   b. Compac Corp.; 120.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
   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 lbf/inch in width.

2.8 SECUREMENTS

A. Bands:

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:\

   a. Childers Products; Bands.
   b. PABCO Metals Corporation; Bands.
   c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with closed seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

   a. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

      (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, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

   a. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

      (1) AGM Industries, Inc.; CWP-1.
      (2) GEMCO; Cupped Head Weld Pin.
      (3) Midwest Fasteners, Inc.; Cupped Head.
      (4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

(1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
(2) GEMCO; Perforated Base.
(3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

(1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
(2) GEMCO; Press and Peel.
(3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
d. Adhesive-backed base with a peel-off protective cover.

5. 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. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

(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. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

a. C & F Wire.
b. Childers Products.
c. PABCO Metals Corporation.
d. RPR Products, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with the requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches on center.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches on center.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation on the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

Q. Equipment Exposed to Weather: Protect outdoor insulation from weather by installation of weather-barrier mastic protective finish, or jacketing, as recommended by the manufacturer.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor

and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. 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.

3.5 DUCTWORK SYSTEM INSULATION

A. Refer to drawings and Division 23 Section, “Air Distribution,” for extent of internally lined ductwork insulation and the extent of the installation of duct wrap.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

C. Provide metal aluminum, jackets and covers for all insulated piping exposed to the outdoors. Install metal jackets with 2-inch overlap at longitudinal and butt joints. Overlap longitudinal joints to shed water. Seal butt joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with aluminum draw bands 12 inches on center and at butt joints. Screw fasteners not permitted. Provide factory aluminum covers for all fittings. PVC fitting covers not permitted.

D. Provide a PVC jacket on all insulated pipe below 9’-0” above the finish floor where exposed in occupied spaces.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
3. Install fitted PVC cover.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
5. Install fitted PVC cover.

3.8 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches on center.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

D. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches on center.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches on center 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 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch on center. Install vapor barrier

consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches on center.
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 on center.

E. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches on center.
b. On duct sides with dimensions larger than 18 inches, space pins 16 inches on center 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 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch on center. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches on center.

3.9 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.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches on center and at end joints.

3.10 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.11 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Exterior Insulation:

1. Rectangular supply, return or exhaust located in a nonconditioned, ventilated space (i.e. a ventilated attic).
2. Round supply or return ducts.
3. Exhaust between isolation damper and penetration of building exterior.

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.
7. Double-wall insulated ductwork.

3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, supply-air, return-air, outdoor-air, and exhaust-air duct and plenum insulation shall be the following:

1. Rectangular Duct:

a. Mineral-Fiber Blanket: 2 inches thick and 1-lb/cu. ft. nominal density.
b. Duct Liner complying with Division 23 Section “Air Distribution.”

2. Round Duct:

a. Mineral-Fiber Blanket: 2 inches thick and 1-lb/cu. ft. nominal density.

B. Exposed supply-air, return-air, outdoor-air, and exhaust-air duct and plenum insulation shall be the following:

1. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

3.13 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.14 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
b. Flexible Elastomeric: 1/2 inch thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. Liquid lines on units 5 tons and smaller do not require insulation.
2. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: ¾ inches thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3. Provide a PVC jacket on all insulated pipe below 9’-0” above the finish floor where exposed in occupied spaces.

3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1. Liquid lines on units 5 tons and smaller do not require insulation.
2. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: ¾ inches thick.

b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3. All exterior insulated piping shall have a metal jacket or have two coats of the manufacturer's recommended protective coating.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

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

C. Pipe, pipe fittings / elbows:

1. PVC: 20 mils thick.

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. All Exposed Exterior Piping:

1. Aluminum, Smooth: 0.016 inch thick.

3.18 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

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SECTION 232300 REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 23 0700; HVAC Insulation.

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data, specifications, installation instructions and dimensioned drawings for each type of valve or refrigerant piping specialty. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Filter dryers.

B. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.

C. Welding Certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" article.

D. Source quality-control reports.

E. Field quality-control reports.

F. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for refrigerant valves and piping specialties. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of ? system products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with systems work similar to that required for this project.

C. Source Limitations: Obtain each type of equipment through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Substitutions & Product Options."

E. Welding Qualifications: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for Intended location and application.

F. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

G. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

H. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.5 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

2.2 VALVES AND SPECIALTIES

A. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

B. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

C. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.

6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

D. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

2.3 REFRIGERANTS

A. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

1. Atofina Chiemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2 and smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

B. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

C. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

D. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

E. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Division 23 Section, "Instrumentation and Control for HVAC," for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed below grade.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

R. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."

S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

U. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealers" for materials and methods.

V. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

W. Insulate refrigerant piping according to Division 23 Section “HVAC Insulation.”

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.

3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

   a. Fill system with nitrogen to the required test pressure.
   b. System shall maintain test pressure at the manifold gage throughout duration of test.
   c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION
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SECTION 233000 AIR DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 22 0700; Mechanical Insulation.

C. Section 23 0593; Testing, Adjusting and Balancing for HVAC.

D. Section 23 0700; HVAC Insulation.

E. Section 23 3300; Air Duct Accessories.

F. Division 26; Electrical work, including electrical service to smoke dampers; not work of this section.

1.2 SUMMARY

A. Section includes air distribution, complete, including ductwork, duct liner, sealants and gaskets, hangers and supports.

B. Ductwork:

1. Low Pressure Ductwork: Defined as ductwork subjected to velocities of 1500 fpm or less, and operating pressure of 2" w.g. or less, positive or negative, for air-conditioning and heating supply air systems,fresh air supply systems, andmechanical exhaust systems,.

C. Outlets and Inlets: Ceiling air diffusers and grilles, wall registers and grilles, and louvers.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data, specifications, installation instructions and dimensioned drawings for each type of manufactured product, factory-fabricated ductwork, air treatment equipment, air inlets and air outlets. Include the following:

1. Submit manufacturer's air treatment equipment specifications and installation instructions including, but not limited to, dimensions, required clearances and access, flow capacity including initial and final pressure drop at rated air flow, efficiency and test method, and fire classification.
2. Submit manufacturer’s data on duct liner and adhesives.
3. Submit manufacturer's data on duct sealants and gaskets.
4. Submit manufacturer's data on outlets and inlets including the following:

    a. Schedule of outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
    b. Data sheet for each type of outlet and inlet, and accessory furnished, indicating construction, finish, and mounting details.
    c. Performance data for each type of outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.

B. Shop Drawings:

1. Submit shop drawings showing dimensioned layouts of ductwork showing both the accurately scaled ductwork and its relation to the space enclosure. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced.

C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

D. Welding Certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" article.

E. Source quality-control reports.

F. Field quality-control reports.

G. Test Reports: Submit leak test report for each duct system tested, including each hood exhaust system.

H. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for system materials and products. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

I. Record Drawings: At project closeout, submit record drawings of installed duct systems, show exact location of duct and air treatment equipment, air inlets and air outlets in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in the manufacture of air distribution products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer’s Qualifications: Firm with at least 3 years of successful installation experience on projects with ductwork systems similar to that required for this project.

C. Source Limitations: Obtain each type of ductwork accessory or equipment through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section “Substitutions & Product Options.”

E. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

G. Standards:

1. Comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) low pressure duct construction standards.
2. Comply with applicable portions of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to duct construction.
3. American Standards: ASTM C 518 2004.

H. UL Compliance:

1. Construct, test, and label fire dampers in accordance with Underwriters Laboratories (UL) Standard 555 "Fire Dampers and Ceiling Dampers."

I. NFPA Compliance:

1. Comply with ANSI/NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" and ANSI/NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

1.5 PERFORMANCE REQUIREMENTS

A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Deliver outlets and inlets wrapped in factory-fabricated fiberboard type containers. Identify on outside of container type of outlet or inlet and location

to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

C. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping. Store outlets and inlets in original cartons and protect from weather and construction work traffic.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions.

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DUCTWORK MATERIALS

A. General:

1. Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements, including proper connection of ductwork and equipment.
2. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains and discolorations, and other imperfections, including those which would impair painting.

C. Except as otherwise indicated, fabricate ductwork from lockforming quality galvanized sheet steel complying with ASTM A 653, G90 zinc coating; mill phosphatized or “paint grip” finish for exposed locations.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum or stainless steel ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. 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.

2.4 FLEXIBLE DUCTS

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Novaflex.
4. Buckley.

B. Insulated, Flexible Duct: UL 181, Class 1 air duct constructed in compliance with NFPA 90A with multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1-inch wg negative.
2. Maximum Air Velocity: 4,000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-value: R-5.0 at a mean temperature of 75 deg. F.

C. Flexible Duct Connectors:

1. Clamps:

a. Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2. Non-Clamp Connectors: Liquid adhesive plus tape.

2.5 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard." Liner shall have an anti-microbial agent to not support microbial growth as tested in accordance with ASTM G 21 and G 22. Fire ratings shall not exceed 25 for flame spread and 50 for smoke developed when tested according to ASTM E 84 "Standard Test Method for Surface Burning Characteristics of Building Materials."

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

a. CertainTeed Corporation.
b. Johns Manville.

c. Knauf Insulation.
d. Owens Corning.

2. Maximum Thermal Conductivity:

a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

3. Thicknesses:

a. 1" thick 3 pound per cubic foot density insulation.
b. 2” thick 6 pound per cubic foot density insulation.

4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

B. Insulation Pins and Washers: 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. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Non-hardening, non-migrating mastic, liquid neoprene based cement or liquid elastic sealant (type applicable for fabrication/installation detail) as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork or for cementing fitting components and longitudinal seams in ductwork. The surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Foil Tape: Pressure sensitive tape with foil backing, non-hardening, as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork.

C. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

D. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone or elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.7 HANGERS AND SUPPORTS

A. Ductwork Support Materials:

1. For concealed galvanized ductwork, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles.
2. For all exposed galvanized duct that shall be painted, provide matching galvanized steel support materials.
3. For exposed stainless steel ductwork, provide matching stainless steel support materials.
4. For aluminum ductwork, provide aluminum support materials except where materials are electrolytically separated from ductwork.
5. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
6. Hanger Rods for Corrosive Environments: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
7. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
8. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.8 DUCTWORK FABRICATION

A. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure and leakage classifications:

1. Supply Ducts: Leakage class: 3; refer to the “Duct Schedule” article for the duct pressure classification.

2. Return, Exhaust, and Low Pressure Supply Ducts: Leakage class: 24; refer to the “Duct Schedule” article for the duct pressure classification.

B. Shop fabricate ductwork in 4, 8, 10 or 12-foot lengths, unless otherwise indicated or required to complete runs. Pre-assemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for reassembly and coordinated installation.

C. Shop fabricate ductwork of gages and reinforcement complying with SMACNA standards latest edition, or shop fabricate ductwork of gages and reinforcement complying with ASHRAE Handbook and Product Directory, 1979 Equipment Volume, Chapter 1 "Duct Construction.”

D. Fabricate duct fittings to match adjoining ducts and to comply with duct requirements as applicable to fittings.

E. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers.

F. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible.

2.9 GRAVITY VENTILATORS

A. General: Except as otherwise indicated, provide standard prefabricated gravity ventilator units of type and size indicated, modified as necessary to comply with requirements and as required for complete installation.

B. Hooded Gravity Ventilators:

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

   a. Aerovent, Inc.
   b. Greenheck Fan Corporation
   c. Loren Cook Co.

2. Provide gravity ventilators, hooded type, curb mounted, of size, type and capacity as scheduled.

   a. Type: Stationary, natural draft type. Provide weatherproof housings to match power ventilators in material and finish. Provide square or rectangular base to suit roof curb.

b. Bird Screens: Provide removable bird screens, 1/2" mesh, 16 gage aluminum or galvanized steel wire.

3. Bird Screen: Provide removable bird screens, 1/2" mesh, 16 ga. aluminum or galvanized steel wire.

C. Prefabricated Roof Curbs:

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

   a. Custom Curb, Inc.
   b. Pate Co.

2. General: Provide manufacturer's standard shop-fabricated units, modified if necessary to comply with requirements.
3. Fabricate structural framing for units of structural quality sheet steel (ASTM A 1011, Grade 40), formed to profiles indicated or, if not indicated, to manufacturer's standard profiles for coordination with roofing, insulation and deck construction. Include 45° cant strips and deck flanges with offsets to accommodate roof insulation. Weld corners and seams to form watertight units. Fabricate units from zinc-coated steel, ASTM A 653, Grade C, designation G90 hot-dip coating, mill phosphatized. Clean and paint with rust-inhibitive metal primer paint, of type recommended by manufacturer, 2.0 mils dry film thickness.
4. Sloping Roof Decks: For deck slopes of one inch per foot or more, fabricate support units for form level top edge. Where slope is less than one inch per foot, provide tapered wood nailers (treated wood) at top of support units to form level top edge.
5. Gage and Height: Fabricate units of metal gage and to height above roof surface as indicated. Where gage or height are not indicated, fabricate units of 14 gage metal and height of 14 inches.
6. Provide treated wood nailer, not less than 1-5/8" thick and of width indicated, but not less than width of support wall assembly. Anchor nailer securely to top of metal frame unit.
7. Provide lumber pressure treated with water-borne preservatives for "above ground" use, complying with AWPB U1.
8. Insulate units inside structural support wall with rigid glass fiber insulation board of approximately 3-lb. density and 1-1/2" minimum thickness, except as otherwise indicated.
9. Provide support liners where shown, formed of 22 gage galvanized sheet metal, mill phosphatized, flanged at lower edges. Extend support liners through deck construction to coordinate with ductwork below as indicated.

10. Metal Deck Reinforcement: Where indicated as integral part of support units, provide channel-shaped metal deck closure strips to reinforce opening through metal decking. Fabricate strips from 14 gage metal to match metal and finish of curb units, except as otherwise indicated.

2.10 OUTLETS AND INLETS

A. General

1. Except as otherwise indicated, provide manufacturer's standard outlets and inlets where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated and as required for complete installation.
2. Performance: Provide outlets and inlets that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
3. Ceiling Compatibility: Provide diffusers and grilles with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.
4. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.
5. Types: Provide outlets and inlets of type, capacity, and with accessories and finishes as listed on schedules. The following requirements shall apply to nomenclature indicated on schedule.
6. Manufactured by Titus, Tuttle and Bailey, Krueger or Price.

B. Diffuser and Grilles:

1. Faces:

   a. Square: Square housing, core of square concentric louvers, square or round duct connection.
   b. Rectangular: Rectangular housing, core of rectangular concentric louvers, square or round duct connection.
   c. Panel: Square or rectangular housing extended to form panel to fit in ceiling system module, core of square or rectangular concentric louvers, square or round duct connection.
   d. Eggcrate: Square, or rectangular housing with ½-by-1/2-by-1-inch grid panel in frame.

2. Mountings:

    a. Stepped-Down: Diffuser housing below ceiling with perimeter flange and gasket to seal against ceiling construction.
    b. Flush: Diffuser housing above ceiling surface with flush perimeter flange and gasket to seal against ceiling.
    c. Lay-In: Diffuser housing sized to fit between ceiling exposed suspension tee bars and rest on top surface of tee bar.
    d. Snap-In: Diffuser housing sized to fit between ceiling concealed suspension runners, and snap into runners.

3. Patterns:

    a. Fixed: Fixed position core with concentric rings or louvers for radial air flow around entire perimeter of diffuser.
    b. Two Position: Manual two-position core with concentric rings or louvers, upper position for horizontal air flow, lower position for vertical air flow.
    c. Adjustable: Manual adjustable core with concentric rings or louvers, fully adjustable for horizontal to vertical air flow.
    d. Four Way: Fixed louver face for four-direction air flow, directions indicated on drawings.

4. Dampers:

    a. Opposed Blade: Adjustable opposed blade damper assembly, key operated from face of diffuser.
    b. Radial, sliding blade dampers not acceptable.
    c. 90A.

5. Accessories:

    a. Equalizing Deflectors: Adjustable parallel blades in frame for straightening air flow.
    b. Smudge Ring: Extension perimeter frame around diffuser, sized so induced air impinges on frame and not on ceiling.
    c. Plaster Ring: Perimeter ring designed to act as plaster stop and diffuser anchor.
    d. Extractor: Curved blades mounted on adjustable frame to produce air scooping action in duct at diffuser take-off.
    e. Blank-Off Baffles: Arc segments designed to fit into diffuser housing to divert air flow from impinging on obstruction.

f. Operating Keys: Tools designed to fit through diffuser face and operate volume control device and/or pattern adjustment.

6. Finishes: Semi-gloss white enamel prime finish.

C. Wall Registers and Grilles:

1. Register and Grille Materials: Manufacturer's standard extruded aluminum frame and adjustable blades.
2. Register and Grille Faces: Horizontal blades, individually adjustable, at manufacturer's standard spacing.
3. Register and Grille Patterns: 2 sets of blades in face, rear set at 90° to face set.
4. Register and Grille Dampers: Adjustable opposed blade damper assembly, key operated from face of register.
5. Register and Grille Accessories:

a. Extractor: Curved blades mounted on adjustable frame to produce air scooping action in duct at register or grille take-off.
b. Plaster Frame: Perimeter frame designed to act as plaster stop and register or grille anchor.
c. Operating Keys: Tools designed to fit through register or grille face and operate volume control device and/or pattern adjustment.

