SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Motors.
 - 2. Packed expansion joints.
 - 3. Alignment guides and anchors.
 - 4. Sleeves without waterstop.
 - 5. Sleeves with waterstop.
 - 6. Stack-sleeve fittings.
 - 7. Sleeve-seal systems.
 - 8. Grout.
 - 9. Silicone sealants.
 - 10. Escutcheons.
 - 11. Thermometers, bimetallic actuated.
 - 12. Thermometers, filled system.
 - 13. Thermometers, liquid in glass.
 - 14. Duct-thermometer mounting brackets.
 - 15. Thermowells.
 - 16. Pressure gauges, dial type.
 - 17. Gauge attachments.
 - 18. Test plugs.
 - 19. Test-plug kits.
- B. Related Requirements:
 - 1. Section 231123 "Facility Natural-Gas Piping" for gas meters.
 - 2. Section 232216 "Steam and Condensate Piping Specialties" for steam and condensate meters.
 - 3. Section 230923.14 "Flow Instruments" for primary flow instruments connecting with the DDC system.

1.2 DEFINITIONS

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

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of product, excluding motors which are included in Part 1 of HVAC equipment Sections.

- a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
- b. Include operating characteristics and furnished accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter.
- B. Welding certificates.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of expansion joint, meter, and gauge to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

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

1.7 COORDINATION

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

PART 2 - PRODUCTS

2.1 MOTORS

- A. Motor Requirements, General:
 - 1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
 - 2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.

- 3. Comply with NEMA MG 1 unless otherwise indicated.
- 4. Comply with IEEE 841 for severe-duty motors.
- B. Motor Characteristics:
 - 1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 ft. above sea level.
 - 2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- C. Polyphase Motors:
 - 1. Description: NEMA MG 1, Design B, medium induction motor.
 - 2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
 - 3. Service Factor: 1.15.
 - 4. Multispeed Motors: Variable torque.
 - a. For motors with 2:1 speed ratio, consequent pole, single winding.
 - b. For motors with other than 2:1 speed ratio, separate winding for each speed.
 - 5. Multispeed Motors, Two Winding: Separate winding for each speed.
 - 6. Rotor: Random-wound, squirrel cage.
 - 7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
 - 8. Temperature Rise: Match insulation rating.
 - 9. Insulation: Class F.
 - 10. Code Letter Designation:
 - a. Motors 15 Hp and Larger: NEMA starting Code F or Code G.
 - b. Motors Smaller Than 15 Hp: Manufacturer's standard starting characteristic.
 - 11. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
- D. Additional Requirements for Polyphase Motors:
 - 1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
 - 2. Motors Used with Variable-Frequency Controllers:
 - a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
 - b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - 3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

- E. Single-Phase Motors:
 - 1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:
 - a. Permanent-split capacitor (PSC).
 - b. Split phase.
 - c. Capacitor start, inductor run.
 - d. Capacitor start, capacitor run.
 - 2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
 - 3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
 - 4. Motors 1/20 hp and Smaller: Shaded-pole type.
 - 5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.
- F. Electronically Commutated Motors:
 - 1. Microprocessor-Based Electronic Control Module: Converts 120 V single-phase AC power to three-phase DC power to operate the brushless DC motor.
 - 2. Three-phase power motor module with permanent magnet rotor.
 - 3. Circuit board or digital speed controller/LED display.
 - 4. Building Automation System Interface: Via DC voltage signal or Digital Serial Interface (DSI).

2.2 EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

- A. Performance Requirements:
 - 1. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
 - 2. Capability: Provide products and installations that will accommodate maximum axial movement as scheduled or indicated on Drawings.
- B. Packed Expansion Joints:
 - 1. Flexible, Ball-Joint Packed Expansion Joints:
 - a. Source Limitations: Obtain rubber union connector expansion joints from single manufacturer.
 - b. Standards: 2021 ASME Boiler and Pressure Vessel Code: Section II, "Materials"; ASME B31.9 for materials and design of pressure-containing parts and bolting.
 - c. Material: Carbon-steel assembly with asbestos-free composition packing.
 - d. Design: Provide 360-degree rotation and angular deflection.
 - e. Minimum Pressure Rating: 250 psig at 400 deg F.
 - f. Angular Deflection for NPS 6 and Smaller: 30 degrees minimum.
 - g. Angular Deflection for NPS 8 and Larger: 15 degrees minimum.

