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SECTION 232113 - HYDRONIC PIPING

Revise this Section by deleting and inserting text to meet Project-specific requirements.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

- 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 pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Dual-temperature heating and cooling water piping.
4. Condenser-water piping.
5. Glycol cooling-water piping.
6. Makeup-water piping.
7. Condensate-drain piping.

8. Blowdown-drain piping.
9. Air-vent piping.
10. Safety-valve-inlet and -outlet piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Plastic pipe and fittings with solvent cement.
2. RTRP and RTRF with adhesive.
3. Pressure-seal fittings.
4. Chemical treatment.
5. Grooved joint couplings and fittings: Include identification by manufacturer's style or series designation.

B. LEED Submittals:

"Product Data for Credit IEQ 4.1" Subparagraph below applies to LEED-NC, LEED-CI, and LEED-CS; coordinate with requirements for solvent cements and adhesive primers.

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

"Laboratory Test Reports for Credit IEQ 4.1" Subparagraph below applies to LEED for Schools.

2. Laboratory Test Reports for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services) "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Shop Drawings:

1. Grooved Joint Couplings and Fittings: Include identification by manufacturer's style or series designation when shown on drawings.

Retain "Delegated-Design Submittal" Paragraph below if design services have been delegated to Contractor.

D. Delegated-Design Submittal:

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 and 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.

1.4 INFORMATIONAL SUBMITTALS

Retain "Coordination Drawings" Paragraph below for situations where limited space necessitates maximum utilization for efficient installation of different components or if coordination is required for installation of products and materials by separate installers. Coordinate paragraph with other Sections specifying products listed below. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space.

- A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Suspended ceiling components.
 2. Other building services.
 3. Structural members.

Coordinate "Qualification Data" Paragraph below with qualification requirements in Section 014000 "Quality Requirements" and as may be supplemented in "Quality Assurance" Article.

- B. Qualification Data: All installation professionals and pipe fitters shall provide proof of manufacturer's field training course completion upon request.

Retain "Welding certificates" Paragraph below if retaining "Steel Support Welding" or "Pipe Welding" Paragraph in "Quality Assurance" Article.

- C. Welding certificates.
- D. Field quality-control reports.

Retain "Water Analysis" Paragraph below if chemical treatment is not specified in Section 232500 "HVAC Water Treatment."

- E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
1. Installers of Grooved Couplings: Installers shall be certified by the grooved coupling manufacturer for the installation of manufacturer's product.
 - a. Manufacturer's Field Training Program:
 - 1) Onsite Certification Training: Training in use of grooving tools, application of groove, and product installation; provided by manufacturer's factory-trained representative (direct employee) for installing contractor's field personnel in the use
 - 2) Training: Designed, developed, administered, and evaluated in accordance to ANSI/IACET Standard for Continuing Education and Training (IACET-International Association for Continuing Education and Training).

Retain "Installers of Pressure-Sealed Joints" Subparagraph below for pressure-sealed joints in copper or steel piping.

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

Retain "Fiberglass Pipe and Fitting Installers" Subparagraph below for fiberglass pipe assembly.

3. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

Retain "Steel Support Welding" and "Pipe Welding" paragraphs below for welded supports or piping. Retain "Welding certificates" Paragraph in "Informational Submittals" Article if retaining below. AWS states that welding qualifications remain in effect indefinitely unless welding personnel have not welded for more than six months or there is a specific reason to question their ability.

- B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- D. Date Stamped Castings: All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.

PART 2 - PRODUCTS

See Editing Instruction No. 1 in the Evaluations for cautions about named manufacturers and products. For an explanation of options and Contractor's product selection procedures, see Section 016000 "Product Requirements."

2.1 PERFORMANCE REQUIREMENTS

Performance requirements in this article are for the piping system. Individual components may have higher pressure or temperature ratings.

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

Working pressure is equal to the relief pressure plus the static height of the system and pumping head. The only working pressure mandated by authorities having jurisdiction is for makeup water.

1. Hot-Water Heating Piping: <Insert **psig (kPa)**> at [**200 deg F (93 deg C)**] <Insert **temperature**>.
2. Chilled-Water Piping: <Insert **psig (kPa)**> at [**200 deg F (93 deg C)**] <Insert **temperature**>.
3. Dual-Temperature Heating and Cooling Water Piping: <Insert **psig (kPa)**> at [**200 deg F (93 deg C)**] <Insert **temperature**>.
4. Condenser-Water Piping: <Insert **psig (kPa)**> at [**150 deg F (66 deg C)**] <Insert **temperature**>.
5. Glycol Cooling-Water Piping: <Insert **psig (kPa)**> at [**150 deg F (66 deg C)**] <Insert **temperature**>.
6. Makeup-Water Piping: [**80 psig (552 kPa)**] <Insert value> at [**150 deg F (66 deg C)**] <Insert **temperature**>.
7. Condensate-Drain Piping: [**150 deg F (66 deg C)**] <Insert **temperature**>.
8. Blowdown-Drain Piping: [**200 deg F (93 deg C)**] <Insert **temperature**>.
9. Air-Vent Piping: [**200 deg F (93 deg C)**] <Insert **temperature**>.
10. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

First four articles below include examples of materials listed in the 2008 ASHRAE HANDBOOK - "HVAC Systems and Equipment," Ch. 45, "Pipes, Tubes, and Fittings." See "Writing Guide" Article in the Evaluations.

2.2 SOURCE LIMITATIONS

- A. Source Limitations: Obtain all grooved joint couplings, fittings, valves, and specialties from single source. Obtain grooving tools from same source as grooved components.