6. Register and Grille Finishes: Semi-gloss white enamel prime finish.

D. Louvers:

1. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

a. Ruskin Mfg. Co.
b. American Warming and Vent, Inc.
c. Vent Products.
d. Pottorff.
e. Greenheck Fan Corporation.

2. General: Except as otherwise indicated, provide manufacturer's standard louvers where shown; of size, shape, capacity, and type indicated; constructed of materials and components as indicated and as required for complete installation.Louvers shall be 4" deep unless otherwise indicated.
3. Performance: Provide louvers that have minimum free area, and maximum pressure drop for each type as listed in manufacturer's current data, complying with louver schedule.

4. FEMA 361 approved stationary blade louver: Provide formed aluminum stationary horizontal chevron louver style as scheduled.
5. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate and that are specifically manufactured to fit into construction openings with accurate fit and adequate support for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver.
6. Materials: Construct of aluminum extrusions, ANSI/ASTM B 221, Alloy 6063-T52. Weld units or use stainless steel fasteners.
7. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.
8. Drainable: Provide drain gutter in each blade and downspouts in jambs and mullions.
9. Finish: Kynar 500 finish, standard color as selected by Architect.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Sealant:

1. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead.
2. Do not use two-part tape sealing system.
3. Do not use liquid sealant on exposed spiral duct.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts according to the higher class listed here or in the “Duct Schedule” article and according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Exhaust Ducts: Seal Class C.
3. Outdoor, Return-Air Ducts: Seal Class C.
4. Unconditioned Space, Exhaust Ducts: Seal Class C.
5. Unconditioned Space, Return-Air Ducts: Seal Class B.
6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
8. Conditioned Space, Exhaust Ducts: Seal Class B.
9. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection

D. Hangers Exposed to View: Threaded rod and angle, channel supports, or steel cable.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

C. Connect diffusers or light troffer boots to ducts directly or with maximum 5’-0” lengths of flexible duct clamped or strapped in place. Refer to the detail on the plans.

3.6 PAINTING

A. Paint interior of metal ducts and plenum surfaces that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

3.8 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.

B. Seal ducts according to the higher class listed here or in the “Duct Sealing” article.

C. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units.

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: B.

D. Return/Exhaust Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: B.

2. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

    a. Pressure Class: Negative 2-inch wg.
    b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: A.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

G. Liner:

1. Rectangular Supply Air Ducts: Fibrous glass, Type I, 1 inch thick unless otherwise indicated on the plans.
2. Rectangular Return Air Ducts: Fibrous glass, Type I, 1 inch thick unless otherwise indicated on the plans.
3. Supply Fan Plenums: Fibrous glass, Type II, 1 inch thick.

H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

    a. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

    a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

        1) Velocity 1500 fpm or Lower: 1.0 radius-to-diameter ratio and three segments for 90-degree elbow.
        2) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

    b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated. Seal all seams.
    c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

    a. Rectangular Main to Rectangular Branch: 45-degree entry.
    b. Rectangular Main to Round Branch: Conical Bell Mouth fitting or High Efficiency as detailed on the plans.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

    a. Velocity 1000 fpm or Lower: 90-degree tap.
    b. Velocity 1000 to 1500 fpm: Conical tap.
    c. Velocity 1500 fpm or Higher: Conical tap or 45-degree lateral as indicated on the plans.

3.10 DUCT LINER APPLICATION

A. Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner, with coated surface exposed to air stream and factory applied edge coating to prevent erosion of glass fibers, with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. 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.
7. 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:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

3.11 INSPECTION

A. Examine areas and conditions under which air distribution work will be installed. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.12 INSTALLATION OF AIR DISTRIBUTION WORK

A. Installation of Ductwork: Assemble and install ductwork in accordance with recognized industry practices which will achieve airtight within specified leakage class and noiseless (no objectional noise) systems, capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance

and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and prevent buckling.

1. Seal all joints and seams for all HVAC duct systems. The use of "duct tape" is not permitted. Comply with duct manufacturer's recommendations. Seal ductwork using the following methods to achieve leakage limit requirements:

    a. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
    b. Joint and Seam Sealants: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 75 percent solids.
    c. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
    d. Foil Tape: Pressure sensitive, 2 mil foil backing, 33 mil elastomeric modified butyl adhesive/sealant, rated up to 10 inch w.g. pressure class, seals on immediate contact, as manufactured by Hardcast or approved equal.

        1) Apply only to low pressure supply ductwork downstream of air terminal boxes and exhaust duct systems.

2. Install concrete inserts for support of ductwork in coordination with formwork, as required to avoid delays in work.
3. Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.
4. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for one-inch clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate

layout with suspended ceiling and lighting layouts and similar finished work.

5. Electrical Equipment Spaces: Do not run ductwork through electrical equipment spaces and enclosures.
6. Where ducts pass through interior partitions and exterior walls, conceal space between construction opening and duct or duct-plus-insulation with sheet metal flanges of same gage as duct. Overlap opening on four sides by at least 1-1/2".
7. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
8. Support ductwork in manner complying with applicable SMACNA duct standards, latest edition, hangers and supports section.
9. Balancing: Refer to Section 23 0593 for air distribution balancing of ductwork; not work of this section. Seal any leaks in ductwork that become apparent in balancing process.

B. Installation of Flexible Ducts: Flexible duct shall be used only for runouts to supply or return diffusers (not for exhaust) and only in lengths of 5’ or less.

C. Installation of Outlets and Inlets: Install outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.

1. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of outlets and inlets with other work.
2. Locate ceiling air diffusers, registers, and grilles, as indicated on Reflected Ceiling Plans. Unless otherwise indicated, locate units in center of acoustical ceiling modules.

D. Balancing: Refer to Division 23 Section, “Testing, Adjusting, and Balancing for HVAC,” for balancing of outlets and inlets; not work of this section.

3.13 CLEANING AND PROTECTION

A. Ductwork:

1. Clean ductwork internally, unit-by-unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
2. Strip protective paper from stainless ductwork surfaces and repair finish wherever it has been damaged.

3. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

B. Field Quality Control:

1. Remake leaking joints as required and apply sealants to achieve specified leakage limits.
2. Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing and as required for compliance with test requirements.
3. Conduct leakage tests in the presence of the Owner's representative. Give seven days advanced notice for testing.
4. Determine leakage from entire system or section of the system by relating leakage to the surface area of the test section.

3.14 EXTRA STOCK/SPARE PARTS

A. Furnish to Owner, with receipt, three operating keys for each type of outlet and inlet that require them.

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SECTION 233300 AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 23 3000; Air Distribution.

1.2 SUMMARY

A. Section Includes

1. Take-offs.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Flange connectors.
6. Turning vanes.
7. Remote damper operators.
8. Duct-mounted access doors.
9. Flexible connectors.
10. Duct accessory hardware.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data, specifications, installation instructions and dimensioned drawings for each type of product specified. Include the following:

B. Submit manufacturer's specifications for each type of duct accessory, including dimensions, capacities, and materials of construction; and installation instructions.

C. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.

D. Welding Certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" article.

E. Source quality-control reports.

F. Field quality-control reports.

G. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for accessory materials and products. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

H. Record Drawings: At project closeout, submit record drawings of installed specialties, show the exact location in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of ductwork accessory system products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with systems work similar to that required for this project.

C. Source Limitations: Obtain each type of accessory through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Submittals & Product Options."

E. Welding Qualifications: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for Intended location and application.

F. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

G. Comply with AMCA 500-D testing for damper rating.

H. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.5 COORDINATION

A. Coordinate the size and location of concrete bases with actual equipment provided and structural and architectural plans.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 TAKE-OFFS

A. High-efficiency take-offs.

1. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:

   a. Buckley.
   b. Flexmaster.

2. Supply air branch duct high efficiency fittings shall be a 45 degree entry take-off with a rectangular to round adapter and equipped with dampers having an operating handle and a locking device. Fittings shall have dampers with locking quadrant type operating handle, and shall clearly indicate damper position. Extension rods shall be installed such that the operating handle is visible and accessible thru the duct wrap insulation. Take-offs shall be heavy-duty galvanized steel with neoprene gasket and 26 gauge galvanized damper.

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:

   a. American Warming and Ventilating; a division of Mestek, Inc.
   b. Flexmaster U.S.A., Inc.
   c. Nailor Industries Inc.
   d. Ruskin Company.
   e. Pottorff.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

    a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
    b. Mitered and welded corners.
    c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized-steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.
7. Bearings:

    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft

1. Size: 1-inch diameter
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a ¾-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 CONTROL DAMPERS

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Flexmaster U.S.A., Inc.
4. Nailor Industries Inc.
5. Ruskin Company.
6. Young Regulator Company.
7. Pottorff.

B. Frames

1. Hat shaped.
2. Galvanized-steel channels, 0.064 inch thick.
3. Mitered and welded corners.

C. Blades

1. Multiple blade with maximum blade width of 8 inches.
2. Opposed-blade design.
3. Galvanized steel.
4. 0.064 inch thick.
5. Blade Edging: Closed-cell neoprene edging.

D. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

E. Bearings:

1. Molded synthetic.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.4 FIRE DAMPERS

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:

1. Cesco Products; a division of Mestek, Inc.
2. Nailor Industries Inc.
3. Ruskin Company.

4. Pottorff.

B. Type: Static; rated and labeled according to UL 555 by an NRTL.

C. Fire Rating:

1. 1-1/2 hours.
2. 3 hours.

D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.5 FLANGE CONNECTORS

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.6 TURNING VANES

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. SEMCO Incorporated.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.7 REMOTE DAMPER OPERATORS

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:

1. Pottorff; a division of PCI Industries, Inc.
2. Ventfabrics, Inc.
3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed, 3/4 inches deep.

F. Wall-Box Cover-Plate Material: Steel.

2.8 DUCT-MOUNTED ACCESS DOORS

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Ductmate Industries, Inc.
4. Flexmaster U.S.A., Inc.
5. McGill AirFlow LLC.
6. Nailor Industries Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:

a. Double wall, rectangular of same or greater gage as ductwork served.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Frames: Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct.
d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

(1) Provide negative pressure relief type access door for positive pressure medium pressure supply ducts.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.9 FLEXIBLE CONNECTORS

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.10 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

C. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12 inches. Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

2.11 DUCT ACCESSORIES 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: Comply with ANSI/ASTM A 653.

1. Galvanized Coating Designation: ANSI/ASTM A 653 G90.
2. Exposed-Surface Finish: Mill phosphatized or “Paint Grip” finish.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum or stainless steel ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with other work, including ductwork, as necessary to interface installation of duct accessories properly with other work.

B. Install duct accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts and in accordance with recognized industry practices to ensure that products serve intended function.

C. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

D. Turning Vanes: Install turning vanes in square or rectangular 90° elbows in supply, return, relief, outside air supply and exhaust air systems and elsewhere as indicated. Install acoustical turning vanes only in high velocity 90° elbows.

E. Access Doors:

1. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

a. Downstream from control dampers and equipment.
b. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from

dampers and inward operation for access doors installed downstream from dampers. Provide negative pressure relief type access door downstream, unless otherwise indicated, of fire dampers and combination fire/smoke dampers for high pressure supply trunk duct only.

c. Control devices requiring inspection.
d. Elsewhere as indicated.

2. Install access doors with swing against duct static pressure.
3. Access Door Sizes (Size and location of doors shall be adequate for inspection and maintenance of duct mounted equipment):

a. One-Hand or Inspection Access: 8 by 5 inches.
b. Two-Hand Access: 12 by 6 inches.
c. Head and Hand Access: 18 by 10 inches.
d. Head and Shoulders Access: 21 by 14 inches.
e. Body Access: 25 by 14 inches.
f. Body plus Ladder Access: 25 by 17 inches.

4. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

F. Installation of Ventilators: Except as otherwise indicated or specified, install ventilators in accordance with manufacturer's installation instructions and recognized industry practices to insure that ventilators serve their intended function.

1. Coordinate ventilator work with work of roofing, walls, and ceilings, as necessary for proper interfacing.
2. Ductwork: Connect ducts to ventilators in accordance with manufacturer's installation instructions. Solder bottom joints and up 2" of side joints of duct under roof ventilator to retain any moisture entering ventilator.
3. Roof Curbs: Furnish roof curbs to roofing installer for installation.

G. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

H. Install steel volume dampers in steel ducts.

I. Set dampers to fully open position before testing, adjusting, and balancing.

J. Install test holes at fan inlets and outlets and elsewhere as indicated.

K. Install fire dampers according to UL listing.

L. Install flexible connectors to connect ducts to equipment.

M. Install duct test holes where required for testing and balancing purposes.

N. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate installed duct accessories to demonstrate compliance with requirements
2. Operate dampers to verify full range of movement.
3. Inspect locations of access doors and verify that purpose of access door can be performed.
4. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
5. Inspect turning vanes for proper and secure installation.
6. Operate remote damper operators to verify full range of movement of operator and damper.
7. Test for air leakage while system is operating. Repair or replace faulty accessories as required to obtain proper operation and leakproof performance.

END OF SECTION
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SECTION 233400 FANS

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 22 0300; Electrical Requirements for Mechanical Equipment.

C. Section 23 0593; Testing, Adjusting and Balancing.

D. Section 23 3000; Air Distribution.

E. Electrical work required in conjunction with fans; Division 26.

1.2 SUMMARY

A. Types of equipment fans required for project include in-line centrifugal fan and ceiling ventilators.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data, specifications, capacity ratings, fan performance curves with operating point clearly indicated, gages and finishes of materials, dimensions, weights, accessories furnished, required clearances, method of field assembly, and installation instructions.

B. Submit equipment connection and support details. Equipment connection details to indicate all connections with sizes and types of duct and fittings to be used. Support details to include fabrication, materials, and methods of support intended. Include detail of vibration isolation.

C. Shop Drawings: Submit shop drawings for fans, showing unit dimension, required clearances, and construction details. Show interface and spatial relationship between ductwork, approximate structures and the work of other trades.

D. Wiring Diagrams: Submit shop drawings detailing the manufacturer's electrical requirements for power supply wiring for fans. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate

between portions of wiring that are factory-installed and portions to be field-installed.

E. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.

F. Source quality-control reports.

G. Field quality-control reports.

H. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for fans. Include this data, lubrication instructions, motor and drive replacement, spare parts lists, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

I. Record Drawings: At project closeout, submit record drawings of installed fan locations, show exact location and connection sizes in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of fans of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with fan systems similar to that required for this project.

C. Source Limitations: Obtain each type of equipment through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Substitutions & Product Options."

E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

F. AMCA Compliance: Provide fans bearing the Air Movement and Control Association, Inc. (AMCA) Certified Ratings Seal.

G. 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.

H. UL Compliance: Provide fan electrical components which have been listed and labeled by Underwriters Laboratories (UL).

I. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

J. ANSI/ABMA 9: Load Ratings and Fatigue Life for Ball Bearings.

K. ANSI/ABMA 11: Load Ratings and Fatigue Life for Roller Bearings.

L. ASHRAE: Test and rate fans in accordance with ASHRAE Standard 51 (AMCA Standard 210).

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver fans with factory-installed shipping skids and lifting lugs. Pack components in factory-fabricated protective containers.

B. Handle fans carefully to avoid damage to components, enclosures, and finish. Do not install damaged components. Replace and return damaged components to fan manufacturer.

C. Store fan in clean, dry place, and protect from weather and construction traffic.

PART 2 - PRODUCTS

2.1 FANS

A. Manufacturer, subject to compliance with the requirements, shall be one of the following or an Engineer approved equivalent:

1. Cook.
2. Greenheck.
3. Acme.
4. Twin City Blower.

B. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished, with indicated capacities, types, sizes, and characteristics.

C. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

1. Fan Shaft: Turned, ground, and polished steel, designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

D. Motors:

1. Torque Characteristics: Sufficient to accelerate the driven loads satisfactorily.
2. Motor Sizes: Minimum sizes and characteristics as indicated. If not indicated, large enough so that the driven load will not require the motor to operate in the service factor range.
3. Temperature Rating: 50°C maximum temperature rise at 40°C ambient for continuous duty at full load (Class A Insulation).
4. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors. Provide permanent-split capacitor classification motors for shaft-mounted fans and capacitor start classification for belted fans.
5. Electronically Commutated Motor: Rated for continuous duty, furnished with:

   a. Internally mounted potentiometer speed controller.

6. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design B; Design C where high starting torque requirements are anticipated.

   a. Enclosure Type: The following features are required:

      1) Open drip-proof motors where satisfactorily housed or remotely located during operation.
      2) Guarded drip-proof motors where exposed to contact by employees or building occupants.

   b. Overload Protection: Built-in, automatic reset, thermal overload protection.

2.2 CEILING VENTILATORS

A. Centrifugal Ceiling Exhausters: Provide centrifugal ceiling exhausters, designed for ceiling or wall mounting, of type, size and capacity as scheduled. Provide AMCA Certified Ratings Seal.

