

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Stainless steel pipe and fittings.
4. Plastic pipe and fittings.
5. Fiberglass pipe and fittings.
6. Piping joining materials.
7. Transition fittings.
8. Dielectric fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated Design Submittals:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors, alignment guides, and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

- B. Steel Support Welding: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
- C. Pipe Welding: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with ASME B31.9 for materials, products, and installation.
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation are to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
 - 1. Hot-Water Heating Piping: 100 psig at 200 deg F
 - 2. Process Hot-Water Heating Piping: 100 psig at 200 deg F
 - 3. Chilled-Water Piping: 150 psig at 73 deg F
 - 4. Process Chilled-Water Piping: 150 psig at 73 deg F
 - 5. Dual-Temperature Heating- and Cooling-Water Piping: 100 psig at 180 deg F
 - 6. Condenser-Water Piping: 150 psig at 110 deg F
 - 7. Glycol Cooling-Water Piping: 150 psig at 73 deg F
 - 8. Makeup-Water Piping: 150 psig at 73 deg F
 - 9. Condensate-Drain Piping: 180 deg F
 - 10. Air-Vent Piping: 200 deg F
 - 11. Pressure-Relief-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type K and ASTM B88, Type L.
- B. Annealed-Temper Copper Tube: ASTM B88, Type K and ASTM B88, Type L.
- C. DWV Copper Tube: ASTM B306, Type DWV.
- D. Cast-Copper, Solder-Joint Fittings: ASME B16.18 pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.
- E. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.
- F. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than NPS 4.

- G. Cast-Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than NPS 4.
- H. Wrought-Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4.
- I. Copper-Tube, Mechanically Formed Tee Fitting: For forming T-branch on copper water tube.
 - 1. Description: Tee formed in copper tube in accordance with ASTM F2014.
- J. Grooved, Mechanical-Joint, Copper Tube Appurtenances:
 - 1. Source Limitations: Obtain grooved mechanical-joint copper tube appurtenances from single manufacturer.
 - 2. Grooved-End Copper Fittings: ASTM B75copper tube or ASTM B584 bronze castings.
 - 3. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting EPDM gasket rated for minimum 230 deg F for use with ferrous housing, and steel bolts and nuts; 300 psig minimum CWP pressure rating.
- K. Copper-Tube, Pressure-Seal-Joint Fittings - Copper or Bronze:
 - 1. Source Limitations: Obtain copper-tube pressure-seal-joint fittings from single manufacturer.
 - 2. Housing: Copper or bronze.
 - 3. O-Rings and Pipe Stops: EPDM.
 - 4. Tools: Manufacturer's special tools.
 - 5. Minimum 200 psig working pressure rating at 250 deg F.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M black steel with plain ends; welded and seamless, Grade B, and schedule number as indicated in Part 3, "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3, "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3, "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3, "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A234/A234M; wall thickness to match adjoining pipe.
- G. Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings:

1. Source Limitations: Obtain grooved mechanical-joint fittings and couplings from single manufacturer.
2. Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47/A47M, Grade 32510 malleable iron; ASTM A53/A53M, Type F, E, or S, Grade B fabricated steel; or ASTM A106/A106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
3. Couplings: Ductile- or malleable-iron housing and EPDM gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

I. Plain-End Mechanical-Joint Couplings:

1. Source Limitations: Obtain plain-end mechanical-joint couplings from single manufacturer.
2. Housing: ASTM A536, Grade 65-45-12 segmented ductile iron or Type 304 stainless steel.
3. Housing coating: None.
4. Gasket: EPDM.
5. Sealing Mechanism: Double-lip sealing system or carbon steel case-hardened jaws.
6. Bolts, hex nuts, washers, or lock bars based on manufacturer's design.
7. Minimum Pressure Rating: Equal to that of the joined pipes.

J. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 STAINLESS STEEL PIPE AND FITTINGS

A. Stainless Steel Pipe, Plain Ends: ASTM A312/A312M plain ends, seamless; stainless steel of types and schedules as indicated in Part 3 "Piping Applications" Article.

B. Appurtenances for Grooved-End, Stainless Steel Pipe:

1. Source Limitations: Obtain appurtenances for grooved-end stainless steel pipe from single manufacturer.
2. Fittings for Grooved-End, Stainless Steel Pipe: Stainless steel casting with dimensions matching stainless steel pipe.
3. Mechanical Couplings for Grooved-End, Stainless Steel Pipe:
 - a. AWWA C606 for stainless steel pipe dimensions.
 - b. Stainless steel housing sections.
 - c. Stainless steel bolts and nuts.
 - d. EPDM gaskets suitable for hot and cold water.

e. Minimum Pressure Rating:

- 1) NPS 8 (DN 200) and Smaller: 600 psig
- 2) NPS 10 to NPS 12 (DN 250 to DN 300): 400 psig
- 3) NPS 14 to NPS 24 (DN 350 to DN 600): 250 psig

C. Stainless Steel Piping, Pressure-Seal-Joint Fittings:

1. Obtain stainless steel piping pressure-seal-joint fittings from single manufacturer.
2. Material: ASTM A312/A312M, Type 316, stainless steel, Schedule 10.
3. Fittings: Type O-Rings and Pipe Stop: EPDM.
4. Tools: Manufacturer's special tool.
5. Minimum 300 psig working-pressure rating at 230 deg F.