2.3 COPPER TUBE AND FITTINGS

Type M (Type C) in "Drawn-Temper Copper Tubing" Paragraph below is not included in Table 5, "Application of Pipe, Fittings, and Valves for Heating and Air Conditioning," in the 2008 ASHRAE HANDBOOK - "HVAC Systems and Equipment."

- A. Drawn-Temper Copper Tubing: [**ASTM B 88, Type L (ASTM B 88M, Type B)**] [**ASTM B 88, Type M (ASTM B 88M, Type C)**].

Type K (Type A) in "Annealed-Temper Copper Tubing" Paragraph below is applicable for belowground installations.

- B. Annealed-Temper Copper Tubing: **ASTM B 88, Type K (ASTM B 88M, Type A)**.

DWV tubing in "DWV Copper Tubing" Paragraph below is intended for nonpressure applications and is applicable for condensate drains.

- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.

1. Grooved-End Copper Fittings: ASME B16.22 wrought copper and **ASTM B 75 (ASTM B 75M)**, copper tube or ASME B16.18 and ASTM B 584, bronze casting. Fittings shall be manufactured to copper-tubing sizes. (Flaring tube or fitting ends to accommodate alternate sized couplings is not permitted.)
 - a. Basis-of Design Product: Subject to compliance with requirements, provide Victaulic Company; "Copper Connection" or comparable product by one of the following:
 - 1) **<Insert engineer approved manufacturer's name>**.
2. Grooved-End-Tube Couplings: Rigid pattern cast with offsetting, angle-pattern, bolt pads; gasketed fitting. Ductile-iron housing with keys matching copper tubing sizes and fitting grooves, **[prelubricated]** EPDM-HP gasket rated for maximum **250 deg F (120 deg C)** for use with housing, and electroplated steel bolts and nuts conforming to ASTM A 449. Installation-Ready, for direct stab installation without field disassembly.
 - a. Basis-of-Design product: Subject to compliance with requirements, provide Victaulic Company; Style 607H or comparable product by one of the following:
 - 1) **<Insert engineer approved manufacturer's name>..**

Verify that fittings in "Copper or Bronze Pressure-Seal Fittings" Paragraph below are available for pipe sizes required for Project.

E. Copper or Bronze Pressure-Seal Fittings:

Retain "Manufacturers" Subparagraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**

Retain "Basis-of-Design Product" Subparagraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed. Retain option and delete insert note if manufacturer's name and model number are indicated on Drawings.

2. Basis-of-Design Product: Subject to compliance with requirements, provide **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. NIBCO INC.
 - b. Viega.
 - c. **<Insert manufacturer's name>**.
3. Housing: Copper.
4. O-Rings and Pipe Stops: EPDM.
5. Tools: Manufacturer's special tools.
6. Minimum **200-psig (1379-kPa)** working-pressure rating at **250 deg F (121 deg C)**.

Verify that fittings in "Copper, Mechanically Formed Tee Option" Paragraph below are available for pipe sizes required for Project.

- F. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube.

Retain "Manufacturers" Subparagraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**

Retain "Basis-of-Design Product" Subparagraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed. Retain option and delete insert note if manufacturer's name and model number are indicated on Drawings.

2. Basis-of-Design Product: Subject to compliance with requirements, provide **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. T-DRILL Industries Inc.
 - b. **<Insert manufacturer's name>**.

- G. Wrought-Copper Unions: ASME B16.22.

2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

Coordinate flange class in "Cast-Iron Pipe Flanges and Flanged Fittings" Paragraph below with products in other parts of this Section and in related Sections to match face size and bolt patterns.

- 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 A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought 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:

Retain "Basis-of-Design Product" Subparagraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed. Retain option and delete insert note if manufacturer's name and model number are indicated on Drawings.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; **<Insert product name or designation>** or comparable product by one of the following:
 - a. **<Insert engineer approved manufacturer's name>**.
2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 53/A 53M, Type F, E, or S, Grade B factory-fabricated steel; or ASTM A 234, Grade WPB wrought steel fittings with grooved ends or shoulders constructed to accept grooved-end couplings of same manufacturer; with nuts and bolts to secure grooved pipe and fittings.
3. Couplings: Two ductile-iron housing segments conforming with ASTM A 536, and [EPDM] [or] [nitrile] gasket of central cavity pressure-responsive design conforming with ASTM D 2000; with ASTM A 449 electroplated steel nuts and bolts to secure grooved pipe and fittings. Couplings shall comply with ASTM F 1476.

Retain one or both of two "Rigid Type Couplings" subparagraphs below.

- a. Rigid Type Couplings: Housings cast with offsetting, angle-pattern bolt pads to provide joint rigidity and support and hanging per ANSI B31.1 and B31.9.
 - 1) Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Style 107H Installation Ready or comparable product from one of the following:
 - a) **<Insert engineer approved manufacturer's name>**.
 - 2) Installation: Suitable for direct stab without field disassembly.
 - 3) Gasket: Grade EHP, suitable for water service of 250 deg F (121 deg C) maximum.
- b. Rigid Type Couplings: Housings cast with offsetting, angle-pattern bolt pads to provide joint rigidity and support and hanging per ANSI B31.1 and B31.9.
 - 1) Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Style 07 "Zero-Flex" or comparable product from one of the following:
 - a) **<Insert engineer approved manufacturer's name>**.

Retain one or both of two "Flexible Type Couplings" subparagraphs below.