- h. Seal Type: Two carbon-steel and graphite seals suitable for continuous operation at temperature up to 650 deg F.
- i. Internal Ball: Plated with minimum 1-mil chrome cover.
- j. Ball Socket: One- or two-piece design with integral socket/retainer.
 - 1) Stuffing Box: Incorporates containment seals and compression seals for containment of injectable packing.
 - 2) Packing Cylinders: Provides packing under full line pressure with check valves to prevent blowback.
- k. End Connections for NPS 2 and Smaller: Threaded.
- 1. End Connections for NPS 2-1/2 and Larger: Flanged.
- C. Alignment Guides and Anchors:
 - 1. Alignment Guides:
 - a. Source Limitations: Obtain alignment guides from single manufacturer.
 - b. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe. Provide dielectric spacer for use with copper tubing/piping.
 - 2. Anchor Materials:
 - a. Steel Shapes and Plates: ASTM A36/A36M.
 - b. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
 - c. Washers: ASTM F844, steel, plain, flat washers.
 - d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - 1) Stud: Threaded, zinc-coated carbon steel.
 - 2) Expansion Plug: Zinc-coated carbon steel.
 - 3) Washer and Nut: Zinc-coated carbon steel.
 - e. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - 1) Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - 2) Stud: ASTM A307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - 3) Washer and Nut: Zinc-coated carbon steel.

2.3 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

- 1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
- 2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
- 3. Steel Sheet Sleeves: ASTM A653/A653M, 24 gaugeminimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
- B. Sleeves with Waterstop:
 - 1. Description: Manufactured galvanized-steel, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.
- C. Stack-Sleeve Fittings:
 - 1. Description: Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
- D. Sleeve-Seal Systems:
 - 1. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - a. Hydrostatic seal: 20 psig.
 - b. Sealing Elements: EPDM-rubberNitrile (Buna-N) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
 - c. Pressure Plates: Stainless steel.
 - d. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.
- E. Grout:
 - 1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
 - 2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 - 3. Design Mix: 5000 psi, 28-day compressive strength.
 - 4. Packaging: Premixed and factory packaged.
- F. Silicone Sealants:
 - 1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.
 - a. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.
 - 2. Silicone Sealant, S, P, T, NT: Single-component, 100/50, pourable, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.
 - a. Standard: ASTM C920, Type S, Grade P, Class 100/50, Uses T and NT.

2.4 ESCUTCHEONS

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

2.5 METERS AND GAUGES FOR HVAC PIPING

- A. Thermometers, Bimetallic Actuated:
 - 1. Source Limitations: Provide bimetallic-actuated thermometers from a single manufacturer.
 - 2. Standard: ASME B40.200.
 - 3. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch nominal diameter.
 - 4. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
 - 5. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
 - 6. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
 - 7. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
 - 8. Window: Plain glass or plastic.
 - 9. Ring: Stainless steel.
 - 10. Element: Bimetal coil.
 - 11. Pointer: Dark-colored metal.
 - 12. Accuracy: Plus or minus 1 percent of scale range.
- B. Thermometers, Filled System Direct-Mounted, Metal-Case, Vapor-Actuated:
 - 1. Source Limitations: Provide filled-system, direct-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
 - 2. Standard: ASME B40.200.
 - 3. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
 - 4. Element: Bourdon tube or other type of pressure element.
 - 5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
 - 6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Pointer: Dark-colored metal.
 - 8. Window: Glass or plastic.

- 9. Ring: Stainless steel.
- 10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device rigid, back and rigid, bottom; with ASME B1.1 screw threads.
- 11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
- 12. Accuracy: Plus or minus 1 percent of scale range.
- C. Thermometers, Filled System Direct-Mounted, Plastic-Case, Vapor-Actuated:
 - 1. Source Limitations: Provide filled-system, direct-mounted, plastic-case, vapor-actuated thermometers from single manufacturer.
 - 2. Standard: ASME B40.200.
 - 3. Case: Sealed type, plastic; 6-inch nominal diameter.
 - 4. Element: Bourdon tube or other type of pressure element.
 - 5. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Pointer: Dark-colored metal.
 - 8. Window: Glass or plastic.
 - 9. Ring: Metal or plastic.
 - 10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
 - 11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - 12. Accuracy: Plus or minus 1 percent of scale range.
- D. Thermometers, Liquid-in-Glass Metal Case, Compact Style:
 - 1. Source Limitations: Provide liquid-in-glass, metal-case, compact-style thermometers by single manufacturer.
 - 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum; 6-inch nominal size.
 - 4. Case Form: Back angle unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
 - 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Window: Glass or plastic.
 - 8. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.