1. Type: Provide galvanized steel housing lined with acoustical insulation, adaptable for ceiling or wall installation. Provide centrifugal forward curved fan wheels mounted on motor shaft with fan shrouds, all removable for service. Provide integral backdraft damper fan discharge.
2. Grille: Provide powder-painted white aluminum grille with flange on intake with thumbscrew attachment to fan housing.
3. Motor: Provide permanent split-capacitor motor, permanently lubricated, with grounded cord and plug.

4. Electrical: Provide junction box for electrical connection on housing, and receptacle for motor plug-in. Accessories:

    a. Variable speed switch with on-off control and speed control for 100 to 50 percent of fan air delivery.
    b. Isolation: Rubber-in-shear vibration isolators.
    c. Transition fittings as indicated on drawings or schedules.

2.3 IN-LINE CENTRIFUGAL FANS

A. General: In-line, direct drive or belt-driven, centrifugal fans consist of housing, wheel, fan shaft, bearings, drive assembly, motor and disconnect switch, mounting brackets, and accessories.

B. Housing: The fan wheel housing and integral outlet duct shall be injection molded from a specially engineered resin exceeding UL requirements for smoke and heat generation. The outlet duct shall have provision for an aluminum backdraft damper with continuous aluminum hinge rod. The inlet box shall be minimum 22 gauge galvanized steel. Motor shall be isolation mounted to a one piece galvanized stamped steel integral motor mount/inlet. A field wiring compartment with disconnect receptacle shall be standard. To accommodate different mounting positions, an adjustable prepunched mounting bracket shall be provided.

C. Wheel: Wheel shall be centrifugal forward curved type, injection molded of polypropylene resin. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.

D. Accessories: The following accessories are required as indicated:

1. Speed Control: Variable speed switch with on-off control and speed control for 100 to 50 percent of fan air delivery.
2. Isolation: Rubber-in-shear vibration isolators.
3. Transition fittings as indicated on drawings or schedules.

PART 3 - EXECUTION

3.1 INSPECTIONS

A. Examine areas and conditions under which fans are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FAN EQUIPMENT

A. Install fans where indicated, in accordance with equipment manufacturer's installation instructions, and with recognized industry practices, to ensure that equipment complies with requirements and serves intended purposes.

B. Coordinate with other work, including ductwork, floor construction, roof, wall, ceiling, and electrical work as necessary to interface installation of air handling equipment with other work.

C. Vibration Isolation:

1. Suspended Units: Suspend units from structural steel support frame using threaded steel rods and rubber-in-shear vibration isolators.

D. Ductwork: Refer to Division 23 Section, “Air Distribution“. Connect ducts to ventilators in accordance with manufacturer's installation instructions.

E. Identification: Install equipment identification complying with Division 23 Section, “Identification for HVAC Piping and Equipment.”

F. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26. Verify proper rotation direction of fan wheels. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.3 ELECTRICAL CONNECTIONS

A. Ensure that fans are wired properly, with rotation in direction indicated and intended for proper performance. Provide positive electrical equipment and motor grounding.

3.4 FIELD QUALITY CONTROL

A. Upon completion of installation of fans test equipment to demonstrate compliance with requirements. Field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected. Perform the following field tests and inspections and prepare the appropriate test reports:

1. Verify that shipping, blocking and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.

END OF SECTION
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PART 1 - GENERAL

1.1 RELATED WORK

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

B. Refer to other Division 23 sections for vent flues, refrigeration and gas piping, etc. required external to furnaces for installation.

C. Refer to Division 26 sections for the following; not work of this section.

1. Power supply wiring from power source to power connection on furnaces. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
2. Interlock wiring specified as factory-installed is work of this section.
3. Interlock wiring between furnaces and between furnaces and field-installed control devices.

D. Provide the following electrical work as work of this section complying with requirements of Division 26 sections:

1. Control wiring between field-installed controls indicating devices and furnace control panels.

E. Refer to other Division 23 sections for automatic temperature controls, not factory-installed, required in conjunction with furnaces; not work of this section.

1.2 SUMMARY

A. This Section includes furnaces and accessories complete with controls.

B. This Section includes furnaces, controls, direct-expansion cooling coils, air filters, and refrigeration components.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications, installation instructions and dimensioned drawings for each type of furnace, coil, and condensing unit. Include rated capacities, weights, marked fan performance curves and furnished specialties and accessories for each furnace and condensing unit.

B. Shop Drawings: Submit shop drawings for furnaces, showing assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

C. Wiring Diagrams: Submit shop drawings detailing the manufacturer's electrical requirements for power supply wiring for furnaces. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.

E. Welding Certificates.

F. Source quality-control reports.

G. Field quality-control reports.

H. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for each type of furnace, control, and accessory, including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

I. Record Drawings: At project closeout, submit record drawings of installed systems, show exact location and connections of ductwork, power and gas piping in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in the manufacture of furnaces of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer’s Qualifications: Firm with at least 3 years of successful installation experience on projects with furnaces similar to that required for this project.

C. Source Limitations: Obtain each type of furnace through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section “Submittals & Product Options.”

E. Welding Qualifications: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for Intended location and application.

F. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

G. Electrical Compliance: Provide components that comply with NFPA 70 and that are listed and labeled by UL.

H. Listing and Labeling: Provide electrically operated fixtures specified in this section that are listed and labeled.

1. The terms "listed" and "labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.5 COORDINATION

A. Coordinate the size and location of concrete bases with actual equipment provided and the architectural and structural plans.

1.6 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to the following:

1. Heat exchanger failure.
2. Compressor failure.
3. Faulty operation of controls.
4. Deterioration of any component beyond the degradation of normal use.

B. Warranty Period:

1. Provide a one (1) year parts and labor warranty for the complete furnace, evaporator coil and condensing unit.
2. Provide a ten (10) year parts only warranty on the complete heat exchanger assembly.
3. Compressor: 5 years.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle furnaces and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged furnace or components; replace with new.

B. Store furnaces and components in clean, dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading furnaces and moving them to final location.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with a protective covering for storage and identified with labels describing the contents.

1. Filters: Furnish one (1) set of each type of filter specified.
2. Fan Motor Drive Belts: Furnish one (1) set of belts for each belt-driven fan.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:

1. Carrier Corp.
2. Daikin
3. Lennox.
4. Trane Co.

2.2 FURNACES, GENERAL

A. Description: Factory assembled, piped, wired, and tested.

B. Configuration: Upflow.

C. Cabinet: Steel with foil-faced, glass-fiber, interior insulation. Lift-out panels expose burners and all other items requiring access for maintenance.

D. Finish of External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.

E. Fan: Centrifugal, factory balanced, resilient mounted.

F. Fan Motors: Energy-efficient type as specified in Section 22 0300 "Electrical Requirements for Mechanical Equipment." Totally enclosed, with internal thermal protection and permanent lubrication.

G. Fan Motors: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.

2.3 GAS-FIRED FURNACES, CONDENSING

A. Comply with ANSI Z21.47, "Gas-Fired Central Furnaces"; and NFPA 54, "National Fuel Gas Code."

1. AGA Approval: Bear label of American Gas Association.
2. Type of Gas: Natural.

B. Efficiency: 93 percent AFUE, minimum.

C. Heat Exchanger: Aluminized-steel welded construction with aluminum-finned, stainless-steel tube condensing coil.

D. Burner Controls: Solid state; control gas valve and ignition.

1. Gas Valve: 100 percent safety gas shutoff; 24-V modulating or 2-stage, combining pressure regulation and manual shutoff.
2. Ignition: Electronic pilot ignition, with electric spark igniter.

E. Gas-Burner Safety Controls:

1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ingnition 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.

F. Combustion Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevetns furnace ooperation if combustion-air inlet or flue outlet is blocked.

G. Automatic Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; terminals for connection to accessories. .

H. Accessories:

1. Combination Combustion-air Intake and Vent: PVC plastic fitting to combine combustion-air inlet and vent through roof.
2. PVC Plastic Vent Materials:

   a. PVC Plastic Pipe: Schedule 40, complying with ASTM D 1785.
   b. PVC Plastic Fittings: Schedule 40, complying with ASTM D2466, socket type.
   c. PVC Solvent Cement: ASTM D2564.

I. Capacities and Characteristics: Refer to equipment schedule on drawings.

2.4 CONTROLS

A. Furnace Controls: Include components required for satisfactory operation of furnaces and auxiliary equipment in all seasons.

B. Control Transformer: 24 VAC output, factory installed, and wired in furnace.

C. Thermostat: 24 VAC, solid-state, programmable, microprocessor-based wall mounting unit with automatic switching from heating to cooling, preferential rate control, multiple temperature presets selectable by day and time, and battery back-up protection of program settings against power failure.

D. Relays: As required to achieve specified operation.

E. Wire and Cable: Specified in Division 26.

2.5 AIR FILTERS

A. Filters: 1-inch- thick pleated fiberglass media with ASHRAE 52.2 MERV rating of 8 or higher in sheet metal rack/side access filter housing.

2.6 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 90.1-2007, “Energy Standard for Buildings except Low-Rise Residential Buildings.”

B. Evaporator Coil: Conform to ANSI/AHRI 210/240, "Unitary Air Conditioning and Air Source Heat Pump Equipment." Mate and match size with furnace, remote condensing unit specified in Section 23 6300 "Condensing Units" with type, capacity, pressure-drop ratings, restricted distributor, or expansion valve. Include condensate drain pan with accessible drain outlet.

C. Evaporator Coil Enclosure: As required to suit furnace and cooling coil. Steel cabinet with access panel and flanges for integral mounting at or on furnace cabinet.

D. Refrigerant Piping: Comply with requirments in Division 23 section “Refrigerant Piping.”

E. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; with insulated suction line and flared fittings at evaporator end; no fitting at condenser end; length as required.

F. 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 selaed 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. Compressor motors shall have manual-reset high-pressure switch and automatic-reset low-pressure switch.
   e. Refrigerant Charge: R-410A..

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid sub-cooler.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kity: Permits operation down to 0 deg F.

G. Capacities and Characteristics: Refer to equipment schedule on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install furnaces and accessories according to manufacturer's written instructions.

B. Install and connect gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's published installation instructions.

1. Connect gas piping according to Division 22 Section, "Natural Gas Piping Systems."
2. Connect vents according to Division 23 Section, "Air Distribution."
3. Vents, Outside-Air Pipe Connections, and Drains: Where polyvinyl chloride (PVC) piping is used, install according to Division 22 Section, "Soil & Waste Piping Systems." Install vent terminal designed to protect against birds, insects, and dirt.
4. Connect condensate drain pans using copper tubing, ASTM B 88, Type K (ASTM B 88M, Type C) with streamline drainage fittings and soldered joints or PVC drainage piping. Extend to nearest equipment drain or floor drain. Construct vented, trap at connection to drain pan and install cleanouts at changes in direction. Terminate to suit local code requirements, except where stricter methods are indicated.

C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base where installation conditions require.

D. Controls: Install thermostats and humidistats at mounting height of 48 inches above floor.

E. Control Wiring: Install control wiring as specified in Division 26 Sections.

F. Connect ducts to furnace with flexible connector according to Division 23 Section, "Air Distribution."

G. Install ground-mounted, compressor-condenser components on 4-inch thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, an formwork are specified in Division 03 Section “Cast-in-Place Concrete.” Coordinate anchor installation with concrete base.

H. Identify furnaces, condensing units and connections according to Division 23 Section, "Mechanical Identification."

I. Test, adjust and balance furnaces in accordance with Division 23 Section, “Testing, Adjusting, and Balancing for HVAC.”

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Gas Piping: Conform to applicable requirements of Division 22 Section, "Natural Gas Piping Systems." Connect gas piping to furnace, full size of furnace gas train inlet, and provide union with sufficient clearance for burner removal and service.
3. Refrigerant Tubing: Conform to applicable requirements of Division 23 Section, "Refrigerant Piping." Connect refrigerant tubing to coils and condensing units.

B. Electrical: Conform to applicable requirements of Division 26 Sections.

1. Install electrical devices provided with furnace but not specified to be factory mounted.

C. Connect motors and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 ADJUSTING AND CLEANING

A. 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.

B. After completing system installation, inspect furnaces and associated components. Repair scratches and mars of finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

3.4 START UP

A. Start-up Services: Provide start-up service in accordance with manufacturer's start-up instructions and in the presence of manufacturer's representative, as specified below.

1. Start each furnace and operate controls.
2. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
3. Test functions, operations, control sequences, and protective features. Adjust to ensure operation is as specified.

B. Correct deficiencies identified by tests and observations and retest until specified requirements are met.
C. Install new filters in each furnace within 14 days after Substantial Completion.

3.5 TRAINING OF OWNER'S PERSONNEL

A. Provide services of manufacturer's technical representative for one 8-hour day to instruct Owner's personnel in operation and maintenance of furnaces. Schedule training with Owner; provide at least 7-day notice to Contractor and Architect of training date.

END OF SECTION
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SECTION 238126 SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Each combination shall be rated in accordance with Air Conditioning Refrigeration Institute's (ARI) Standard 210/240 and bear the ARI label.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Daikin AC, Inc.
   2. LG Air Conditioning
   3. Mitsubishi Cooling & Heating
   4. Sanyo Fisher (U.S.A.) Corp.

2.2 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
   1. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
   2. Drain Pan and Drain Connection: Comply with ASHRAE 62.1-2004.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Fan: Direct drive, centrifugal fan.

D. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Special Motor Features: Multi-tapped, multispeed with internal thermal protection and permanent lubrication.

E. Filters: Disposable, with ASHRAE 52.2 MERV rating of 6 or higher.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   1. Compressor Type: Scroll.
   2. Refrigerant: R-410A.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid sub-cooler.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Aluminum-propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Low Ambient Kit: Permits operation down to 0 deg F.

H. Mounting: Equipment mounting rail.

I. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1-2004, "Energy Standard for Buildings except Low-Rise Residential Buildings."

2.4 ACCESSORIES

A. Thermostat: Low voltage with sub-base to control compressor and evaporator fan with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection, including auto setting.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Condensate Pump.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounted compressor-condenser components on 4-inch thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement and formwork are specified in Division 3 Section “Cast-in-Place Concrete.” Coordinate anchor installation with concrete base.

D. Install and connect refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238126

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SECTION 260500 COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED WORK

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and other Sections of Division 26.

B. Section 22 0300; Electrical Requirements for Mechanical Equipment, for factory installed motors, controllers, accessories and connections.

C. Division 26; for materials and methods common to the remainder of Division 26 work including:
   1. Access to electrical installations.
   2. Excavation for electrical installations within the building boundaries and from building to utility connections.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this section to expand the requirements specified in Division 01.
   1. Code Requirements, Fees and Permits.
   2. Product Substitution Procedures.
   3. Submittals.
   4. Coordination drawings.
   5. Drawings.
   6. Local Conditions.
   7. Temporary Power.
   8. Cutting and patching.
   9. Rough-ins.
   10. Quality Assurance.
   11. Record documents.
   12. Operation and Maintenance Manuals.
   13. Electrical installations.
   14. System Demonstration and Owner’s Instruction.

1.3 CODE REQUIREMENTS, FEES, AND PERMITS

A. Provide work in accordance with applicable codes, rules, ordinances, industry standards, utility company regulations, and regulations of local, state and federal governments and other authorities having lawful jurisdiction.

B. Unless otherwise noted, conform to latest editions and supplements of following codes, standards or recommended practices as adopted by the authority having jurisdiction:
   1. National Electric Code
   2. International Building Code
   3. ASA - American Standards Association
   4. ASME - American Society of Mechanical Engineers
   5. ASTM - American Society of Testing Materials
   6. NBS - National Bureau of Standards
   7. NEMA - National Electrical Manufacturer's Association
   8. NFPA - National Fire Protection Association
   9. UL - Underwriters' Laboratories, Inc.
   10. NSF - National Sanitation Foundation
   11. occupational Safety and Health Act of 1970
   12. Life Safety Code, N.F.P.A. No. 101
   13. N.F.P.A. 17/17A, 72, 72B, 54 and 96.

C. In case of differences between building codes, regulations, laws, local ordinances, industry standards, and utility company regulations, and the Contract Documents, the most stringent governs. Promptly notify Architect in writing of any such difference.

D. Obtain the required permits in connection with this work and coordinate with the serving utility company for the installation of the electric service as shown on the plans.

1.4 PRODUCT SUBSTITUTION PROCEDURES

A. Manufacturers' of other products than those listed may be considered. Submit substitution request in compliance with Division 01 Section, "Substitution & Product Options." All Division 26 substitution requests shall be submitted at least five working days prior to bid. Requests for substituion received by Engineer later than 5 days prior to bid opening may be rejected without review.

1.5 SUBMITTALS

A. The format and quantity of the submittals shall comply with the requirements of Division 01 General requirements and other Division 26 Sections.

B. Refer to the individual sections of Division 26 for additional and/or specific requirements.

C. Arrange product data in sets/electronic files with sections corresponding to and in the same order as Division 22 and 23 sections.

D. Provide an index of the sections at the front of the submittal listing the section number and items included in each section.

E. Provide cover sheet for each section, listing each type of material or equipment, designation and model number if any, and the name of the supplier.

F. Clearly indicate sizes, capacities, brand names, motor HP, accessories, options, materials, gages, dimensions, and other pertinent information. Pertinent information shall include items scheduled on the drawings as a minimum. Clearly indicate designations corresponding to drawings and schedules.