- c. Flexible Type Couplings: For use in locations where vibration attenuation and stress relief are required, and for the elimination of flexible connectors.
 - 1) Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Installation Ready Style 177 or comparable product by one of the following:
 - a) **<Insert engineer approved manufacturer's name>**.
 - 2) Installation: Suitable for direct stab without field disassembly.
 - 3) Gasket: Grade EHP, suitable for water service of **250 deg F (121 deg C)** maximum.
- d. Flexible Type Couplings: For use in locations where vibration attenuation and stress relief are required, and for the elimination of flexible connectors.
 - 1) Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Style 77 or comparable product by one of the following:
 - a) **<Insert engineer approved manufacturer's name>**.
- e. 14 inch (350 mm) and Larger Couplings: 2-Segment couplings for installation on AGS / wedge-shaped grooved pipe and products rated to **350 psig CWP (2400 kPa)**.
 - 1) Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Style W07 (rigid) and Style W77 (flexible) or comparable product by one of the following:
 - a) **<Insert engineer approved manufacturer's name>**,
 - 2) Flush Seal wide width gasket; grade to suit the intended service.
- f. Flange Adapter: For direct connection to ANSI Class 125 or 150 flanged components.
 - 1) Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Style 741 and W741 or comparable product by one of the following:
 - a) **<Insert engineer approved manufacturer's name>**.

I. Stainless Steel Pressure-Seal Fittings:

Retain "Basis-of-Design Product" Subparagraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed. Retain option and delete insert note if manufacturer's name and model number are indicated on Drawings.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Vic-Press for Schedule 10S Pipe or comparable product by one of the following:
 - a. <Insert engineer approved manufacturer's name>.
2. Pipe: Stainless steel, ASTM A-312 / A 312M, Schedule 10S, Type [304] [316], with plain ends.
3. Housing: Stainless steel; Type [304] [316].
4. O-Rings and Pipe Stop: [EPDM] [HNBR].
5. Tools: Manufacturer's special tool, Victaulic Company, Series PFT-510.
6. Minimum 500-psig (3450-kPa) working-pressure rating at [230 deg F (110 deg C)] [210 deg F (98 deg C)].

Non-reinforced, welded, in-branch connections weaken a main pipeline; reinforcement is necessary unless wall thickness of both mains and branches is sufficient to sustain pressure required in "Performance Requirements" Article.

- J. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.5 PLASTIC PIPE AND FITTINGS

See the Evaluations for discussion of product characteristics and maximum temperatures.

- A. CPVC Plastic Pipe: ASTM F 441/F 441M, with wall thickness as indicated in "Piping Applications" Article.
 1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
- B. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.
 1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

2.6 FIBERGLASS PIPE AND FITTINGS

Piping is available with ends for other types of joints. See the Evaluations for discussion of product characteristics and maximum temperatures and pressures.

- A. RTRP: ASTM D 2996, filament-wound pipe with tapered bell and spigot ends for adhesive joints.
- B. RTRF: Compression or spray-up/contact molded of same material, pressure class, and joining method as pipe.

- C. Flanges: ASTM D 4024. Full-face gaskets suitable for the service, minimum 1/8-inch (3.2-mm) thick, 60-70 durometer. ASTM A 307, Grade B, hex head bolts with washers.

2.7 VALVES

- A. BALL VALVES: 800-psig (5515-kPa), Ductile-Iron Ball Valves.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Style 726 or comparable product by one of the following:
 - a. <Insert engineer approved manufacturer's name>.
2. Description:
 - a. CWP Rating: 800-psig (5515-kPa).
 - b. Body Material: Two-piece; ASTM A395, ductile iron.
 - c. Ends: Grooved.
 - d. Seats: PTFE.
 - e. Stem and Ball: Chrome plated steel [**stainless steel**].
 - f. Port: Standard.
 - g. Operator: Lever or gear as required.

- B. BALL VALVES: 300-psig (9400-psig), Vic-Press End Ball Valves.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Style 589 and Style 569 of comparable product by one of the following:
 - a. <Insert engineer approved manufacturer's name>.
2. Description:
 - a. CWP Rating: [300-psig (2065-kPa)] [400-psig (2750-kPa)].
 - b. Body Material:
 - 1) Two-piece; ASTM B30, forged brass.
 - 2) Three-piece; ASTM A351, stainless steel.
 - c. Ends: Vic-Press for Schedule 10S Pipe.
 - d. Seats: PTFE.
 - e. Stem and Ball:
 - 1) Chrome plated brass; standard port.
 - 2) Stainless steel; full port.
 - f. Operator: Lever handle.

- C. BUTTERFLY VALVES

1. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Vic300 MasterSeal and AGS-Vic300 or comparable product by one of the following:
 - a. <Insert engineer approved manufacturer's name>.
2. Description:
 - a. CWP Rating: 300-psig (2065-kPa).
 - b. Body Material: ASTM A536, ductile iron.
 - c. Ends: Grooved.
 - d. Seats: Elastomer [EPDM] [Nitrile].
 - 1) Pressure responsive, suitable for hot water to +250 deg F (+120 deg C).
 - 2) Disc mounted, suitable for hot water to +230 deg F (+110 deg C).
 - e. Disc: Coated ductile iron [Stainless steel].
 - f. Stem: Stainless steel.
 - 1) Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.
 - g. Operator: Lever or gear as required.