- 9. Connector: 3/4 inch, with ASME B1.1 screw threads.
- 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- E. Thermometers, Liquid in Glass Plastic Case, Compact Style:
 - 1. Source Limitations: Provide liquid-in-glass, plastic-case, compact-style thermometers from single manufacturer.
 - 2. Standard: ASME B40.200.
 - 3. Case: ; 6-inchnominal size.
 - 4. Case Form: Back angle unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
 - 6. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F.
 - 7. Window: Glass or plastic.
 - 8. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - 9. Connector: 3/4 inch, with ASME B1.1 screw threads.
 - 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- F. Thermometers, Liquid in Glass Metal Case, Industrial Style:
 - 1. Source Limitations: Provide liquid-in-glass, metal-case, industrial-style thermometers from single manufacturer.
 - 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
 - 4. Case Form: Adjustable angle unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
 - 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Window: Glass or plastic.
 - 8. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - 9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
 - 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- G. Duct-Thermometer Mounting Brackets:
 - 1. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.
- H. Thermowells:

- 1. Standard: ASME B40.200.
- 2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
- 3. Material for Use with Copper Tubing: CNR or CUNI.
- 4. Material for Use with Steel Piping: CRES.
- 5. Type: Stepped shank unless straight or tapered shank is indicated.
- 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
- 7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
- 8. Bore: Diameter required to match thermometer bulb or stem.
- 9. Insertion Length: Length required to match thermometer bulb or stem.
- 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
- 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- 12. Heat-Transfer Medium: Mixture of graphite and glycerin.
- I. Pressure Gauges, Dial Type Direct Mounted, Metal Case:
 - 1. Source Limitations: Provide dial-type, direct-mounted, metal-case pressure gauges from single manufacturer.
 - 2. Standard: ASME B40.100.
 - 3. Case: Liquid-filled Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
 - 4. Pressure-Element Assembly: Bourdon tube.
 - 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - 6. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 7. Dial: Nonreflective aluminum with permanent scale markings graduated in psi.
 - 8. Pointer: Dark-colored metal.
 - 9. Window: Glass or acrylic plastic.
 - 10. Ring: Brass.
 - 11. Accuracy: Grade A, plus or minus 1 percent of middle half of span.
- J. Pressure Gauges, Dial Type Direct Mounted, Plastic Case:
 - 1. Source Limitations: Provide dial-type, direct-mounted, plastic-case pressure gauges from a single manufacturer.
 - 2. Standard: ASME B40.100.
 - 3. Case: Sealed type; plastic; 4-1/2-inch nominal diameter.
 - 4. Pressure-Element Assembly: Bourdon tube.
 - 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - 6. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 7. Dial: Nonreflective aluminum with permanent scale markings graduated in psi.
 - 8. Pointer: Dark-colored metal.
 - 9. Window: Safety glass or acrylic plastic.
 - 10. Accuracy: Grade A, plus or minus 1 percent of middle half of span.

- K. Gauge Attachments:
 - 1. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
 - 2. Siphons: Loop-shaped section of stainless steel pipe with NPS 1/4 pipe threads.
 - 3. Valves: Brass or stainless steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.
- L. Test Plugs:
 - 1. Source Limitations: Provide test plugs from single manufacturer.
 - 2. Description: Test-station fitting made for insertion in piping tee fitting.
 - 3. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
 - 4. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
 - 5. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
 - 6. Core Inserts: EPDM self-sealing rubber.
- M. Test-Plug Kits:
 - 1. Source Limitations: Provide test-plug kits from single manufacturer.
 - 2. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes are to be of diameter to fit test plugs and of length to project into piping.
 - 3. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range is to be at least 25 to 125 deg F.
 - 4. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range is to be at least 0 to 220 deg F.
 - 5. Pressure Gauge: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
 - 6. Carrying Case: Metal or plastic, with formed instrument padding.
- N. Sight Flow Indicators:
 - 1. Source Limitations: Provide sight flow indicators from single manufacturer.
 - 2. Description: Piping inline-installation device for visual verification of flow.
 - 3. Construction: Bronze or stainless steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
 - 4. Minimum Pressure Rating: 125 psig.
 - 5. Minimum Temperature Rating: 200 deg F.
 - 6. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
 - 7. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS - GENERAL

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.2 INSTALLATION OF PACKED EXPANSION JOINTS

A. Install packed expansion joints with packing suitable for fluid service.

3.3 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
 - 3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.4 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

- A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.5 INSTALLATION OF SLEEVES - GENERAL

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.

- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout or silicone sealant, seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.6 INSTALLATION OF SLEEVES WITH WATERSTOP

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

3.7 INSTALLATION OF STACK-SLEEVE FITTINGS

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

- 4. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.
- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.8 INSTALLATION OF SLEEVE-SEAL SYSTEMS

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

3.9 INSTALLATION OF ESCUTCHEONS

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

3.10 INSTALLATION OF METERS AND GAUGES

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing, and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer-mounting brackets in walls of ducts. Attach to duct with screws.
- H. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.
- I. Install valve and snubber in piping for each pressure gauge for fluids (except steam).
- J. Install valve and syphon fitting in piping for each pressure gauge for steam.

- K. Install test plugs in piping tees.
- L. Install flow indicators in piping systems in accessible positions for easy viewing.
- M. Install permanent indicators on walls or brackets in accessible and readable positions.
- N. Install connection fittings in accessible locations for attachment to portable indicators.
- O. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic zone.
 - 2. Inlet and outlet of each hydronic boiler.
 - 3. Two inlets and two outlets of each chiller.
 - 4. Inlet and outlet of each hydronic coil in air-handling units.
 - 5. Two inlets and two outlets of each hydronic heat exchanger.
 - 6. Inlet and outlet of each thermal-storage tank.
 - 7. Outside-, return-, supply-, and mixed-air ducts.
- P. Install pressure gauges in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
 - 3. Suction and discharge of each pump.

3.11 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.12 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gauges to proper angle for best visibility.

3.13 FIELD QUALITY CONTROL

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

- B. Escutcheons:
 - 1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.14 SLEEVES APPLICATION

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above and below Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 2. Concrete Slabs-on-Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs above Grade:
 - a. Sleeves with waterstops.
 - 4. Interior Walls and Partitions:
 - a. Sleeves without waterstops.

3.15 ESCUTCHEONS APPLICATION

- A. Escutcheons for New Piping and Relocated Existing Piping:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - 2. Chrome-Plated Piping: One piece, cast brass or split-plate steel with polished, chromeplated finish.
 - 3. Insulated Piping:
 - a. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
 - a. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

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

3.16 THERMOMETER SCALE-RANGE APPLICATION

- A. Scale Range for Chilled-Water Piping:
- B. Scale Range for Condenser-Water Piping:
 - 1. 0 to 150 deg

- C. Scale Range for Heating, Hot-Water Piping:
 - 1. 30 to 240 deg F.
- D. Scale Range for Steam and Steam-Condensate Piping:
 - 1. 50 to 400 deg F.
- E. Scale Range for Air Ducts:
 - 1. 0 to 100 deg F.

3.17 PRESSURE-GAUGE APPLICATION

- A. Pressure gauges at discharge of each pressure-reducing valve are to be the following:
 - 1. Liquid filled, direct mounted, metal case.
- B. Pressure gauges at inlet and outlet of each chiller chilled-water and condenser-water connection are to be the following:
 - 1. Liquid filled, direct mounted, metal case.
- C. Pressure gauges at suction and discharge of each pump are to be the following:
 - 1. Liquid-filled, direct mounted, metal case.

3.18 PRESSURE-GAUGE SCALE-RANGE APPLICATION

- A. Scale Range for Chilled-Water Piping:
 - 1. 0 to 160 psi.
- B. Scale Range for Condenser-Water Piping:
 - 1. 0 to 160 psi.
- C. Scale Range for Heating, Hot-Water Piping:
 - 1. 0 to 160 psi.
- D. Scale Range for Steam Piping:
 - 1. 0 to 30 psi for low pressure steam.
 - 2. 0 to 100 psi for medium pressure steam.

END OF SECTION 230500