G. Provide performance charts and curves, installation instructions, and complete wiring diagrams.

H. Submittals failing to meet specified requirements will be returned without review or approval.

1.6 PLANS

A. Plans show general arrangement of panels, circuits, lights and equipment systems. Follow closely as actual building construction and work of other trades will permit.

B. Consider architectural and structural plans part of this work insofar as these plans furnish information relating to design and construction of building. These plans take precedence over the Electrical Plans.

C. Due to the small scale of the Electrical Plans, it is not possible to indicate all offsets, fittings and accessories which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings and accessories required to meet the conditions.

D. Record difference between electrical work as installed and as shown in Contract Documents on a set of Record Documents. Return these prints to Architect at completion of project.

E. Do not scale electrical drawings for dimensions. Accurately lay out work from dimensions indicated on structural and architectural drawings, and as verified in the field.

1.7 LOCAL CONDITIONS

A. Visit site and determine existing local conditions affecting work.

B. No subsequent compensation will be considered for any consequence related to failure to determine site conditions or nature of existing or new construction..

C. Locations and elevations of the various utilities and services included within the scope of this work have been obtained from substantially reliable sources and are offered as a general guide only, without guarantee as to accuracy. Verify the location and elevation of all utilities and their relation to the work.

1.8 CONCRETE BASES

A. Coordinate the size and location of concrete bases with actual equipment provided and the Architectural and Structural Plans.

B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes of the project.
   1. Construct concrete bases of dimensions indicated, but not less than 6 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section, "Cast-in-Place Concrete."

1.9 TEMPORARY ELECTRICAL UTILITIES

A. Comply with requirements of Division 01 for Construction Facilities and Temporary Controls.

B. General: Engage appropriate local utility company to install temporary service or connect to existing service. Where utility company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with all utility company requirements and recommendations. Arrange with the utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

C. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations. Install electric power service overhead, unless otherwise indicated.

D. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
   1. Install and operate temporary lighting that fulfills security and protection requirements.
   2. If the Owner's permanent lighting is used at anytime during construction, then at the end of construction (defined by Owner's Acceptance of "Substantial Completion") the contractor shall furnish all new lamps in all permanent light fixtures.
   3. Note: Contractor shall request and allow engineer to examine all cartons of the new lamps before the new lamps are installed at end of construction.

E. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install two telephone lines for each field office.
   1. Provide additional telephone lines in each field office for the following:
      a. Provide a dedicated telephone line for each facsimile machine.
      b. Provide a dedicated telephone line for each computer.

   2. At each telephone, post a list of important telephone numbers including police and fire departments, Contractor's home office, Architect's office, Owner's office, Principal subcontractor's field and home offices.
   3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

F. Electronic Communication Service: Provide temporary electronic communication service, including electronic mail in each field office.

1.10 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code-Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Certify that each welder has passed ASW qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of different electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at the expense of the Contractor. No additional money will be paid due to lack of coordination between the trades.

1.11 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Store products in either environmentally controlled spaces or supply sufficient electric heat internally to prohibit degradation from condensation.

1.12 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 01 Section, "Execution & Closeout Procedures." In addition to the requirements specified in Division 01, indicate installed conditions for:
   1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
   2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
   3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

B. Engage the services of a Land Surveyor or Professional Engineer registered in the state in which the project is located as specified in Division 01 Section, "Execution & Closeout Procedures," to record the locations of underground installations.

1.13 OPERATION AND MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 01 Section, "Execution & Closeout Procedures." In addition to the requirements specified in Division 01, include the following information for equipment items:
   1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
   2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
   3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
   4. Servicing instructions and lubrication charts and schedules.

1.14 SYSTEM DEMONSTRATION AND OWNER'S INSTRUCTIONS

A. Demonstrate to the satisfaction of Owner's representative that electrical systems and components are operating properly.

B. Utilizing Operation and Maintenance Manual, provide Owner's representative(s) instruction in the operation and maintenance of systems.

C. Provide minimum of 8 hours formal instruction balanced as required between classroom type instruction and "hands-on" instruction for each of the following:
   1. Electrical Systems and Equipment

D. Provide additional instruction where necessary to fully prepare Owner to operate and maintain systems and components.

E. Refer to individual Division 26 sections for additional requirements.

F. Demonstration and instruction to begin after Substantial Completion and before final payment.

PART 2 - PRODUCTS -- Not Applicable

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 01 Section, “Project Management & Coordination.” "CUTTING AND PATCHING." In addition to the requirements specified in Division 01, the following requirements apply:

B. Perform cutting, fitting, and patching of electrical equipment and materials required to:
   1. Remove existing work not to be reused or reconnected after completion.
   2. Uncover Work to provide for installation of ill-timed Work.
   3. Remove and replace defective Work.
   4. Remove and replace Work not conforming to requirements of the Contract Documents.
   5. Remove samples of installed Work as specified for testing.
   6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect’s observation of concealed Work.

C. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.

D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

E. Provide and maintain temporary partitions or dust barriers to prevent the spread of dust and dirt to adjacent areas.

F. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
   1. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers.
   2. Patch specified finished surfaces and building components using new materials specified for the original installation and experienced installers.
   3. Installers' qualifications refer to the materials and methods required for the surface and building components being patched. Refer to Division 01 Section, “Definitions,” for definition of experienced "Installer."

G. Do not endanger or damage installed Work through procedures and processes of cutting and patching.

H. Arrange for repairs required to restore other work, because of damage caused as a result of electrical installations.

I. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

J. Locate, identify, and protect electrical services passing through remodeling or demolition areas and serving other areas required to be maintained operational. When transit services must be interrupted, provide temporary services for the affected areas and notify the Owner prior to changeover.

3.2 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to drawings and equipment specifications in Divisions 02 through 23 for rough-in requirements.

3.3 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
   1. Coordinate electrical systems, equipment, and materials installation with other building components.
   2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in other building components to allow for electrical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment or efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
7. Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment to provide the maximum headroom possible.
8. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, structural components, and the work of all other trades involved with the project.
9. 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. Do not interrupt electrical or telephone service without Owner's written permission.
10. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Architect.
11. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
12. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
13. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section Access Doors and Panels and Division 26 Section, “Common Work Results for Electrical.” Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.4 WARRANTIES

A. Refer to the Division 01 Sections, “Substitution & Product Options,” and “Execution & Closeout Procedures,” for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.

B. Compile and assemble the warranties specified in Division 26, into a separated set of vinyl covered, three ring binders, tabulated and indexed by section for easy reference, refer to Division Number 01 for additional requirements.

C. Provide complete warranty information for each item, product, or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

3.5 CLEANING

A. Refer to the Division 01 Section, “Execution & Closeout Procedures” for general requirements for final cleaning.

B. Clean all light fixtures, lamps and lenses prior to final acceptance. Replace all inoperative lamps

END OF SECTION
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SECTION 260526 GROUNDING

PART 1 - GENERAL

1.1 RELATED WORK

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and other Division 26 Sections.

B. Requirements of this section apply to electrical grounding and bonding work specified elsewhere in these specifications.

C. Section 26 0533; Raceways.

D. Section 26 0536; Wires and Cables.

E. Section 26 2416; Panelboards.

1.2 SUMMARY

A. Extent of grounding work is indicated by drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.

B. Solid grounding is the type of electrical grounding and bonding work specified in this section.

C. Application of electrical grounding and bonding work in this section includes the following:
1. Underground metal piping.
2. Underground metal water piping.
3. Underground metal structures.
4. Metal building frames.
5. Electrical power systems.
6. Grounding plate electrodes.
7. Grounding electrodes.
8. Counterpoise loops.
9. Separately derived systems.
10. Raceways.
11. Service equipment.
12. Enclosures.
13. Equipment.
14. Lighting standards.
15. Landscape lighting.
16. Signs.

D. Refer to other Division 26 sections for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work not work of this section.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications, installation instructions and dimensioned drawings for each grounding system and accessories.

B. Shop Drawings: Submit wiring diagrams: for electrical grounding and bonding work which indicates layout of ground rings, location of system grounding electrode connections, routing of grounding electrode conductors, also include diagrams for circuits and equipment grounding connections.

C. Welding Certificates.

D. Source quality-control reports.

E. Field quality-control reports.

F. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for grounding system materials and products. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

G. Record Drawings: At project closeout, submit record drawings of installed systems, show the exact location of the ground components in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of electrical grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, ground electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical grounding work similar to that required for this project.

C. Source Limitations: Obtain each type of equipment through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section, “Substitutions & Product Options.”

E. Welding Qualifications: Field Welding: Comply with AWS Code for procedures, appearance, and quality of welds; and methods used in correcting welding work. Provide welded connections where grounding conductors connect to underground grounding and plate electrodes. Use of exothermic or "Cadweld" system is acceptable.

F. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.
2. UL Compliance: Comply with applicable requirements of UL Standards No.'s 467 "Electrical Grounding and Bonding Equipment", and 869, "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use with Copper conductors". Provide grounding and bonding products which are UL-listed and labeled for their intended usage.
3. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:
1. Burndy Corporation.
2. Caldweld Div.; Erico Products Inc.
3. Ideal Industries, Inc.
4. Thomas and Betts Corp.

2.2 MATERIALS AND COMPONENTS

A. General: Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE requirements and with established industry standards for those applications indicated.

B. Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC.

C. Bonding Jumper Braid: Copper braided tape, constructed of 30-gage bare copper wires and properly sized for indicated applications.

D. Flexible Jumper Strap: Flexible flat conductor, 480 strands of 30-gage bare copper wire; 3/4" wide, 9-1/2" long; 48,250 CM. Select braid with holes sized for 3/8" diameter bolts, and protect braid with copper bolt hole ends.

E. Bonding Plates, Connectors, Terminals and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated applications.

F. Ground Electrodes and Plates:
   1. Ground Electrodes: Solid copper, 5/8" dia. x 10 ft.
   2. Ground Electrodes: Steel with copper welded exterior, 3/4" dia. x 10 ft.
   3. Ground Plates: Sheet copper plate, 20-gage x 36" x 36", with 2 cable attachments for either 1/0 or 2/0 cables.

G. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ELECTRICAL GROUNDING

A. General: Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.

B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.

C. All connections to the grounding electrode shall be of the exothermic type.

D. Ground electrical service system neutral at service entrance equipment to grounding electrodes.

E. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, boxes, grounding conductor in raceways and cables, receptacle ground connectors, motor frames and enclosures and plumbing systems.

F. Install counterpoises which encircle the building and are connected to each structural column, and to each driven electrode.

G. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus, or bushing.

H. Connect grounding electrode conductors to 1-inch diameter, or greater, metallic cold water pipe using a suitably sized ground clamp. Provide connections to flanged piping at street side of flange.

I. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

J. Install braided type bonding jumpers with code-sized ground clamps on water meter piping to electrically bypass water meters.

K. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible to minimize transient voltage rises.

L. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

M. Install clamp-on connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 25 ohms, take appropriate action to reduce resistance to 25 ohms, or less, by installing and connecting additional ground rods; then retest to demonstrate compliance.

END OF SECTION
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SECTION 260533 RACEWAYS

PART 1 - GENERAL

1.1 RELATED WORK

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and other Division 26 Sections.

B. Section 26 0536; Wires and Cables.

1.2 SUMMARY

A. Extent of raceway work is indicated by drawings and schedules or as required by equipment or system vendor. All wiring shall be installed in raceways.

B. Types of raceways specified in this section include the following:
1. Rigid metal conduit
2. Electrical metallic tubing (EMT)
3. Flexible metal conduit
4. Liquid-tight flexible metal conduit
5. Rigid nonmetallic conduit
6. Underground plastic utilities duct
7. Intermediate metal conduit.
8. Surface metal raceway.
9. Overhead metal raceway.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions for each type of raceway system required. Include data substantiating that materials comply with requirements.

B. Maintenance Data: Submit maintenance data and parts lists for each type of raceway system installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual.

C. Codes and Standards:
1. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publications pertaining to raceways.
2. UL Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to electrical raceway systems. Provide raceway products and components which have been UL listed and labeled.

3. NEC Compliance: Comply with applicable requirements of NEC pertaining to construction and installation of raceway systems.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection to fulfill wiring requirements, and comply with applicable portions of NEC for raceways. All interior conduit and tubing shall be metallic.

B. Manufacturer of conduit, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:
1. Wheatland Tube
2. Wiremold
3. Square D
4. B-Line
5. Robintech
6. Triangle
7. Youngstown Steel
8. Walker
9. Carlon
10. Anaconda
11. Allied Tube and Conduit

C. Manufacturer of conduit fittings, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:
1. Appleton
2. Carlon
3. RACO
4. Steel City
5. Crouse-Hinds
6. Wheatland Tube

D. Manufacturer of conduit sealing products, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:
1. Dow Corning – Silicone RTV Foam.
2. Nelson – Flameseal.
3. 3m – Fire Barrier.
4. T & B – Flamesafe.

E. Rigid Metal Conduit: Provide rigid steel, zinc-coated, threaded type conforming to Fed. Spec. WW-C-581, ANSI C80.1 and UL 6. Provide zinc coating fused to inside and outside walls. All conduits over 2" in diameter shall be rigid metal.

F. Rigid Metal Conduit Fittings: Cast malleable iron, galvanized or cadmium plated, conforming to Federal Specification WW-C-581, ANSI C80.1 and UL 6.
   1. Use Type 1 fittings for raintight connections.
   2. Use Type 2 fittings for concrete tight connections.
   3. Use Type 3 fittings for other miscellaneous connections.

G. Electrical Metallic Tubing (EMT): Federal Specifications WW-C-563, ANSI C80.3 and UL 797.

H. EMT Fittings: Federal Specifications W-F-408. Compression fittings only. Do not use set-screw type or indenter fittings.

I. Conduit Bodies: Provide galvanized cast-metal conduit bodies of types, shapes and sizes as required to fulfill job requirements and NEC requirements. Construct conduit bodies with threaded- conduit-entrance ends, removable covers, either cast or galvanized steel, and corrosion-resistant screws.

J. Flexible Metal Conduit: Federal Specification WW-C-566 and UL 1. Formed from continuous length of spirally wound, interlocked zinc-coated strip steel.

K. Flexible Metal Conduit Fittings: Provide conduit fittings for use with flexible steel conduit of threadless hinged clamp type.
   1. Straight Terminal Connectors: One-piece, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.
   2. 45 or 90 Degree Terminal Angle Connectors: Two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

L. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight flexible metal conduit; construct of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coat with liquid-tight jacket of flexible polyvinyl chloride (PVC). Exterior jacket shall be color stable when exposed to sunlight.

M. Liquid-Tight Flexible Metal Conduit Fittings: Federal Specifications W-F-406, Type 1, Class 3, Style G. Provide cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated or non-insulated throat.

N. Intermediate Steel Conduit: Rigid intermediate grade (IMC) hot-dip galvanized conforming to Fed. Spec. WW-C-581 and UL 1242.

O. PVC Externally Coated Rigid Steel Conduit: Rigid steel zinc-coated with additional external coating of PVC conforming to ANSI C80.1 and NEMA RN 1.

2.2 NONMETALLIC CONDUIT

A. General: Provide nonmetallic conduit and fittings of types, sizes and weights for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements which comply with provisions of NEC for raceways.

B. Manufacturer of non-metallic conduit and fittings, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:
   1. Hubbell.
   2. Crouse-Hinds.
   3. Arlington Industries Inc.
   4. Thomas & Betts.
   5. Appleton Electric

C. Electrical Plastic Conduit:
   1. Heavy Wall Conduit: Schedule 40, 90 C, UL rated, construct of polyvinyl chloride and conforming to NEMA TC-2, for direct burial, or normal above-ground use, UL listed and in conformity with NEC Article 352.
   2. Extra Heavy Wall Conduit: Schedule 80, UL rated, construct of polyvinyl chloride compound C-200 PVC, and UL listed in accordance with NEC Article 352 for direct burial, or above- ground use.

D. Provide all-weather quick-set clear cement and conduit bender designed specifically for PVC.

E. PVC Conduit and Tubing Fittings: NEMA TC 3, mate and match to conduit or tubing type and material.

F. Conduit and Tubing Accessories: Provide conduit, tubing and duct accessories of types, sizes, and materials, complying with manufacturer's published product information which mate and match conduit and tubing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which raceways are to be installed and substrate which will support raceways. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF RACEWAYS

A. General: Install raceways as indicated; in accordance with manufacturer's written installation instructions and in compliance with NEC, and NECA's "Standards of Installation." Install units plumb and level, and maintain manufacturer's recommended clearances.

B. Coordinate with other work including wires/cables, boxes, and panel work, as necessary to interface installation of electrical raceways and components with other work.