D. CHECK VALVES

1. Basis-of-Design Product: Subject to compliance with requirements, Victaulic Company; Series 716 and Series W715 or comparable product by one of the following:
 - a. <Insert engineer approved manufacturer's name>.
2. Description:
 - a. CWP Rating:
 - 1) NPS 2 through NPS 12: 300-psig (2065-kPa).
 - 2) NPS 14 through NPS 24: 230-psig (1575-kPa).
 - b. Body Material: ASTM [A536] [A395] ductile iron.
 - c. Ends: Grooved.
 - d. Spring and Shaft: Stainless steel.
 - e. Disc: Stainless steel or elastomer coated ductile iron.
 - f. Suitable for vertical or horizontal installation.

2.8 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 (3.2-mm) 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. Grooved Joint Lubricant: Compatible with gasket elastomer and fluid media. Supplied by coupling manufacturer.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Vic-Lube or comparable product by one of the following:
 - a. <Insert engineer approved manufacturer's name>.

See the Evaluations for discussions of solder and brazing materials described in "Solder Filler Metals" and "Brazing Filler Metals" paragraphs below.

- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8/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.
- H. Solvent Cements for Joining Plastic Piping:
 1. CPVC Piping: ASTM F 493.

One or more of first three subparagraphs below may be required to comply with Project requirements or authorities having jurisdiction. Retain first two subparagraphs below if required for LEED-NC, LEED-CI, or LEED-CS Credit IEQ 4.1.

- a. CPVC solvent cement shall have a VOC content of 490 g/L or less.
- b. Adhesive primer shall have a VOC content of 550 g/L or less.

Retain first subparagraph below if required for LEED for Schools Credit IEQ 4.1.

- c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

One or more of three subparagraphs below may be required to comply with Project requirements or authorities having jurisdiction. Retain first two subparagraphs below if required for LEED-NC, LEED-CI, or LEED-CS Credit IEQ 4.1.

- a. PVC solvent cement shall have a VOC content of 510 g/L or less.
- b. Adhesive primer shall have a VOC content of 550 g/L or less.

Retain subparagraph below if required for LEED for Schools Credit IEQ 4.1.

- c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

One or both subparagraphs below may be required to comply with Project requirements or authorities having jurisdiction. Retain first subparagraph if required for LEED-NC, LEED-CI, or LEED-CS Credit IEQ 4.1.

1. Fiberglass adhesive shall have a VOC content of 80 g/L or less.

Retain subparagraph below if required for LEED for Schools Credit IEQ 4.1.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

- J. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.9 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings:

Retain "Manufacturers" Subparagraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Charlotte Pipe and Foundry Company.
 - b. IPEX Inc.
 - c. KBI (King Bros. Industries).
 - d. **<Insert manufacturer's name>**.
2. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:

Retain "Manufacturers" Subparagraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Charlotte Pipe and Foundry Company.
 - b. IPEX Inc.
 - c. KBI (King Bros. Industries).
 - d. NIBCO INC; Model #T/S-1710.
 - e. **<Insert manufacturer's name>**.
2. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.10 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.

Fittings in "Dielectric Unions" Paragraph below are available in NPS 1/2 to NPS 2 (DN 15 to DN 50).

B. Dielectric Unions:

Retain "Manufacturers" Subparagraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. Central Plastics Company.
 - d. Hart Industries International, Inc.
 - e. Jomar International, Ltd.
 - f. Matco-Norca.
 - g. Watts Regulator Co.
 - h. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.
 - i. **<Insert manufacturer's name>**.
2. Description:
 - a. Standard: ASSE 1079.

Revise pressure rating in "Pressure Rating" Subparagraph below to suit Project, or insert other options for specific applications.

- b. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**] [**150 psig (1035 kPa)**] [**250 psig (1725 kPa)**] <Insert value>.
- c. End Connections: Solder-joint copper alloy and threaded ferrous.

Fittings in "Dielectric Flanges" Paragraph below are available in NPS 1-1/2 to NPS 4 (DN 40 to DN 100).

C. Dielectric Flanges:

Retain "Manufacturers" Subparagraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. Watts Regulator Co.
 - e. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.
 - f. <Insert manufacturer's name>.
2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.

Revise pressure rating in "Pressure Rating" Subparagraph below to suit Project, or insert other options for specific applications.

- c. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**] [**150 psig (1035 kPa)**] [**175 psig (1200 kPa)**] [**300 psig (2070 kPa)**] <Insert value>.
- d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

Flanges in "Dielectric-Flange Insulating Kits" Paragraph below are available in NPS 1/2 to NPS 48 (DN 15 to DN 1200).

D. Dielectric-Flange Insulating Kits:

Retain "Manufacturers" Subparagraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
 - a. Advance Products & Systems, Inc.

- b. Calpico, Inc.
- c. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.
- e. <Insert manufacturer's name>.

2. Description:

- a. Nonconducting materials for field assembly of companion flanges.

Revise pressure rating in "Pressure Rating" Subparagraph below to suit Project, or insert other options for specific applications.

- b. Pressure Rating: [**150 psig (1035 kPa)**] <Insert value>.
- c. Gasket: Neoprene or phenolic.
- d. Bolt Sleeves: Phenolic or polyethylene.
- e. Washers: Phenolic with steel backing washers.

Nipples in "Dielectric Nipples" Paragraph below are available in NPS 1/2 to NPS 4 (DN 15 to DN 100).

E. Dielectric Nipples:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Style 47 or comparable product by one of the following:
 - a. Elster Perfection.
 - b. <Insert engineer approved manufacturer's name>.
- 2. Description:
 - a. Standard: IAPMO PS 66 and ASTM F 492-77.
 - b. Electroplated steel nipple or ductile iron casing, complying with ASTM F 1545.

Revise pressure rating and temperature in "Pressure Rating" Subparagraph below to suit Project, or insert other options for specific applications.