2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys.

E. Flux: ASTM B813, water flushable.

F. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

G. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.6 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.7 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Source Limitations: Obtain dielectric unions from single manufacturer.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 150 psig
 - c. End Connections: Solder-joint copper alloy and threaded ferrous. Solder joints are not to be used on pipe sizes greater than NPS 4.
- C. Dielectric Flanges:
 - 1. Source Limitations: Obtain dielectric flanges from single manufacturer.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 150 psig
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 - 1. Source Limitations: Obtain dielectric-flange insulating kits from single manufacturer.
 - 2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
 - 1. Source Limitations: Obtain dielectric nipples from single manufacturer.
 - 2. Description:
 - a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F1545.
 - c. Pressure Rating: Minimum 300 psig at 225 deg F
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hot-Water Heating Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:
 - 1. Type L or K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 - 2. Schedule 40, Grade B, steel pipe; Class 150, malleable-iron fittings; and threaded joints.
- B. Hot-Water Heating Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:
 - 1. Schedule 40, Grade B, steel pipe; Class 150, malleable-iron fittings; welded joints, cast-iron flanges, flange-fittings, and flanged joints.
- C. Chilled-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to be Any of the Following:
 - 1. Type L or K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 - 2. Schedule 40, Grade B steel pipe; Class 150, malleable-iron fittings; and threaded joints.
- D. Chilled-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:
 - 1. Type K drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 - 2. Schedule 40, Grade B, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- E. Dual-Temperature Heating- and Cooling-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:
 - 1. Type L or K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 - 2. Schedule 40, Grade B steel pipe; Class 150, malleable-iron fittings; and threaded joints.
- F. Dual-Temperature Heating and Cooling-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:
 - 1. Type K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 - 2. Schedule 40, Grade B steel pipe, Class 150, malleable-iron fittings; welded joints, cast-iron flanges and flange-fittings; and flanged joints.
- G. Condenser-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:
 - 1. Type L or K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 - 2. Schedule 40, Grade B steel pipe; Class 150, malleable-iron fittings; and threaded joints.
- H. Condenser-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:
 - 1. Type K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

2. Schedule 40, Grade B steel pipe, Class 150, malleable-iron fittings; welded joints, cast-iron flanges and flange-fittings; and flanged joints.
- I. Process Heating-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:
 1. Type L or K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 2. Schedule 40, Grade B steel pipe; Class 150, malleable-iron fittings; and threaded joints.
 - J. Process Heating-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:
 1. Type K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 2. Schedule 40, Grade B steel pipe, Class 150, malleable-iron fittings; welded joints, cast-iron flanges and flange-fittings; and flanged joints.
 - K. Process Cooling-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:
 1. Type L or K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 2. Schedule 40, Grade B steel pipe; Class 150, malleable-iron fittings; and threaded joints.
 - L. Process Cooling-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:
 1. Type K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 2. Schedule 40, Grade B steel pipe, Class 150, malleable-iron fittings; welded joints, cast-iron flanges and flange-fittings; and flanged joints.
 - M. Glycol Cooling-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:
 1. Type L or K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 2. Schedule 40, Grade B steel pipe; Class 150, malleable-iron fittings; and threaded joints.
 - N. Glycol Cooling-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:
 1. Type K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 2. Schedule 40, Grade B steel pipe, Class 150, malleable-iron fittings; welded joints, cast-iron flanges and flange-fittings; and flanged joints.
 - O. Makeup-Water Piping Installed Aboveground to Be Any of the Following:
 1. Type L or K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 - P. Condensate-Drain Piping Installed Aboveground to Be Any of the Following:
 1. Type L or K or DWV, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

Q. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems, according to piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

R. Pressure-Relief-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed, with metal-to-plastic transition fittings for plastic piping systems, according to piping manufacturer's written instructions.

3.2 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."
- Q. Install air vents and pressure-relief valves in accordance with Section 232116 "Hydronic Piping Specialties."
- R. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- S. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- T. Install shutoff valve immediately upstream of each dielectric fitting.
- U. Comply with requirements in Section 230500 "Common Work Results for HVAC" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- V. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
- D. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- E. Threaded Joints: Thread pipe with tapered pipe threads in accordance with 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.
- F. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:
1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. CPVC Piping: Join in accordance with ASTM D2846/D2846M Appendix.
 3. PVC Pressure Piping: Join ASTM D1785 schedule number, PVC pipe, and PVC socket fittings in accordance with ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings in accordance with ASTM D2855.
 4. PVC Nonpressure Piping: Join in accordance with ASTM D2855.
- I. Fiberglass-Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.
- J. Pressure-Seal Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.

3.4 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges or flange kits.
- D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- C. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

- D. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Install hangers for fiberglass piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- F. Support horizontal piping within 12 inches of each fitting and coupling.
- G. Support vertical runs of copper tubing and steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- H. Support vertical runs of fiberglass piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections are to be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230500 "Common Work Results for HVAC."

3.7 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

3.8 SYSTEM STARTUP

- A. Perform the following before operating the system:
 1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Set makeup pressure-reducing valves for required system pressure.
 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 7. Verify lubrication of motors and bearings.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping in accordance with ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure is to be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install pressure-relief valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient-temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure is not to exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9.
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

END OF SECTION 232113