3.3 INSTALLATION OF CONDUITS

A. General: Install concealed conduits in new construction work, either in walls, slabs, or above ceilings. Run conduits concealed in existing work where practicable. Where conduits cannot be concealed in finished areas, use surface metal raceways.
   1. Mechanically fasten together metal conduits, enclosures, and raceways to form continuous electrical conductor. Connect to electrical boxes, fittings and cabinets to provide electrical continuity and firm mechanical assembly.
   2. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.
   3. Install miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that have been specifically designed and manufactured for their particular application. Install expansion fittings in raceways every 200' linear run or wherever structural expansion joints are crossed.
   4. Use roughing-in dimensions of electrically operated unit furnished by supplier. Set conduit and boxes for connection to units only after receiving review of dimensions and after checking location with other trades.
   5. Provide nylon pull cord in all empty conduits. Test conduits required to be installed, but left empty; test with ball mandrel. Clear any conduit which rejects ball mandrel. Pay costs involved for restoration of conduit and surrounding surfaces to original condition.
   6. Minimum size of rigid, intermediate, and EMT conduits, for above grade homeruns only, shall be 3/4".
   7. Flexible conduit minimum size shall be 3/4", except final flexible conduit for lighting fixtures may be minimum size of 1/2".
   8. Power conduits 2" and larger, where located below 10’-0” above the finish floor and exposed, shall be rigid.
   9. Install control wiring in conduit according to these specifications.

B. Conduit Installation: Conduits underground and under-slab shall be PVC with rigid steel elbows. PVC conduit shall not penetrate the slab, all slab

penetrations shall be made with rigid steel elbows. Conduits for feeders inside the building and above 5’ above the finish floor shall be EMT. Provide rigid steel conduit for feeders that are exposed running from the floor to 5’ above the finish floor only. Conduits on the exterior of the building and exposed to weather shall be rigid steel. Follow minimum requirements in other areas as follows:

1. Galvanized rigid steel: Minimum 3/4-inch size may be used in all areas.
2. Electrical Metallic Tubing: Minimum 3/4-inch size may be used in indoor dry locations where it is:
   a. Not subject to damage.
   b. Not in contact with earth.
   c. Not in concrete slabs on grade.
   d. In compliance with other qualifications in this section.

3. Use flexible conduit in movable partitions and from junction boxes to recessed lighting fixtures (maximum of 6’-0” long), and final 24" of connection to motors, or control items subject to movement or vibration, and in cells of precast concrete panels. No flexible conduit shall be installed in permanent walls. No flexible conduit over 6'-0" in length shall be installed.
4. Refer to Division 26 Section, “Wires & Cables,” for Metal Clad (MC) cable use, requirements and installation requirements.
5. Use liquid-tight flexible conduit where subjected to one or more of the following conditions:
   a. Exterior location.
   b. Moist or humid atmosphere where condensate can be expected to accumulate.
   c. Corrosive atmosphere.
   d. Subjected to water spray or dripping oil.

C. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean.

D. Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.

E. Size conduits to meet NEC, except no conduit smaller than 3/4-inch shall be used for any feeder or branch circuit homerun.

F. Fasten conduit terminations in sheet metal enclosures by two locknuts, and terminate with bushing. Install locknuts inside and outside enclosure.

G. Conduits shall not cross pipe shafts or ventilating duct openings.

H. Conduits shall be a minimum distance of 6" from parallel runs of flues, hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.

I. Support riser conduit at each floor level with clamp hangers.

J. Use of running threads at conduit joints and terminations is prohibited. Where required, use three-piece union or split coupling.

K. Complete installation of electrical raceways before starting installation of cables/wires within raceways.

L. Install no more than the equivalent of four 90-degree bends between boxes. (Two 90-degree bends for telephone conduits, data conduits, and sound system conduit.)

M. Concealed Conduits:
   1. Metallic raceways installed underground or in floors below grade, or outside are to have conduit threads painted with corrosion inhibiting compound before couplings are assembled. Draw up coupling and conduit sufficiently tight to ensure watertightness.
   2. For floors-on-grade, install conduits under concrete slabs.
   3. Install underground conduits minimum of 24" below finished grade.

N. Conduits in Concrete Slabs:
   1. Place conduits between bottom reinforcing steel and top reinforcing steel.
   2. Place conduits either parallel or at 90 degrees to main reinforcing steel.
   3. Separate conduits by not less than diameter of largest conduit to ensure proper concrete bond.
   4. Conduits crossing in slab must be reviewed for proper cover by Engineer.
   5. Embedded conduit diameter shall not exceed 1/3 of slab thickness.
   6. Turns within in the slab shall be with rigid conduit elbows when the turn is tighter than a 3’-0” radius.

O. Conduits shall not damage or run through structural members. Avoid horizontal or cross runs in building partitions or side walls.

P. Exposed Conduits:
   1. Install exposed conduits and extensions from concealed conduit systems neatly, parallel with, or at right angles to walls of building.
   2. Install exposed conduit work as not to interfere with ceiling inserts, lights or ventilation ducts or outlets.
   3. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed the following:
      a. up to 1": 6'-0"
      b. 1-1/4" and over: 8'-0"

4. Run conduits for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.
5. Above requirements for exposed conduits also apply to conduits installed in space above ceilings and in crawl spaces.

Q. Non-Metallic Conduits:
1. Make solvent cemented joints in accordance with recommendations of manufacturer. Clean joints and fittings with primer solvent before applying PVC cement.
2. Install PVC conduits in accordance with NEC and in compliance with local utility practices.
3. Where PVC is used below first floor slab, rigid steel ells shall be utilized in long radius form to extend vertically toward or through slab, and rigid steel entries into cabinets or terminal chambers, only shall be allowed. Do not extend any PVC into building spaces.

END OF SECTION
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SECTION 260536 WIRES & CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to this section.

B. Section 26 0500; Common Work Results for Electrical.

C. Section 26 1300; Boxes and Fittings.

D. Section 31 2000; Earthwork.

1.2 SUMMARY

A. This Section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 600 volts and less.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications and installation instructions for electrical wires, cables and connectors. Include the insulation temperature rating and jacket type for each wire or cable.

B. Source quality-control report.

C. Field quality-control report.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications : Firms regularly engaged in the manufacture of wire and cable of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with wire and cable systems work similar to that required for this project.

C. Source Limitations: Obtain each type of wire or cable through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section “Substitutions & Products Options.”

E. Regulatory Requirements:
1. Comply with provisions of the NFPA 70 "National Electrical Code" (NEC).
2. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.

F. UL Compliance: Provide components which are listed and labeled by UL under the following standards.
1. UL Std. 4 Armored Cable.
2. UL Std. 83 Thermoplastic-Insulated Wires and Cables.
3. UL Std. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors.
4. UL Std. 486B Wire Connectors for Use with Aluminum Conductors.
5. UL Std. 854 Service Entrance Cable.

G. NEMA/ICEA Compliance: Provide components which comply with the following standards.
1. WC-1 Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy per UL 493 and UL 719.
2. WC-1 Cross Linked Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy per UL 83.
3. WC-1 Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy per UL 1063.
4. WC-1 Metal Clad Cables 600V Type MC cables containing 4 conductors or less, in sizes 14-10 AWG per UL 1569.

H. IEEE Compliance: Provide components which comply with the following standard.
1. Std. 82 Test Procedures for Impulse Voltage Tests on Insulated Conductors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:
1. Wire and Cable:
   a. Southwire Co.
   b. Phelps Dodge International Corp.
   c. Prysmian Group.
   d. Coleman Cable Inc.
   e. Encore Wire Corp.
   f. Senator Wire and Cable Co.
   g. The Okonite Co.

h. General Cable.
i. AFC Cable Systems.
j. Cerro Wire.

2. Joints and Splices- Indent Type Pressure Connector for #8 AWG and Smaller:
   a. Buchanan.
   b. Burndy.
   c. Ideal.
   d. Thomas & Betts.

3. Joints and Splices- Insulated Spring Compression Connectors for #10 AWG and Smaller:
   a. Buchanan, Bcap.
   b. Ideal, Wing nut.
   c. ITT Holub, Free Spring.
   d. T & B, Piggy.
   e. 3M, Scotchlok.

4. Joints and Splices- Mechanical Compression or Bolted Type Connector for #6 AWG or Larger
   a. AMP, Inc.
   b. Anderson.
   c. Blackburn.
   d. Burndy Corp.
   e. General Electric Co.
   f. Ideal Industries.
   g. ITT Weaver.
   h. O.Z./Gedney Co.
   i. T & B.
   j. 3M Co.

2.2 WIRES & CABLES

A. General: Provide wire and cable suitable for the temperature, conditions and location where installed.

B. Conductors: Provide solid conductors for power and lighting circuits no. 10 AWG and smaller. Provide stranded conductors for sizes no. 8 AWG and larger.

C. Conductor Material: Soft-drawn, annealed copper with a conductivity of 98% pure copper for all wires and cables.

D. Insulation:
   1. THHN for 600-volt and below for power wiring.
   2. Cabling installed in conduit as shown on Drawings or manufacturer recommended and Engineer approved cable for low voltage systems.
   3. Color coding for phase identification in accordance with Part 3 below.

E. Jackets: Factory-applied nylon or PVC external jacketed wires and cables for pulls in raceways over 100-feet in length, for pulls in raceways with more than three equivalent 90 deg. bends, for pulls in conduits underground or under slabs on grade, and where indicated.

F. Cables: Provide the following type(s) of cables in NEC approved locations and applications where indicated. provide cable UL-listed for particular application:
   1. Metal-Clad Cable: Type MC.

G. Lighting fixture "whips" shall be minimum of two No. 12 and one No. 12 ground and may be in 1/2" flexible conduit.

2.3 CONNECTORS FOR CONDUCTORS

A. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

B. Provide UL-listed factory-fabricated, pre-insulated solderless spring compression metal connectors on conductors No. 10 or smaller.

C. Use indent type pressure connectors on conductors No. 8 and smaller.

D. Use UL Listed mechanical compression or bolted type connectors on conductors No. 6 and larger.

PART 3 - EXECUTION

3.1 WIRING METHOD

A. Use the following wiring methods as indicated.
   1. Wire: Install all wire in raceway.
   2. Metal Clad Cable, Type MC: For 20 amp branch circuits (lighting and power) only and is not allowed for the circuit home run or in inaccessible areas such as above gypsum ceilings, in non-accessible plenum/attic spaces or in masonry walls. The branch circuit home run (from the panel to the first device) shall be conduit.

3.2 INSTALLATION OF WIRES AND CABLES

A. General: Install electrical cables, wires and connectors in compliance with NEC.

B. Coordinate cable installation with other work.

C. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.

D. Use pulling means including, fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway. Do not use rope hitches for pulling attachment to wire or cable.

E. Conceal all cable in finished spaces.

F. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.

G. Keep conductor splices to minimum.

H. Install splices and tapes which possess equivalent-or-better mechanical strength and insulation rating than conductors being spliced.

I. Use splice and tap connectors which are compatible with conductor material.

J. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than no. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.

K. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.
   1. Minimum wire sizes shall be as follows:
      a. Branch circuits on 120/240 volt systems, #12 gauge, except on home runs longer than 100 feet actual wire length from center of the circuit to the panel, #10 gauge minimum.
      b. Control wiring: #14 gauge except on runs longer than 50 feet, #12 gauge minimum wire size.
      c. Fixture Wiring: #18 gauge, when factory installed.

   2. Communications and Signal Systems: as specifically required.
   3. Conductors: Size according to the National Electric Code.

L. Multiwire branch circuits with a “shared neutral” are NOT allowed for single phase circuits. The only allowed multiwire branch circuit with a “shared neutral” is a multi-pole individual branch circuit to a single piece of equipment (for example “current carrying conductors that share a common yoke”).

3.3 FIELD QUALITY CONTROL

A. Prior to energization of circuitry, check installed wires and cables with megohm meter to determine insulation resistance levels to ensure requirements are fulfilled.

B. Prior to energization, test wires and cables for electrical continuity and for short-circuits.

C. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

3.4 COLOR CODING FOR PHASE IDENTIFICATION

A. Color code conductor insulation for #8 AWG or smaller shall be with a factory applied continuous color. Identify circuit numbers at the end of the wire.

B. Provide 3” long bands of 1” wide colored tape at the end of wire at panelboards, cabinets and boxes for larger than #8 AWG conductors. Identify both phase and circuit numbers at these locations.

C. Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows:

Voltage	120/240
Phase	single
Phase A	black
Phase B	red
Phase C	N/A
Neutral	white
Ground	green

END OF SECTION
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SECTION 260548 SEISMIC PROTECTION

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 26 0533; Raceways.

C. Section 26 5100; Interior Lighting.

1.2 SUMMARY

A. Provide seismic protection for electrical equipment and conduit installation.

B. General: The requirements for seismic protection measures of this Section to be applied to electrical equipment and systems are in addition to any other items called for in other sections.

C. Electrical equipment shall include the following items to the extent required on Drawings or in other sections:
   1. Light fixtures.
   2. Motor control centers.
   3. Switchboards (floor mounted).
   4. Engine-drive generators.
   5. Switchgear.
   6. Unit substations.
   7. Transformers.
   8. Ducts

D. Zone
   1. This facility is located in Seismic Zone D.

E. Exclusion
   1. Seismic restraints may be omitted from all electrical conduit less than 2-1/2" inside diameter (i.d.).

1.3 REFERENCES

A. Comply with publications listed below:
   1. American National Standards Institute, Inc.
      a. ANSI B18.2.1 - Square and Hex Bolts and Screws Inch Series.

2. American Society for Testing and Materials.
   a. ASTM A 307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   b. ASTM A 325 - High Strength Bolts for Structural Steel Joints.

3. American Society of Mechanical Engineers.
   a. ASME B18.2.2 - Square and Hex Nuts (Inch Series).

4. Underwriters Laboratories.
   a. UL 1598 - Lighting Fixtures.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications, installation instructions and dimensioned drawings for each type of bracing.

B. Shop Drawings: Submit shop drawings for seismic protection and bracing systems, showing materials, size, locations and elevations. Show interface and spatial relationship between brazed equipment and approximate structures.

C. Welding Certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" article.

D. Source quality-control reports.

E. Field quality-control reports.

F. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for system materials and products. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

G. Record Drawings: At project closeout, submit record drawings of installed bracing systems, show exact location and connection types and locations in accordance with the requirements of Division 01.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of system products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with systems work similar to that required for this project.

C. Source Limitations: Obtain each type of equipment through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section Substitutions and Product Options.

E. Welding Qualifications: Qualify processes and operators according to ASME. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for Intended location and application.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Sway Brace: Structural steel conforming to ASTM A 36.

B. Lighting Fixture Supports: Malleable iron.

PART 3 - EXECUTION

3.1 SWAY BRACES

A. Install sway bracing on conduit to preclude damage during seismic activity. Brace conduit grouped for support on trapeze-type hangers at the same intervals as determined by smallest diameter conduit of the group. Do not fasten sway braces to dissimilar parts of a building that may respond in a different mode during an earthquake; for example, a wall and a roof.

B. Secure trapeze-type hangers with minimum of two 1/2" bolts.

C. Rigidly attach bracing to conduit except where it would interfere with thermal expansion of the conduit.

3.2 FLEXIBLE COUPLINGS OR JOINTS

A. Provide flexible couplings at bottom of all conduit risers larger than 2-1/2" in diameter (i.d.).

B. Install flexible couplings adjacent to the building on all underground conduit 4" and larger.

C. Install additional flexible couplings where shown.

3.3 ANCHOR BOLTS

A. Install floor and pad mounted equipment required by this Section with cast-in-place anchor bolts using 2 bolts per nut. If the size and number of anchor bolts are not shown, conform to the schedule for equipment weights or manufacturer's installation instructions, whichever is more stringent.

B. Anchor bolts that exceed normal depth of equipment foundation piers or pads shall either extend into concrete floor or the foundation shall be increased in depth to accommodate bolt lengths.

C. Expansion anchors shall not be used to resist seismic or vibratory loads unless test data is provided to verify the adequacy of the anchor and application. In no case shall the expansion anchor size be less than required for bolts in the schedule for equipment weights.

3.4 RESILIENT VIBRATION ISOLATION DEVICES

A. Select anchor bolts for vibration isolation devices and snubbers to equipment base and foundations using the schedule for equipment by weight except use 5 times the actual equipment weight, or in accordance with manufacturer's installation instructions, whichever is more stringent.

3.5 MULTI-DIRECTIONAL SEISMIC SNUBBERS

A. Install multi-directions seismic snubbers employing elastomeric pads and providing 1/4" free vertical and horizontal movement from the static deflection point on all floor- or slab-mounted equipment.

B. Snubber Medium: Multiple pads of cotton duct and neoprene or other suitable materials arranged around a flanged steel trucing so both horizontal and vertical forces are resisted by snubber medium.

3.6 EQUIPMENT SWAY BRACING

A. Provide bracing of angles, rods, bars, or pipes for all items support from overhead floor or roof structures. Secure bracing at both ends with minimum 1/2" bolts.

B. Provide sufficient bracing for equipment to resist a horizontal force equal to 113% of the weight of equipment without exceeding safe working stress of bracing components. Conform to schedule for maximum length for anchor braces.

C. In lieu of bracing with vertical supports, items may be supported with hangers inclined at 45° directed up and radially away from equipment and oriented symmetrically in 90° intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45° angle.

3.7 LIGHTING FIXTURE IN BUILDINGS

A. Pendant Fixtures: Provide loop and hook or swivel hanger assemblies fitted with a restraining device to hold the stem in the support position during earthquake motions. Provide pendant-supported fluorescent fixtures with a flexible hanger device at the attachment to the fixture channel to preclude breaking of the support. Motion of swivels or hinged joints shall not cause sharp bends in conductors or damage insulation.