- c. Pressure Rating: [**300 psig (2070 kPa) at 225 deg F (107 deg C)**] <Insert value and temperature>.
- d. End Connections: Male threaded [**and**] [**or**] grooved.
- e. Lining: Inert and noncorrosive, propylene, NSF / FDA listed.

2.11 BYPASS CHEMICAL FEEDER

Retain this article if chemical-treatment systems are not specified in Section 232500 "HVAC Water Treatment."

- A. Description: Welded steel construction; **125-psig (860-kPa)** working pressure; **5-gal. (19-L)** capacity; with fill funnel and inlet, outlet, and drain valves.
 - 1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

Retain at least one pipe material in paragraphs below for each service required for Project. Services are specified separately to allow different pipe materials and joining methods for each. If materials and methods are the same for multiple services, combine the requirements by revising paragraph titles. To allow Contractor to choose among various pipe materials, retain multiple materials for each required service and pipe size. Pipe materials and joining methods in this article, in general, are as listed in the 2008 ASHRAE HANDBOOK - "HVAC Systems and Equipment," Ch. 45, "Pipes, Tubes, and Fittings." The change point for pipe materials and joining methods is specified, in this master, where the pipe size changes from NPS 2 to NPS 2-1/2 (DN 50 to DN 65). Revise this change point to suit office policy. See "Writing Guide" Article in the Evaluations.

Retain "any of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- A. Hot-water heating piping, aboveground, [**NPS 2 (DN 50) and smaller**] <Insert pipe size range>, shall be[**any of**] the following:

Retain one or more of four subparagraphs below. If more than one type of material and joining method is retained and it is not the intent to give Contractor the choice to select materials, delete "any of" option in paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. [**Type L (Type B)**] [**Type M (Type C)**], drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**pressure-seal**] joints.
2. [**Schedule 40**] [**Schedule 30**] [**Schedule 20**], Grade B, Type 96 steel pipe; [**Class 125, cast-iron**] [**Class 150, malleable-iron**] [**Class 250, cast-iron**] [**Class 300, malleable-iron**] fittings; cast-iron flanges and flange fittings; and threaded joints.
3. Schedule 10S stainless steel pipe; stainless steel, pressure-seal couplings and fittings; and pressure-seal joints.

CPVC pipe in subparagraph below has temperature and pressure limitations. See Evaluations.

4. [**Schedule 40**] [**Schedule 80**] CPVC plastic pipe and fittings and solvent-welded joints.

Retain "any of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- B. Hot-water heating piping, aboveground, [**NPS 2-1/2 (DN 65) and larger**] <Insert pipe size range>, shall be[**any of**] the following:

Retain one or more of five subparagraphs below. If more than one type of material and joining method is retained and it is not the intent to give Contractor the choice to select materials, delete "any of" option in paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. [**Type L (Type B)**] [**Type M (Type C)**], drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] joints.

2. [Schedule 40] [Schedule 30] [Schedule 20] steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. [Schedule 40] [Schedule 30] [Schedule 20] steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

CPVC and RTRP in two subparagraphs below have temperature and pressure limitations. See Evaluations.

4. [Schedule 40] [Schedule 80] CPVC plastic pipe and fittings and solvent-welded joints.
5. RTRP and RTRF with adhesive or flanged joints.

Retain "either of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- C. Hot-water heating piping installed belowground and within slabs shall be [either of] the following:

Retain one or both subparagraphs below. If retaining both and it is not the intent to give Contractor the choice to select materials, delete "either of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. Type K (Type A), annealed-temper copper tubing, wrought-copper fittings, and [soldered] [brazed] joints. Use the fewest possible joints.

RTRP in subparagraph below has temperature and pressure limitations. See Evaluations.

2. RTRP and RTRF with adhesive or flanged joints.

Retain "any of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- D. Chilled-water piping, aboveground, [NPS 2 (DN 50) and smaller] <Insert pipe size range>, shall be [any of] the following:

Retain one or more of four subparagraphs below. If more than one type of material and joining method is retained and it is not the intent to give Contractor the choice to select materials, delete "any of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. [Type L (Type B)] [Type M (Type C)], drawn-temper copper tubing, wrought-copper fittings, and [soldered] [brazed] [pressure-seal] joints.
2. [Schedule 40] [Schedule 30] [Schedule 20] steel pipe; [Class 125, cast-iron] [Class 150, malleable-iron] [Class 250, cast-iron] [Class 300, malleable-iron] fittings; cast-iron flanges and flange fittings; and threaded joints.
3. Schedule 10S stainless steel pipe; stainless steel, pressure-seal couplings and fittings; and pressure-seal joints.

CPVC pipe in subparagraph below has temperature and pressure limitations. See Evaluations.

4. [Schedule 40] [Schedule 80] CPVC plastic pipe and fittings and solvent-welded joints.

Retain "any of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- E. Chilled-water piping, aboveground, [**NPS 2-1/2 (DN 65) and larger**] <Insert pipe size range>, shall be[**any of**] the following:

Retain one or more of five subparagraphs below. If more than one type of material and joining method is retained and it is not the intent to give Contractor the choice to select materials, delete "any of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. [**Type L (Type B)**] [**Type M (Type C)**], drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] joints.
2. [**Schedule 40**] [**Schedule 30**] [**Schedule 20**] steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. [**Schedule 40**] [**Schedule 30**] [**Schedule 20**] steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

CPVC and RTRP in two subparagraphs below have temperature and pressure limitations. See Evaluations.