B. Recessed Fluorescent Fixtures: Support recessed individual and continuous-row mounted fixtures by a seismic-resistant suspended ceiling support system and bolt at each corner of fixture or provide fixture support wires attached to the building structural members using two wires for individual fixtures and one wire per unit on continuous row mounted fixtures.

C. Assembly Mounted on Outlet Box: Design supporting assemblies intended to be mounted on an outlet box to accommodate mounting features on 4" boxes, 3" plaster rings, and fixture studs.

D. Surface Mounted Fluorescent Fixtures: Provide seismic-resistant ceiling support system for individual and continuous-row mounted fixtures.
   1. Suspended Ceiling: Provide locking-type scissor clamp or full loop band securely attached to ceiling support system.
   2. Underside of Structural Slab: Anchor to slab at each corner of fixture.

E. Wall Mounted Emergency Light Unit: Securely anchor in-place to resist seismic disturbance.

3.8 TEST

A. In lieu of the requirements for equipment supports, lighting fixtures and the complete fixture-supporting assembly may be tested as specified hereinafter. Such tests shall be conducted by an approved and independent testing laboratory, and the results of such test shall specifically state whether or not the lighting fixture supports satisfy the requirements given herein.

B. Test Equipment: To simulate earthquake motion, attach fixtures and supports to a carriage suspended on rollers from an overhead track. Provide oscillatory

motion of approximately one cycle per second using a gear motor and crank assembly. Adjust the exact number of cycles per second and the actual dimensions of the crank apparatus to produce a minimum carriage acceleration of 0.28g. The actual fixture mounting surface shall be on the underside of the carriage and shall provide for orienting the fixture in a horizontal plane in various positions, ranging from parallel to perpendicular to the line of traverse.

C. Test Requirements: Conduct test with the maximum fixture weight to produce the most severe loading conditions. Test fixtures having stems with the actual stem length to be used. Test for 1 minute duration with the mounting surface in the line of traverse, at 45° to the line of traverse, and at 90° to the line of traverse. Test a total of 2 fixtures in each test position. After each of the six tests, subject stem assemblies to tensile strength test. The sample stems shall withstand, without failure, a force of not less than four times the weight it is intended to support.

D. Acceptance: No component of a fixture, not its supports shall be accepted individually. For acceptance, the fixture and its supports shall exhibit no undue damage, and no component of the fixture shall fail or fall from the fixture during testing.

E. Design Criteria: In lieu of the above test requirements, lighting fixtures shall be designed to resist a lateral force of 113 percent of the fixture weight.

F. Lighting Fixture Supports: Recessed lighting fixtures not over 56 pounds in weight may be supported and attached directly to the ceiling system runners by a positive attachment such as screws or bolts.

3.9 MISCELLANEOUS EQUIPMENT

A. The following specific items of equipment to be furnished under this contract shall be constructed and assembled so as to be capable of withstanding the horizontal equivalent static force of 0.23 times the operating weight of the equipment, at vertical center of gravity of the equipment without causing permanent deformation, dislocations, separation of components, or other damage, which would render the equipment inoperative for significant periods of time following an earthquake:
   1. Motor Control Centers.
   2. Engine-Generators.
   3. Substations.
   4. Transformers.
   5. Switch Boards and Switch Gear.
   6. Free Standing Electric Motors.

3.10 SCHEDULES

Minimum bolt sizes for cast-in-place anchor bolts:

Maximum Equipment Weight (Pounds)	Minimum Bolt Size (inches)* Zone 4	Zone 3	Zone 2	Zone 1
500	1/2	1/2	1/2	½
1,000	1/2	1/2	1/2	½
5,000	1/2	1/2	1/2	½
10,000	1/2	1/2	1/2	½
20,000	1/2	1/2	1/2	½
30,000	5/8	5/8	1/2	½
50,000	7/8	3/4	1/2	½
100,000	1-1/8	1	3/4	½

Based on four bolts per item, a minimum embedment of 12 bolt diameters, a minimum bolt spacing of 16 bolt diameters and a minimum edge distance of 12 bolt diameters. Use equivalent total cross-sectional area when more than four bolts per item are provided. Anchor bolts must conform to ASTM A 307. Anchor bolts shall have an embedded straight length equal to at least twelve times nominal diameter of the bolt.

END OF SECTION
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SECTION 260553 ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED WORK

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

1.2 SUMMARY

A. Provide identification for products and systems.

B. Types of electrical identification work specified in this section include the following:
   1. Buried cable warnings.
   2. Electrical power, control and communication conductors.
   3. Electrical power, control and communication raceways.
   4. Electrical power systems operation and maintenance identification.
   5. Danger signs.
   6. Equipment/system identification signs or labels.
   7. Permanent nameplates.
   8. Color coding.

C. Provide field marking and identification of equipment and conductors in compliance with the NEC.
   1. Checklist for marking and identification is included for information.
      a. Section 110-27(c): Warning Sign for Exposed Parts.
      b. Section 110-22: Marking of Disconnects.
      c. Section 200-6(a,b,d): Identification of "grounded" conductor.
      d. Section 210-5(a): Identification of "grounded" conductor.
      e. Section 210-5(b): Identification of "grounding" conductor.
      f. Section 210-5(c): Identification of “ungrounded” conductors.
      g. Section 215-8: Identification of "high" leg (feeders).
      h. Section 230-2: Number and Location of Electrical Services.
      i. Section 230-56: Identification of "high" leg (services).
      j. Section 230-70(b): Identification of Service Disconnect.
      k. Section 230-72(a): Marking of Loads fed from Service Disconnect.
      l. Section 230-200: Requires Services Rated over 600V to Comply with All Markings Required for Services Rated 600V or less.
      m. Section 310-12: Identification of All Conductors.
      n. Section 408-3(e): Phase Arrangement in Switchboards and Panelboards.
      o. Section 110-22: Marking of Circuit Directory in Panelboards.

p. Section 430-74(a), Ex. No. 1: Marking of Control Power Disconnect for Motors.
q. Section 450-8(c): Warning Sign for Transformer Installations.
r. Section 517-19(a): Emergency Receptacles Indicating Panelboard and Circuit Number.
s. Section 517-160(a) (5): Identification of Isolated Power System Circuits in Health Care Facilities.
t. Section 620-51: Identification of Elevator Disconnects.
u. Section 620-53: Identification of Car Light Disconnects.
v. Section 645-10: Identification of Emergency Disconnect in Computer Rooms.
w. Section 700-8: Identification of Emergency Power Source(s).
x. Section 700-9(a): Identification of Emergency Power System Enclosures.
y. Section 760-10: Identification of Fire Signaling Circuits.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each type of identification.

B. Source quality-control reports.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of system products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Source Limitations: Obtain each type of identification through one source from a single manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:
1. Brady, W.H. Co.
2. Ideal Industries, Inc.
3. Seton Name Plate Co.
4. Panduit Corp.

2.2 MATERIALS

A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

B. Color-Coded Plastic Tape:
   1. General: Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 1-1/2" wide.
   2. Colors: Unless otherwise indicated or required by governing regulations. Provide color tape corresponding to color-coding of phase conductors.

C. Underground-Type Plastic Line Marker:
   1. General: Manufacturer's standard permanent, red-colored, continuous-printed detectable plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable.

D. Cable/Conductor Identification Bands:
   1. General: Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

E. Engraved Plastic-Laminate Signs:
   1. General: Provide engraving stock melamine plastic laminate, complying with ASTM D 709, in sizes and thicknesses indicated, engraved with engraver's standard letter style of 3/16” high and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
   2. Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.
   3. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:
   1. Install electrical identification products as indicated in accordance with manufacturer's written instruction and requirements of NEC.
   2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.

3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Underground Cable Identification:
1. General: During backfilling/topsoiling of each exterior underground electrical, signal or communication cable, install continuous underground-type detectable plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install single line marker.
2. Install line marker for every buried cable regardless of whether direct-buried or protected in conduit.

C. Cable/Conductor Identification:
1. General: Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

D. Equipment/System Identification:
1. General: Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/4" high lettering on 1" high sign (1 1/2" high where 2 lines are required), white lettering in black field (red for 250-volt and over systems). Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
   a. Panelboards, electrical cabinets and enclosures.
   b. Access panel/doors to electrical facilities.
   c. Major electrical switchgear.
   d. Electrical substations.
   e. Motor control centers.
   f. Power transfer equipment.
   g. Transformers.
   h. Disconnect switches.

2. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate the substrate.

3.2 SYSTEMS IDENTIFICATION

A. Identify systems by wire markers at the following locations:
   1. Mark all power and lighting branch circuits and feeders at pull boxes, fixtures, outlets, motors, etc., with markers indicating panel and circuit number at which each circuit or feeder originates.
   2. Mark all branch circuits in the panelboard gutters. Markers shall indicate corresponding branch circuit numbers.
   3. Mark all signal and control wires at all termination points, such as cabinets, terminal boxes, equipment racks, control panels, consoles, etc. Provide marking in accordance with approved schedules prepared by the system manufacturer.
   4. Indicate both ends of all pull wires by means of labels or tags, reading "PULL WIRE" and shall be numbered to refer to the same pull wire.

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SECTION 261300 BOXES AND FITTINGS

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 26 0533; Raceways.

1.2 SUMMARY

A. Types of electrical boxes and fittings specified in this section include the following:
   1. Outlet boxes
   2. Junction boxes
   3. Pull boxes
   4. Bushings
   5. Locknuts
   6. Knockout closures
   7. Floor boxes
   8. Poke-throughs

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications, installation instructions and dimensioned drawings for each type of box or specialty fitting.

B. Source quality-control reports.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of system products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with systems work similar to that required for this project.

C. Source Limitations: Obtain each type of equipment through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section, “Substitutions & Product Options.”

E. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.

F. UL Listing and Labeling: Provide items under this section listed and labeled by UL where a standard exists.

G. OSHA Reg. 1910-7 listing by an accredited laboratory is acceptable.

H. NEMA Compliance: Comply with applicable requirements of NEMA Standard 250, "Enclosures for Electrical Equipment."

I. ANSI/NEMA FB 1 for fittings and conduit bodies.

J. ANSI/NEMA OS 1 for sheet steel outlet boxes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:
1. Appleton Electric.
2. Bridgeport.
3. Crouse-Hinds.
4. Hoffman Co.
5. Hubbell, Inc.
6. Mulberry Metal Products Inc.
7. Neer.
8. O.Z. Gedney Co.
9. Pass and Seymour, Inc.
10. Quazite Corp.
11. Raco Manufacturing.
12. Steel City.
13. Square "D", Inc.
14. Thomas & Betts Co.
15. Walker/Wiremold Inc.

2.2 MATERIALS

A. Fixture Outlet Boxes: Provide galvanized coated flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct outlet boxes

with mounting holes, and conduit-sized knockout openings in bottom and sides. Provide boxes with threaded screw holes and device type box covers, and for equipment type grounding. Round boxes shall not be used.

1. Fixture Outlet Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations.

B. Device Boxes: Provide galvanized coated flat rolled sheet-steel, non-gangable device box, 4" square, 2-1/8" deep. Provide plaster ring to flush out with finish wall. Provide grounding screw. Provide device box supports and mounting brackets as required.

C. Raintight Outlet boxes: Provide corrosion-resistant cast-metal raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring-hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant, plugs and fasteners.

D. Junction and Pull Boxes: Provide galvanized code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers. Boxes shall have UL label and shall not be shop built. Locate junction and pull boxes above removable ceilings or in rooms with no ceiling.

E. Floor Boxes: Provide concrete-tight adjustable floor boxes as indicated, with threaded-conduit-entrance ends, and vertical adjusting rings and gaskets. Provide round metal covers with two large cable egress doors and 180-degree access opening. Box shall be equal to Hubbell model CFB2G30RCR with the cover equal to Hubbell model CFBS1R6CVR_ _ _ (color as selected by the architect).

F. Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

2.3 CONDUIT FITTINGS

A. Construct locknuts for securing conduit to metal enclosure with sharp edge for digging into metal, and ridged outside circumference for proper fastening.

B. Bushings for terminating conduits 1" and larger are to have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation. The bushing body is to be constructed of thermoplastic, bakelite, or steel.

C. Install insulated type bushings for terminating conduits 2-1/2" and larger. Bushings are to have flared bottom and ribbed sides. Upper edge to have phenolic insulating ring molded into bushing.

D. Bushing of standard or insulated type to have screw type grounding terminal.

E. Miscellaneous fittings such as reducers, chase nipples, three-piece unions, split couplings, and plugs to be specifically designed for their particular application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.

C. Provide weathertight outlets for interior and exterior locations exposed to weather or moisture.

D. Provide knockout closures to cap unused knockout holes where blanks have been removed.

E. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.

F. Do not install boxes back-to-back in walls. Provide a minimum of 6" of separation.

G. Position recessed outlet boxes accurately to allow for surface finish thickness.

H. Set floor boxes level and flush with finish flooring material. Install floor boxes as directed by Architect.

I. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches of box.

J. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry.

K. Provide electrical connections for installed boxes.

L. Subsequent to installation of boxes, protect boxes from construction debris and damage.

M. Do not use sectional or handy boxes.

N. Use multiple-gang boxes where more than one device are mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

O. Install outlets mounted above counters, benches, and back-splashes, coordinate with the millwork plans.

P. Position outlets to locate luminaires as shown on reflected ceiling plans.

Q. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

R. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

S. Provide cast outlet boxes in exterior locations exposed to the weather and wet locations.

T. Set switch boxes within 6 inches of door jamb where applicable.

3.2 DEMONSTRATION

A. Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

END OF SECTION
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SECTION 261420 ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

C. This section is a Division 26 Basic Materials and Methods section and is part of each Division 23 and 26 section making reference to electrical connections for equipment specified herein.

D. Owner-furnished equipment has been defined from vendor's information current at commencement of design. Obtain latest rough-in from vendor prior to completing rough-in provisions.

1.2 SUMMARY

A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electric connections are hereby defined to include connections used for providing electrical power to or receiving power from equipment.

B. Applications of electrical power connections specified in this section include the following:
   1. To motors.
   2. To lighting fixtures.
   3. To grounds, including earthing connections.

C. Refer to Division 23 sections for motor starters and controls furnished with equipment.

D. Junction boxes and disconnect switches required for connecting motors and other electrical units of equipment are specified in applicable Division 26 sections.

E. Refer to Division 23 sections for control system wiring.

F. Refer to sections of other divisions for specific individual equipment power requirements.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications, installation instructions and dimensioned drawings for each type of connection specialty.

B. Source quality-control reports.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. General: For each electrical connection indicated, provide complete assembly of materials including, but not necessarily limited to, disconnect switches, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items, accessories and specialties as needed to complete splices and terminations of types indicated.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect area and conditions under which electrical connections for equipment are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Install electrical connections as indicated in accordance with manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.

B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with equipment installation work.

C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

D. Maintain existing electrical service and feeders to occupied area and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When "cutting-over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

E. Cover splices with electrical insulation material equivalent to, or of greater insulation resistivity rating than electrical insulation rating of those conductors being spliced.

F. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL 486A.

H. Fasten identification markers to each electrical power supply wire/cable conductor which indicate their voltage, phase and feeder number in accordance with Division 26 Section, “Electrical Identification.” Affix markers on each terminal conductor as close as possible to the point of connection.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirements. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION
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SECTION 261900 SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 26 0533; Raceways.

C. Section 26 1300; Boxes and Fittings.

1.2 SUMMARY

A. Provide conduit supports for the entire project complete.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of support products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Source Limitations: Obtain each type of support through one source from a single manufacturer.

PART 2 - PRODUCTS

2.1 CONDUIT SUPPORTS

A. Singular Runs: Galvanized conduit straps or ring bolt type hangers with specialty spring clips. Do not use plumbers perforated straps.

B. Multiple Runs: Conduit rack with 25% spare capacity.

C. Vertical Runs: Channel support with conduit fittings, clamp type supports where conduits penetrate floors.

D. Trapeze Style Hangers: 1-5/8" x 1-5/8" galvanized steel channels, supported by 3/8" rod hangers.

2.2 ANCHOR METHODS

A. Hollow Masonry: Toggle bolts or spider type expansion anchors.

B. Solid Masonry: Lead expansion anchors or preset inserts.

C. Metal Surfaces: Machine screws, bolts or welded studs.

D. Wood Surfaces: Wood screws.

E. Concrete Surfaces: Load expansion anchors with machine or lag bolts.

2.3 METAL FRAMING SYSTEMS

A. Provide metal framing systems for electrical equipment and conduits as required for proper support spacing and approved for the purpose.

B. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:
   1. Powerstrut
   2. Unistrut
   3. Kindorf

C. All members and fittings to be galvanized, including screws, nuts, washers, inserts, springs, clamps, hangers, clips, and fittings.

2.4 SLEEVES

A. Where conduits pass through interior masonry or fire-rated walls, install 22-gauge galvanized sheet iron sleeves. Finish flush with each finished surface. Size sleeves to readily permit the subsequent insertion of conduits of the proper size. After conduits have been installed, close opening with flush escutcheon and firestop material.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Layout to maintain headroom, neat mechanical appearance, and to support equipment loads as required.