4. [**Schedule 40**] [**Schedule 80**] CPVC plastic pipe and fittings and solvent-welded joints.
5. RTRP and RTRF with adhesive or flanged joints.

Retain "either of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- F. Chilled-water piping installed belowground and within slabs shall be[**either of**] the following:

Retain one or both subparagraphs below. If retaining both and it is not the intent to give Contractor the choice to select materials, delete "either of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. **Type K (Type A)**, annealed-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] joints. Use the fewest possible joints.

RTRP in subparagraph below has temperature and pressure limitations. See Evaluations.

2. RTRP and RTRF with adhesive or flanged joints.

Retain "any of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- G. Dual-temperature heating and cooling water piping, aboveground, [**NPS 2 (DN 50) and smaller**] <Insert pipe size range>, shall be[**any of**] the following:

Retain one or more of four subparagraphs below. If more than one type of material and joining method is retained and it is not the intent to give Contractor the choice to select materials, delete "any of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. [**Type L (Type B)**] [**Type M (Type C)**], drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**pressure-seal**] joints.
2. [**Schedule 40**] [**Schedule 30**] [**Schedule 20**] steel pipe; [**Class 125, cast-iron**] [**Class 150, malleable-iron**] [**Class 250, cast-iron**] [**Class 300, malleable-iron**] fittings; cast-iron flanges and flange fittings; and threaded joints.

3. Schedule 10S stainless steel pipe; stainless steel, pressure-seal couplings and fittings; and pressure-seal joints.

CPVC pipe in subparagraph below has temperature and pressure limitations. See Evaluations.

4. [Schedule 40] [Schedule 80] CPVC plastic pipe and fittings and solvent-welded joints.

Retain "any of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- H. Dual-temperature heating and cooling water piping, aboveground, [NPS 2-1/2 (DN 65) and larger] <Insert pipe size range>, shall be[any of] the following:

Retain one or more of five subparagraphs below. If more than one type of material and joining method is retained and it is not the intent to give Contractor the choice to select materials, delete "any of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. [Type L (Type B)] [Type M (Type C)], drawn-temper copper tubing, wrought-copper fittings, and [soldered] [brazed] joints.
2. [Schedule 40] [Schedule 30] [Schedule 20] steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. [Schedule 40] [Schedule 30] [Schedule 20] steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

CPVC and RTRP in two subparagraphs below have temperature and pressure limitations. See Evaluations.

4. [Schedule 40] [Schedule 80] CPVC plastic pipe and fittings and solvent-welded joints.
5. RTRP and RTRF with adhesive or flanged joints.

Retain "either of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- I. Dual-temperature heating and cooling water piping installed belowground and within slabs shall be[either of] the following:

Retain one or both subparagraphs below. If retaining both and it is not the intent to give Contractor the choice to select materials, delete "either of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. Type K (Type A), annealed-temper copper tubing, wrought-copper fittings, and [soldered] [brazed] joints. Use the fewest possible joints.

RTRP in subparagraph below has temperature and pressure limitations. See Evaluations.

2. RTRP and RTRF with adhesive or flanged joints.

Retain "any of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- J. Condenser-water piping, aboveground, [NPS 2 (DN 50) and smaller] <Insert pipe size range>, shall be[any of] the following:

Retain one or more of four subparagraphs below. If more than one type of material and joining method is retained and it is not the intent to give Contractor the choice to select materials, delete "any of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. [**Type L (Type B)**] [**Type M (Type C)**], drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**pressure-seal**] joints.
2. [**Schedule 80**] [**Schedule 40**] [**Schedule 30**] [**Schedule 20**] steel pipe; [**Class 125, cast-iron**] [**Class 150, malleable-iron**] [**Class 250, cast-iron**] [**Class 300, malleable-iron**] fittings; cast-iron flanges and flange fittings; and threaded joints.
3. Schedule 10S stainless steel pipe; stainless steel, pressure-seal couplings and fittings; and pressure-seal joints.

CPVC pipe in subparagraph below has temperature and pressure limitations. See Evaluations.

4. [**Schedule 40**] [**Schedule 80**] CPVC plastic pipe and fittings and solvent-welded joints.

Retain "any of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- K. Condenser-water piping, aboveground, [**NPS 2-1/2 (DN 65) and larger**] <Insert pipe size range>, shall be[**any of**] the following:

Retain one or more of five subparagraphs below. If more than one type of material and joining method is retained and it is not the intent to give Contractor the choice to select materials, delete "any of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. [**Type L (Type B)**] [**Type M (Type C)**], drawn-temper copper tubing, wrought-copper or cast-bronze fittings, and grooved joints.
2. [**Schedule 80**] [**Schedule 40**] [**Schedule 30**] [**Schedule 20**] steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. [**Schedule 80**] [**Schedule 40**] [**Schedule 30**] [**Schedule 20**] steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

CPVC and RTRP in two subparagraphs below have temperature and pressure limitations. See Evaluations.

4. [**Schedule 40**] [**Schedule 80**] CPVC plastic pipe and fittings and solvent-welded joints.
5. RTRP and RTRF with adhesive or flanged joints.

Retain "either of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- L. Condenser-water piping installed belowground and within slabs shall be[**either of**] the following:

Retain one or both subparagraphs below. If retaining both and it is not the intent to give Contractor the choice to select materials, delete "either of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. **Type K (Type A)**, annealed-temper copper tubing, wrought-copper fittings, and **[soldered] [brazed]** joints. Use the fewest possible joints.

RTRP in subparagraph below has temperature and pressure limitations. See Evaluations.