B. Install horizontal supports at eight feet on centers, at fittings and corners, and as required for proper support.

C. Provide a complete installation with all channels, accessories, screws, nuts, washers, inserts, springs, clamps, hangers, clips, fittings, bracket framing fittings, post bases and brackets to provide a structurally rigid support or mounting system.

END OF SECTION

SECTION 262400 EQUIPMENT

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Division 23; Mechanical Equipment.

C. Section 26 0533; Raceways.

D. Section 26 0536; Wires and Cables.

1.2 SUMMARY

A. Provide feeder, branch circuit, control wiring, disconnects, and provide final connections to all equipment, including elevators, kitchen, medical, and Owner-furnished equipment.

B. Set, shim, align and check rotation of all motors not received as an integral part of any equipment assembly.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of system products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with systems work similar to that required for this project.

C. Source Limitations: Obtain each type of equipment through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Substitutions & Product Options."

E. National Electrical Code References:
   1. Appliances: Article 422.
   2. Fixed Electric Space Heating Equipment: Article 424.

3. Motors, Motor Circuits and Controllers; Article 430.
4. Air-Conditioning and Refrigeration Equipment: Article 440.
5. Elevators: Article 620.

F. Safety Codes and Standards:
1. Enclosed Switches: UL 98.
2. Elevator Safety Code: ANSI A17.1.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications, installation instructions and dimensioned drawings for each type of equpmment installed.

B. Shop Drawings: Submit shop drawings for transformers, showing dimensions, and weight loadings for transformer installations, showing layout, mountings and supports, spatial relationship to panelboards and associated equipment, include transformer connections to electrical equipment.

C. Wiring Diagrams: Submit wiring protection and control diagrams for equipment provided. Clearly differentiate between portions of wiring that are manufacturer installed and portions to be field installed.

D. Source quality-control reports.

E. Field quality-control reports.

F. Operation and Maintenance Manual Data: Include product data, shop drawings and record drawings in the maintenance manual. Include "trouble-shooting" maintenance guides. Furnish these materials with protective covering for storage and identified with labels describing the contents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Disconnect Switches:
1. Quick-make, quick-break operating mechanism.
2. Horsepower rated.
3. Voidable interlocked cover to prevent unauthorized opening in the ON position.
4. Padlocking provisions for locking in either the ON or OFF position.
5. Enclosures:
   a. Indoor: NEMA 1 in dry areas, NEMA 3R in wet locations.
   b. Outdoor: NEMA 3R.

6. Cabinets: NEMA 1 in dry areas, NEMA 3R in wet locations.

B. Time Switch
   1. 7-day electronic time switch.
   2. Type 1 gray painted steel case.
   3. 120/208/240/277 Volt AC 60 Hz operation.
   4. 2 – AAA batteries for battery backup.
   5. 1 single pole single throw 30 amp circuit.
   6. Equal to Intermatic Model No. ET1705C.

C. Photocell
   1. Equal to Intermatic Model No. K4321C with light shield Model No. K4000.

D. Lighting Contactor
   1. Provide a minimum of 3 spare poles in each contactor.
   2. NEMA type 1 enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install, wire and connect all equipment in compliance with manufacturers shop drawings, wiring diagrams and installation instructions.

3.2 TESTS AND DEMONSTRATION

A. After installation is complete, test and adjust the system.

B. After testing and making any necessary adjustments, demonstrate that the system is operating properly and performs the specified functions.

END OF SECTION
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SECTION 262416 PANELBOARDS

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Division 26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

A. Extent of panelboard, load-center and enclosure work, including cabinets and cutout boxes, is indicated by drawings and schedules, and as specified herein.

B. Types of panelboards and enclosures in this section include the following:
   1. Lighting and appliance panelboards.

C. Refer to other Division 26 sections for cable/wire, electrical boxes and fittings, and raceway work required in conjunction with installation of panelboards and enclosures.

D. Wires/cables, electrical boxes and fittings, and raceways required in conjunction with the installation of panelboards and enclosures are specified in other Division 26 sections.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications, installation instructions and dimensioned drawings for each type of panelboard and enclosure. Include wiring diagrams for panelboards showing connections to electrical power feeders and distribution branches.

B. Source quality-control reports.

C. Field quality-control reports.

D. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for panelboards and enclosures. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

E. Record Drawings: At project closeout, submit record drawings of installed panelboard locations and circuit number modifications in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of panelboards and enclosures of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 15 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with systems work similar to that required for this project.

C. Source Limitations: Obtain each type of equipment through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Substitutions & Product Options."

E. Codes & Standards:
   1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Article 408 as applicable to installation, and construction of electrical panelboards and enclosures.
   2. UL Compliance: Comply with applicable requirements of UL 67, "Electric Panelboards", and UL's 50, 467, 486A, 486B, 489, 869 and 1053 pertaining to panelboards, accessories and enclosures. Provide units which are UL-listed and labeled.
   3. Special-Use Markings: Provide panelboards, constructed for special-use, with appropriate UL marks which indicates that special type of use/application.
   4. NEMA Compliance:
      a. Comply with NEMA Standards Pub/No. 250, "Enclosures for Electrical Equipment (1000 Volt Maximum)",
      b. Comply with NEMA Standards. Pub/No. PB 1, "Panelboards", and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."
      c. Comply with NEMA Standards. Pub/No. AB 1, for molded case circuit breakers.

   5. ANSI Compliance: Comply with ANSI Z55.1 for panelboard finishes.

1.5 SEQUENCING & SCHEDULING

A. Coordinate installation of panelboards and enclosures with installation of wires/cables, electrical boxes and fittings, and raceway work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:
   1. Cutler-Hammer Products, Eaton Corp.
   2. General Electric Company.
   3. Siemens-Allis, Inc.
   4. Square D Company.

2.2 LIGHTING AND APPLIANCE PANELBOARD TYPE

A. NQ or NQOD
   1. Interior
      a. Shall be type NQ or NQOD panelboard rated for 240 Vac/48 Vdc maximum. Continuous main current ratings, as indicated on associated drawings, not to exceed 600 amperes maximum.
      b. Minimum short circuit current rating: As indicated in rms symmetrical amperes at 240 Vac.
      c. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for plug-on or bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing rated 100-400 amperes shall be plated aluminum. Bussing rated for 600 amperes shall be plated copper as standard construction. Bus bar plating shall run the entire length of the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
      d. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.
      e. A solidly bonded aluminum equipment ground bar shall be provided.
      f. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have filler plates covering unused mounting spaces.
      g. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, CSA and UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.

h. Interiors shall be field convertible for top or bottom incoming feed. Main circuit breakers in 100A interiors shall be [horizontally] [vertically] mounted. Main circuit breakers over 100A shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.
i. Interior phase bus shall be pre-drilled to accommodate field installable options, i.e., Sub-Feed Lugs, Sub-Feed Breakers, Thru-Feed Lugs.

2. Main Circuit Breaker
   a. The main circuit breaker shall be of the same manufacturer as the panel and branch breakers.
   b. Main circuit breakers shall have an overcenter, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.
   c. Two- and three-pole circuit breakers shall have common tripping of all poles. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.
   d. Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings.
   e. Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
   f. Lugs shall be UL Listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16. Lug body shall be bolted in place; snap-in designs are not acceptable.
   g. The circuit breakers shall be UL Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Ground Fault Shunt Trip, Auxiliary Switch, Alarm Switch, Mechanical Lug Kits, and Compression Lug Kits.

3. Branch Circuit Breakers
   a. The branch circuit breakers shall be of the same manufacturer as the panel and the main breakers. Circuit breakers shall be UL Listed with

amperage ratings, interrupting ratings, and number of poles as indicated on the associated drawings.

b. Molded case branch circuit breakers shall have bolt-on type bus connectors.

c. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.

d. There shall be two forms of visible trip indication. The breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red VISI-TRIP® indicator appearing in the clear window of the circuit breaker housing.

e. The exposed faceplates of all branch circuit breakers shall be flush with one another.

f. Lugs shall be UL Listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16.

g. Breakers shall be UL Listed for use with the following factory installed accessories: Shunt Trip, Auxiliary Switch, and Alarm Switch.

4. Enclosures

a. Type 1 Boxes

1) Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements. Unpainted galvannealed steel is not acceptable.

2) Boxes shall have removable endwalls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.

3) Box width shall be 26” wide maximum.

b. Type 1 Fronts

1) Front shall meet strength and rigidity requirements per UL 50 standards. Front shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.

2) Fronts shall be hinged 1-piece with door. Mounting shall be as indicated on associated drawings.

3) Panelboards shall have MONO-FLAT fronts with concealed door hinges and mounted with trim screws. Front shall not be removable with the door locked. Doors on front shall have rounded corners and edges shall be free of burrs.

4) Front shall have cylindrical tumbler type lock with catch and spring-loaded stainless steel door pull. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory cardholder shall be mounted on the inside of door.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which panelboards and enclosures are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B.

C. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.

D. Provide properly wired electrical connections within enclosures.

E. Fill out panelboard's circuit directory card upon completion of installation work.

F. Insert fuses, if any, of ratings indicated, within installed panelboards.

3.3 GROUNDING

A. Provide equipment grounding connections for panelboards as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds. Bond panelboard ground bus kits together as required by NEC Article 517-14.

3.4 FIELD QUALITY CONTROL

A. Prior to energization of circuitry, check all accessible connections to manufacturer's tightening torque specifications.

B. Prior to energization of panelboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled. Record values for maintenance procedures beginnings.

C. Prior to energization, check panelboards for electrical continuity of circuits, and for short-circuits.

3.5 ADJUSTING & CLEANING

A. Adjust operating mechanism for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finishes.

3.6 DEMONSTRATION

A. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION
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SECTION 262726 WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

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

1.2 SUMMARY

A. Provide wiring devices and plates, complete.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications, installation instructions, ratings and dimensioned drawings for each type of device.

B. Source quality-control reports.

C. Field quality-control reports.

D. Operation and Maintenance Manual Data: Include product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing the contents.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of devices of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with systems work similar to that required for this project.

C. Source Limitations: Obtain each type of device through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Substitutions & Product Options."

E. National Electrical Code References:

1. Switches: Article 404.
2. Receptacles: Article 406.

F. Safety Standards:
1. Switches: UL 20.
2. Receptacles: UL 498.
3. Plates: UL 514D.
4. Ground Fault Circuit Interrupters: UL 943.

G. Manufacturer's Standards:
1. NEMA WD-1.
2. ANSI C 73A.

H. All devices shall be specification grade, minimum.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer, subject to compliance with requirements, shall be one of the following or an Engineer approved equivalent:
1. Hubbell
2. Pass & Seymour
3. Leviton
4. Cooper

2.2 MATERIALS

A. Devices
1. Switches: Heavy duty, AC quiet type, toggle handle, 20 amp, 120-277 volts, equal to Hubbell No. CS1201.
   a. Three-way Switches: Heavy duty, AC quiet type, toggle handle, 20 amp., 120-277 volts, equal to Hubbell No. CS3201.
   b. Four-way switch: Heavy duty, AC quiet type, toggle handle, 20 amp., 120-277 volts, equal to Hubbell No. 1224.
   c. Dimmer Switch: 0-10 volts, LED dimmer equal to Lutron NovaT NTSTV-DV.
   d. Timer Switch: Commercial, 20 (8 max. load) amp, 120-277 volts, 30 minute max timer, equal to Hubbell No. DT5050W.
   e. Occupancy Sensor: Commercial, passive infrared technology, manual time delay adjustment (20 sec. to 30 min.), auto on operation, 20 amp, 120 volt AC only equal to Hubbell No. WS1000W.

2. Receptacles/Plug-in Devices:

a. Duplex Receptacles: Heavy duty, 2 pole, 3 wire, grounding, 20 amp, 125 volts, equal to Hubbell No. 5352 series, corrosion resistant on exterior.
b. Ground Fault Circuit Interrupters: Heavy duty, Class A, 20 amp, 125 volts, equal to Hubbell GF-5362 series, for individual receptacle protection or feed-thru installation.

B. Colors:
a. Devices, unless noted otherwise on the plans shall be white. Verify prior to ordering.
b. Emergency Devices, unless noted otherwise on the plans shall be red. Verify prior to ordering.

C. Device Plates:
1. aluminum equal to Hubbell No. WP26E_ for vertical or horizontal applications.
2. Materials:
a. Molded of impact resistant thermoplastic, equal to Hubbell NP series.
b. 0.04 inch thick, type 302, satin finished stainless steel.

3. Colors:
a. Wall mounted device plates shall be stainless steel.
b. Ceiling mounted device plates shall be white thermoplastic.

D. Labeling:
1. For standard duplex and single receptacles, indicate on the backside of the receptacle faceplate, with a black permanent marker, the panel and circuit number feeding the receptacle.
2. On other than standard duplex and single receptacles, provide an engraved or embossed face plate indicating the voltage, phase, amperes, panel name and circuit number.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Where switches operate vertically, single or double pole switches shall be "ON" in the upper position. If operated horizontally, single or double switches shall be “ON” in the right position. Where more than one switch is shown at one outlet, install under one plate in an order appropriate to the location of the outlets controlled.

B. Mount duplex receptacles vertically.

C. All duplex receptacles mounted vertically shall have ground prong hole in lower position. All duplex receptacles mounted horizontally shall have ground prong hole in left position.

D. Install plates with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Mount switches flush with plate so switch handle will not strike plate.

E. Mounting heights shall be to the centerline of the device in permanent walls (unless otherwise specified):
   1. Duplex and single receptacles 18" above finish floor.
   2. Receptacles, data or telephone outlets above counters (coordinate with the counter and the cabinetry) 6" above backsplash.
   3. Telephone outlets 18" above finish floor.
   4. Data outlets (computer-printer) 18" above finish floor.
   5. Wall switches-dimmers 46" above finish floor.
   6. GFI receptacle in toilet room (unless noted to be above the counter) 42"above finish floor.

END OF SECTION
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SECTION 265100 INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Section 26 0533; Raceways.

C. Section 26 0536; Wire and Cable.

D. Section 26 2726; Wiring Devices.

1.2 SUMMARY

A. Provide a complete lighting system as shown and specified.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications, installation instructions and dimensioned drawings for each type of light fixture. Include certified photometric data including CU and VCP tables for each light fixture specified. Submit IES data for fixtures upon request.

B. Shop Drawings: Submit shop drawings in booklet form with separate sheet for each fixture, assembled in "luminaire type" alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet.

C. Wiring Diagrams: Submit wiring diagrams for lighting fixtures showing connections to electrical power panels, switches, dimmers, controllers, and feeders. Differentiate between portions of wiring which are manufacturer-installed and portions which are field-installed.

D. Samples: Submit samples upon request.

E. Source quality-control reports.

F. Field quality-control reports.

G. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for each lighting fixture and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings and record

drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

H. Extra Stock: Furnish stock or replacement lamps amounting to 15% (but not less than one lamp of each type) of each type and size lamp used in each type fixture. Deliver replacement stock as directed to Owner's storage space, and obtain receipt.

I. Record Drawings: At project closeout, submit record drawings of installed light fixtures, show exact location and associated circuitry in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of light fixtures of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with light fixtures similar to that required for this project.

C. Source Limitations: Obtain each type of light fixture and accessory through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section, "Substitutions & Product Options."

E. Codes and Standards
   1. Electrical Code Compliance: Comply with the applicable National Electrical Code (NEC) references:
      a. Article 210, "Branch Circuits."
      b. Article 250, "Grounding and Bonding."
      c. Article 400, "Flexible Cord and Cables."
      d. Article 402, "Fixture Wires."
      e. Article 410, "Luminaires, Lampholders, and Lamps."

   2. UL Compliance: Comply with applicable requirements of UL Standards and provide light fixtures and components which are UL-Listed and labeled per the following standards:
      a. Standard 62, "Flexible Cords and Cables."
      b. Standard 66, "Fixture Wire."
      c. Standard 153, "Standard for Portable Electric Luminaires."
      d. Standard 183, "Standard for Manufactured Wiring Systems."
      e. Standard 486A-486B, "Wire Connectors."
      f. Standard 496, "Lampholders."
      g. Standard 542, "Standard for Fluorescent Lamp Starters."

h. Standard 676, “Standard for Underwater Luminaires and Submersible Junction Boxes.”
i. Standard 1574, “Standard for Track Lighting Systems.”
j. Standard 1581, “Reference Standard for Electrical Wires, Cables and Flexible Cords.”

3. NEMA Compliance: Comply with applicable portions of the following NEMA Standards:
   a. Publication No. BL 1, “Fluorescent Ballast Connector.”
   b. Publication No. BL 2, “Energy Efficiency for Electronic Ballasts for T8 Fluorescent Lamps.”
   c. Publication No. LL 7, “Generic Designation System for Pin-Based Compact fluorescent and T5 Twin Fluorescent Lamps.”
   d. Publication No. LL 9, “Dimming of T8 Fluorescent Lighting Systems.”
   e. Publication No. LE 4, “Recessed Luminaires-Ceiling Compatibility.”
   f. Publication No. LE 5, “Procedure for Determining Luminaire Efficacy Ratings for Fluorescent Luminaires.”

4. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

1.5 COORDINATION

A. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of exterior lighting fixtures with other work.

B. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of lighting fixtures with other work.

C. Sequence lighting installation with other work to reduce possibility of damage and soiling of fixtures during remainder of construction period.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver exterior lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from construction debris and physical damage.

B. Store exterior lighting fixtures in original wrappings in a clean dry place. Protect from weather, dirt, fumes, water, construction debris, and damage.

C. Handle exterior lighting fixtures carefully to prevent damage, breaking, and scoring. Do not install damaged fixtures or components; remove units from site and replace with new.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to the following:
   1. Driver failures.
   2. Faulty operation of controls.
   3. Deterioration of any competent beyond the degradation of normal use.

B. Warranty Period(s) from date of Substantial Completion:
   1. Provide a one (1) year parts and labor warranty for the complete fixture.
   2. Provide a two (2) year parts only warranty on the fixture ballast.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers, subject to compliance with requirements, shall be the following or an Engineer approved equivalent(s):

B. Fixtures.
   1. Williams.
   2. Cooper.
   3. Hubbell.
   4. LBL.
   5. Philips.
   6. LSI.
   7. Holophane.
   8. Advent.
   9. Lithonia Lighting.

C. Emergency Fixtures.
   1. Dual-Lite.
   2. Williams.
   3. Cooper.
   4. Chloride.

D. Drivers.
   1. Advance.
   2. Osram-Sylvania.
   3. Venture.

2.2 MATERIALS

A. Fixtures: Provide lighting fixtures of rigid construction, dimensionally stable, and assembled with secure fastenings. Protect ferrous parts from corrosion by

plating or finish with high reflectance enamel with non-yellowing binder and high pigment to binder ration, with matte finish. Prepare ferrous parts for finish by a 5 state phosphatizing process. Finish aluminum parts used as reflector surfaces with Alzak process. Firmly support shielding materials, make tight, with no loose panels or parts, and showing no leaks of unshielded or unintentional light. All plastics used in shielding shall be virgin acrylic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide fixture wiring suitable for the temperature rating of the fixture. Where a junction box is required to change from branch circuit to fixture wiring, use approved pre-wired fixtures or install a separate junction box, at the Contractor's option. Provide fully accessible junction box after installation of covering materials. Where flexible conduit, MC cable or portable cord is used, install a grounding jumper; ground all fixtures.

B. Suspend lighting fixtures from structural members or from ceiling structural members, by minimum 1-1/2 inch channels, by standard bar hangers, or other approved means. Under no circumstances will they be suspended from the ceiling. Coordinate fixture locations with ceiling patterns. Refer to architectural room finish schedule for ceiling construction details and mounting heights.

C. Provide structural steel necessary to support the fixtures under this section. Provide plaster frames as required. Where lighting fixtures located in plaster ceilings have a square or rectangular pattern, provide necessary corner plaster frames for a complete system.

D. The lighting fixture schedule shown on the contract document indicates the type of fixture required but the contractor shall provide the proper fixture for the ceiling type as indicated in the architectural finish schedule.

3.2 TESTS AND DEMONSTRATIONS

A. After installation is complete, test and adjust the system.

B. After testing and making any necessary adjustments, demonstrate to the Owner's representative that the system is operating properly and performs the specified functions.

END OF SECTION
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SECTION 265600 EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Division 26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

A. Extent of exterior lighting fixture work is indicated by drawings and schedules.

B. Types of exterior lighting fixtures in this section include the following:
   1. LED

C. Applications of exterior lighting fixtures required for project include the following:
   1. Outdoor area lighting.
   2. Outdoor security lighting.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, specifications, installation instructions and dimensioned drawings for each type of exterior light fixture and accessory. Include certified photometric data including CU and VCP tables for each light fixture specified. Submit IES data for fixtures upon request.

B. Shop Drawings: Submit shop drawings in booklet form with separate sheet for each fixture, assembled in "luminaire type" alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet.

C. Wiring Diagrams: Submit wiring diagrams for exterior lighting fixtures showing connections to electrical power panels, switches, dimmers, controllers, and feeders. Differentiate between portions of wiring which are manufacturer-installed and portions which are field-installed.

D. Illumination Data: Provide isofootcandle (isolux) plot diagram of footcandles on horizontal pavement surface which shows composite values of illuminance projected from the arrangement of light sources from indicated fixture locations

and heights. Show on the graphic plots the locations, spacings and heights of luminaires.

E. Source quality-control reports.

F. Field quality-control reports.

G. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for each exterior lighting fixture and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings and record drawings in the maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing contents.

H. Extra Stock: Furnish stock or replacement lamps amounting to 15% (but not less than one lamp of each type) of each type and size lamp used in each type fixture. Deliver replacement stock as directed to Owner's storage space, and obtain receipt.

I. Record Drawings: At project closeout, submit record drawings of installed systems, show exact location and circuitry information in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in the manufacture of exterior lighting fixtures of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer’s Qualifications: Firm with at least 3 years of successful installation experience on projects with systems work similar to that required for this project.

C. Source Limitations: Obtain each type of light fixture and accesory through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section, “Substitution & Product Options.”

E. Codes and Standards:
   1. Electrical Code Compliance: Comply with the applicable National Electrical Code (NEC) references:
      a. Article 210, “Branch Circuits.”
      b. Article 250, “Outside Branch Circuits and Feeders.”
      c. Article 250, “Grounding and Bonding.”
      d. Article 402, “Fixture Wires.”
      e. Article 410, “Luminaires, Lampholders, and Lamps.”

2. UL Compliance: Comply with applicable requirements of UL Standards and provide light fixtures and components which are UL-Listed and labeled per the following standards:
   a. Standard 62, “Flexible Cords and Cables.”
   b. Standard 66, “Fixture Wire.”
   c. Standard 153, “Standard for Portable Electric Luminaires.”
   d. Standard 183, “Standard for Manufactured Wiring Systems.”
   e. Standard 486A-486B, “Wire Connectors.”
   f. Standard 496, “Lampholders.”
   g. Standard 542, “Standard for Fluorescent Lamp Starters.”
   h. Standard 676, “Standard for Underwater Luminaires and Submersible Junction Boxes.”
   i. Standard 1581, “Reference Standard for Electrical Wires, Cables and Flexible Cords.”

3. NEMA Compliance: Comply with applicable portions of the following NEMA Standards:
   a. Publication No. BL 1, “Fluorescent Ballast Connector.”
   b. Publication No. BL 2, “Energy Efficiency for Electronic Ballasts for T8 Fluorescent Lamps.”
   c. Publication No. LL 7, “Generic Designation System for Pin-Based Compact fluorescent and T5 Twin Fluorescent Lamps.”
   d. Publication No. LE 5, “Procedure for Determining Luminaire Efficacy Ratings for Fluorescent Luminaires.”

4. IES Compliance: Comply with IES RP-8, 19, 20, and PB-15 pertaining to exterior, parking, and roadway lighting practices and fixtures.
5. NFPA Compliance: Comply with applicable requirements of NFPA 78, "Lightning Protection Code", pertaining to installation of exterior lighting fixtures.
6. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

1.5 COORDINATION

A. Coordinate the size and location of concrete bases with actual equipment provided and structural and architectural plans.

B. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of exterior lighting fixtures with other work.

C. Sequence exterior lighting installation with other work to reduce possibility of damage and soiling of fixtures during remainder of construction period.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver exterior lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from construction debris and physical damage.

B. Store exterior lighting fixtures in original wrappings in a clean dry place. Protect from weather, dirt, fumes, water, construction debris, and damage.

C. Handle exterior lighting fixtures carefully to prevent damage, breaking, and scoring. Do not install damaged fixtures or components; remove units from site and replace with new.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to the following:
   1. Driver failures.
   2. Faulty operation of controls.
   3. Deterioration of any component beyond the degradation of normal use.

B. Warranty Period(s) from date of Substantial Completion:
   1. Provide a one (1) year parts and labor warranty for the complete fixture.
   2. Provide a two (2) year parts only warranty on the fixture ballast.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers, subject to compliance with requirements, shall be the following or an Engineer approved equivalent:

B. Fixtures
   1. Williams.
   2. LSI Industries Inc.
   3. Philips.
   4. Cooper Lighting.
   5. Crouse-Hinds Lighting Products Div; Cooper Industries Inc.
   6. Devine Lighting Div; Kidde & Co., Inc.
   7. Dual-Lite Mfg. Inc.
   8. Emco.
   9. Emerson Electric Co.
   10. Gardco.
   11. General Electric Co.
   12. Sylvania, Inc.
   13. Guth Lighting Div; General Signal Corp.
   14. Holophane.
   15. KIM Lighting, Inc.
   16. Lithonia Lighting.

17. McGraw-Edison Co.
18. Wide-Lite Corp., Div of Philips.

C. Drivers
1. Advance.
2. Osram-Sylvania.
3. Venture.

2.2 EXTERIOR LIGHTING FIXTURES

A. General: Provide lighting fixtures, of sizes, types and ratings indicated; complete with, but not limited to, housings, energy efficient ballasts, starters and wiring.

B. Wiring: Provide electrical wiring within fixture suitable for connection to branch circuit wiring as follows:
1. NEC Type AF for 120-volts, minimum No. 18 AWG.

C. Exterior Lighting Fixture Types: Fixtures are scheduled on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which lighting fixtures are to be installed, and substrate which will support lighting fixtures. Notify Contractor in writing of conditions detrimental to proper completion of the Work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF EXTERIOR LIGHTING FIXTURES

A. Install exterior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B, and the National Electrical Code.

C. Fasten electrical lighting fixtures and brackets securely to indicated structural supports, including poles/standards; and ensure that installed fixtures are plumb and level.

3.3 GROUNDING

A. Provide equipment grounding connections for exterior lighting fixtures as indicated. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounds.

3.4 FIELD QUALITY CONTROL

A. Replace defective and burned out lamps for a period of one year following the Date of Substantial Completion.

B. At the Date of Substantial Completion, replace lamps in exterior lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by the Architect.
   1. Refer to Division 01 sections for the replacement/restoration of lamps in exterior lighting fixtures, where used for temporary lighting prior to Date of Substantial Completion.

3.5 ADJUSTING AND CLEANING

A. Aim adjustable lighting fixtures and lamps in night test of system. Verify that measured illuminance values comply with isolux plot diagram values.

B. Clean exterior lighting fixtures of dirt and debris upon completion of installation.

C. Protect installed fixtures from damage during construction period.

3.6 DEMONSTRATION

A. Upon completion of installation of exterior lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION
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SECTION 333100 SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Division 03; sections for concrete work required for sanitary sewage systems.

C. Division 23; "Soil and Waste Systems" for interior building systems including drain, waste, and vent piping.

D. Division 31; "Earthwork" for excavation and backfill required for sanitary sewage system.

1.2 SUMMARY

A. Extent of sanitary sewage systems work is indicated on drawings and schedules, and by requirements of this section.

B. Sewer collection system work includes sanitary sewer conduits.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data, specifications, installation instructions and dimensioned drawings for pipe, fitting, accessory or specialty for sewerage system materials and products.

B. Shop Drawings: Submit shop drawings for sanitary sewerage system, showing piping materials, size, locations, and inverts. Include details of underground structures, connections, and cleanouts. Show interface and spatial relationship between piping and proximate structures.

C. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.

D. Welding Certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" article.

E. Source quality-control reports.

F. Field quality-control reports.

G. Record Drawings: At project closeout, submit record drawings of installed sanitary sewage piping and products, in accordance with requirements of Division 01.

H. Operation and Maintenance Manual Data: Submit maintenance data and parts lists for sanitary sewerage system materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual. Furnish these materials with protective covering for storage and identified with labels describing the contents in accordance with the requirements of Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of sanitary sewage system products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with sanitary sewerage systems work similar to that required for this project.

C. Source Limitations: Obtain each type of sanitary sewerage piping, fitting and accessory through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of the system and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

E. Codes and Standards:
1. Plumbing Code: Comply with the requirements of the International Plumbing Code or of the code as adopted by the authority having jurisdiction.
2. Arkansas: Comply with the applicable portions of the Arkansas Plumbing code and regulations pertaining to sanitary sewage systems.

PART 2 - PRODUCTS

2.1 IDENTIFICATION

A. Underground-Type Plastic Line Marker: Manufacturer's standard, permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide green tape with black printing reading "CAUTION SEWER LINE BELOW".

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering identification markers which may be incorporated in the work include, but are not limited to, the following:
1. Manufacturer: Subject to compliance with requirements, provide identification markers of one of the following:

a. Emed Co., Inc.
b. Seton Name Plate Corp.

2.2 PIPES & PIPE FITTINGS

A. Furnish ells, tees, reducing tees, wyes, couplings, increasers, crosses, transitions, and end caps of same type and class of material as conduit, or of material having equal or superior physical and chemical properties as acceptable to the architect.

B. Polyvinyl Chloride (PVC) Sewer Pipe: ASTM D 3033, Type PSP, SDR 35; or ASTM D 3034, Type PSM, SDR 35. Fittings: PVC, ASTM D 3033 or ASTM D 3034, solvent-cement joints complying with ASTM D 2855 using solvent cement complying with ASTM D 2564; or elastomeric joints complying with ASTM D 3212 using elastomeric seals complying with ASTM F 477.

C. Polyvinyl Chloride (PVC) DWV Pipe: Schedule 40, ASTM D 2665. Fittings: PVC Schedule 40, ASTM D 2665; solvent-cement joints, ASTM D 2664; or threaded joints.

D. Polyvinyl Chloride (PVC) Sewer Pipe: ASTM F 679, wall thickness T-1. Fittings: PVC, ASTM F 679, elastomeric joints complying with ASTM D 3212 using elastomeric seals complying with ASTM F 477.

2.3 CLEANOUTS

A. General: Provide as indicated, pipe extension to grade with ferrule and countersunk cleanout plug. Provide round cast-iron access frame set in concrete over the cleanout, with a heavy-duty secured scoriated cover with lifting device.

PART 3 - EXECUTION

3.2 PIPING SCHEDULE

A. Exterior below grade piping shall be:
   1. Polyvinyl Chloride pipe.

3.3 INSPECTION

A. General: Examine areas and conditions under which sanitary sewer system materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.4 INSTALLATION OF IDENTIFICATON

A. General: During back-filling/top-soiling of sanitary sewer systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade.

3.5 INSTALLATION OF PIPE & FITTINGS

A. General: Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.

B. Inspect piping before installation to detect apparent defects. Mark defective materials with white paint and promptly remove from site.

C. Lay piping beginning at low point of system, true to grades and alignment indicated, with unbroken continuity of invert.

D. Plastic Pipe: Install in accordance with manufacturer's installation recommendations, and in accordance with ASTM D 2321.

E. Cleaning Piping: Clear interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed.
   1. In large, accessible piping, brushes and brooms may be used for cleaning.
   2. Place plugs in ends of uncompleted conduit at end of day or whenever work stops.
   3. Flush lines between manholes if required to remove collected debris.

F. Joint Adapters: Make joints between different types of pipe with standard manufactured adapters and fittings intended for that purpose.

3.6 CLOSING ABANDONED UTILITIES

A. Close open ends of abandoned underground utilities which are indicated to remain in place. Provide sufficiently strong closures to withstand hydro-static or earth pressure which may result after ends of abandoned utilities have been closed.

B. Close open ends of concrete or masonry utilities with not less than 8" thick brick masonry bulkheads.

C. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods for size and type material being closed. Wood plugs are not acceptable.

3.7 INTERIOR INSPECTION

A. Inspect piping to determine whether line displacement or other damage has occurred.

B. Make inspections after lines between manholes, or manhole locations, have been installed and approximately 2-ft. of backfill is in place, and again at completion of project.

C. If inspection indicates poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects, and reinspect.

3.8 TAP CONNECTIONS

A. Make connections to existing piping and underground structures, so that finished work will conform as nearly as practicable to requirements specified for new work.

B. Use commercially manufactured wyes for branch connections. Field cutting into piping will not be permitted. Spring wyes into existing line and encase entire wye, plus 6" overlap, with not less than 6" of 3,000 psi 28-day compressive strength concrete.

C. Branch connection made from side into existing 4” to 21” piping shall have wye sprung into existing line, and entire wye encased with not less than 6” of 3,000 psi 28-day compressive strength concrete.

D. For branch connections from side into existing 24" or larger piping or to underground structures, cut opening into unit sufficiently large to allow 3" of concrete to be packed around entering connection. Cut ends of connection passing through pipe or structure to conform to shape of, and be flush with, inside wall, unless otherwise indicated. On outside of pipe or structure wall, encase entering connection in 6" of concrete for a minimum length of 12" to provide additional support or collar from connection to undisturbed ground.
   1. Provide concrete which will attain minimum 28-day compressive strength of 3,000 psi, unless otherwise indicated.
   2. Use epoxy bonding compound as interface between new and existing concrete and piping materials.

E. Take care while making tap connections to prevent concrete or debris from entering existing piping or structure. Remove debris, concrete, or other extraneous material which may accumulate.

3.9 BACKFILLING

A. General: Conduct backfilling operations of open-cut trenches closely following laying, jointing, and bedding of pipe, and after initial inspection and testing are completed. To minimize local area traffic interruptions, allow no more than 100 ft. between pipe laying and point of complete backfilling.

3.10 FIELD QUALITY CONTROL

A. Testing: Perform testing of completed piping in accordance with local authorities having jurisdiction.

END OF SECTION
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