2. RTRP and RTRF with adhesive or flanged joints.

Retain "any of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- M. Glycol cooling-water piping, aboveground, **[NPS 2 (DN 50) and smaller]** <Insert pipe size range>, shall be **[any of]** the following:

Retain one or more of four subparagraphs below. If more than one type of material and joining method is retained and it is not the intent to give Contractor the choice to select materials, delete "any of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. **[Type L (Type B)] [Type M (Type C)]**, drawn-temper copper tubing, wrought-copper fittings, and **[soldered] [brazed] [pressure-seal]** joints.
2. **[Schedule 40] [Schedule 30] [Schedule 20]** steel pipe; **[Class 125, cast-iron] [Class 150, malleable-iron] [Class 250, cast-iron] [Class 300, malleable-iron]** fittings; cast-iron flanges and flange fittings; and threaded joints.
3. Schedule 10S stainless steel pipe; stainless steel, pressure-seal couplings and fittings; and pressure-seal joints.

CPVC pipe in subparagraph below has temperature and pressure limitations. See Evaluations.

4. **[Schedule 40] [Schedule 80]** CPVC plastic pipe and fittings and solvent-welded joints.

Retain "any of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- N. Glycol cooling-water piping, aboveground, **[NPS 2-1/2 (DN 65) and larger]** <Insert pipe size range>, shall be **[any of]** the following:

Retain one or more of five subparagraphs below. If more than one type of material and joining method is retained and it is not the intent to give Contractor the choice to select materials, delete "any of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. **[Type L (Type B)] [Type M (Type C)]**, drawn-temper copper tubing, wrought-copper or cast-bronze fittings, and grooved joints.
2. **[Schedule 40] [Schedule 30] [Schedule 20]** steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. **[Schedule 40] [Schedule 30] [Schedule 20]** steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

CPVC and RTRP in two subparagraphs below have temperature and pressure limitations. See Evaluations.

4. **[Schedule 40] [Schedule 80]** CPVC plastic pipe and fittings and solvent-welded joints.
5. RTRP and RTRF with adhesive or flanged joints.

6. Schedule 10S stainless steel pipe; stainless steel, pressure-seal couplings and fittings; and pressure-seal joints

Retain "either of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- O. Glycol cooling-water piping installed belowground and within slabs shall be[**either of**] the following:

Retain one or both subparagraphs below. If retaining both and it is not the intent to give Contractor the choice to select materials, delete "either of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. **Type K (Type A)**, annealed-temper copper tubing, wrought-copper fittings, and **[soldered] [brazed]** joints. Use the fewest possible joints.

RTRP in subparagraph below has temperature and pressure limitations. See Evaluations.

2. RTRP and RTRF with adhesive or flanged joints.

Retain "either of" option in first paragraph below to allow Contractor to select piping materials from those retained.

- P. Makeup-water piping installed aboveground shall be[**either of**] the following:

Retain one or both subparagraphs below. If retaining both and it is not the intent to give Contractor the choice to select materials, delete "either of" option in last paragraph above and identify each material on Drawings. Show points of transition from one material to another.

1. **[Type L (Type B)] [Type M (Type C)]**, drawn-temper copper tubing, wrought-copper fittings, and **[soldered] [brazed]** joints.
2. **[Schedule 40] [Schedule 80]** CPVC plastic pipe and fittings, and solvent-welded joints.

- Q. Makeup-Water Piping Installed Belowground and within Slabs: **Type K (Type A)**, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

Retain one of two "Condensate-Drain Piping" paragraphs below.

- R. Condensate-Drain Piping: **[Type M (Type C)] [Type DWV]**, drawn-temper copper tubing, wrought-copper fittings, and soldered joints[**or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints**].
- S. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.
- T. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- U. 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 (Type A)**, annealed-temper copper tubing with soldered or flared joints.
- V. Safety-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 PIPING INSTALLATIONS

Indicate piping locations and arrangements on Drawings if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.

- 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 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 (DN 20)** ball valve, and short **NPS 3/4 (DN 20)** 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 [**mechanically formed**] 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 unions in piping, [**NPS 2 (DN 50)**] <Insert pipe size> and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, [**NPS 2-1/2 (DN 65)**] <Insert pipe size> and larger, at final connections of equipment and elsewhere as indicated.
- S. Unions and flanges for servicing and disconnect are not required in installations using grooved joint couplings. (The couplings serve as disconnect points.)
- T. Install shutoff valve immediately upstream of each dielectric fitting.
- U. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" 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 230517 "Sleeves and Sleeve Seals for HVAC Piping."

Retain first paragraph below for piping that penetrates an exterior concrete wall or concrete slab.

- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for [**NPS 2 (DN 50)**] <Insert pipe size> and Smaller: Use dielectric [**nipples**] [**unions**].
- C. Dielectric Fittings for [**NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**] <Insert pipe size range>: Use dielectric [**flanges**] [**flange kits**] [**nipples**].
- D. Dielectric Fittings for [**NPS 5 (DN 125)**] <Insert pipe size> and Larger: Use [**dielectric flange kits**] [**nipples**].

3.4 HANGERS AND SUPPORTS

Piping support must account for expansion and contraction, vibration, dead load of piping and its contents, and seismic-bracing requirements.

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

Retain first paragraph below for projects in areas that require seismic restraints.

- B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
 4. Spring hangers to support vertical runs.
 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

Verify actual supported loads for hanger sizes and spacing. Consult structural engineer. Maximum spacing in first two paragraphs below is from MSS SP-69, "Pipe Hangers and Supports - Selection and Application," and the International Mechanical Code. Maximum spacing for steel pipe required by the International Mechanical Code is 12 feet (3.7 m). If hanger spacing is determined by local codes that differ from MSS SP-69 and the International Mechanical Code, delete first two paragraphs. Contractor is then obligated to comply with the maximum spacing required by authorities having jurisdiction.

- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4 (DN 20): Maximum span, 7 feet (2.1 m).
 2. NPS 1 (DN 25): Maximum span, 7 feet (2.1 m).
 3. NPS 1-1/2 (DN 40): Maximum span, 9 feet (2.7 m).
 4. NPS 2 (DN 50): Maximum span, 10 feet (3 m).
 5. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m).
 6. NPS 3 (DN 80) and Larger: Maximum span, 12 feet (3.7 m).
- E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
 2. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
 3. NPS 1-1/4 (DN 32): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).

4. **NPS 1-1/2 (DN 40):** Maximum span, **8 feet (2.4 m)**; minimum rod size, **3/8 inch (10 mm)**.
 5. **NPS 2 (DN 50):** Maximum span, **8 feet (2.4 m)**; minimum rod size, **3/8 inch (10 mm)**.
 6. **NPS 2-1/2 (DN 65):** Maximum span, **9 feet (2.7 m)**; minimum rod size, **3/8 inch (10 mm)**.
 7. **NPS 3 (DN 80) and Larger:** Maximum span, **10 feet (3 m)**; minimum rod size, **3/8 inch (10 mm)**.
- F. **Plastic Piping Hanger Spacing:** Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- G. **Fiberglass Piping Hanger Spacing:** Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- H. **Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.**
- I. **In grooved installations, the use of Victaulic Style 107H; Style 07H; Style 07 Zero Flex; and AGS Style W07 rigid couplings permit support and hanging in accordance with ANSI B31.1 and B31.9.**

3.5 PIPE 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 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.
- D. **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.
- E. **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.
- F. **Welded Joints:** Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "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 according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
 4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- I. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

Retain "Grooved Joints" Paragraph below for grooved-end pipe couplings for copper or steel pipe.

- J. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
1. Assure grooved ends are clean and free from indentations, projections, or roll marks.
 2. Use gaskets molded and produced by coupling manufacturer of an elastomer suitable for intended service.
 3. On-Site Training: For contractor's field personnel in use of grooving tools and installation of product shall be provided by coupling manufacturer's factory-trained representative. (Distributor's representative is not considered qualified to conduct the training.)
 4. Job Site Visitation: Manufacturer's representative shall periodically visit jobsite to ensure best practices in grooved product installation are being followed.

Where required, maintain the below paragraphs:

5. The installing contractor shall be certified by the grooved coupling manufacturer for the installation of their product. A manufacturer's factory trained representative (direct employee) shall provide on-site certification training for the installing contractor's field personnel in the use of grooving tools, application of groove, and product installation
6. A field training program must be designed, developed, administered and evaluated in accordance to the ANSI/IACET Standard for Continuing Education and Training. (IACET-International Association for Continuing Education and Training)
7. All installation professionals and pipe fitters must be able to provide proof of successful course completion upon request

Retain "Mechanically Formed, Copper-Tube-Outlet Joints" Paragraph below for mechanically formed outlets in place of tee fittings in copper pipe.

- K. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

Retain "Pressure-Sealed Joints" Paragraph below for pressure-sealed joints in copper or stainless steel piping.

- L. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall 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 gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 CHEMICAL TREATMENT

Delete this article if using Section 232500 "HVAC Water Treatment."

Delete first paragraph below if water analysis has been or will be conducted by Owner.

- A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:

Consult water-treatment specialist and insert, in subparagraphs below, specific values required for Project.

1. pH: [9.0 to 10.5] <Insert values>.
2. "P" Alkalinity: [100 to 500] <Insert values> ppm.
3. Boron: [100 to 200] <Insert values> ppm.
4. Chemical Oxygen Demand: Maximum of [100] <Insert value> ppm. Revise this value if closed system contains glycol.
5. Corrosion Inhibitor:

Retain one of first five subparagraphs below.

- a. Sodium Nitrate: [1000 to 1500] <Insert values> ppm.
 - b. Molybdate: [200 to 300] <Insert values> ppm.
 - c. Chromate: [200 to 300] <Insert values> ppm.
 - d. Sodium Nitrate Plus Molybdate: [100 to 200] <Insert values> ppm each.
 - e. Chromate Plus Molybdate: [50 to 100] <Insert values> ppm each.
6. Soluble Copper: Maximum of [0.20] <Insert value> ppm.
 7. Tolyriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum of [10] <Insert value> ppm.
 8. Total Suspended Solids: Maximum of [10] <Insert value> ppm.
 9. Ammonia: Maximum of [20] <Insert value> ppm.
 10. Free Caustic Alkalinity: Maximum of [20] <Insert value> ppm.
 11. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maximum of [1000] <Insert number> organisms/mL.

- b. Total Anaerobic Plate Count: Maximum of [100] <Insert number> organisms/mL.
- c. Nitrate Reducers: [100] <Insert number> organisms/mL.
- d. Sulfate Reducers: Maximum of [zero] <Insert number> organisms/mL.
- e. Iron Bacteria: Maximum of [zero] <Insert number> organisms/mL.

12. <Insert other requirements if necessary>.

Retain first paragraph below if chemical water treatment is not specified in Section 232500 "HVAC Water Treatment." Coordinate floor drain location for equipment drain near feeder.

- B. Install bypass chemical feeders in each hydronic system where indicated.
 1. Install in upright position with top of funnel not more than 48 inches (1200 mm) above the floor.
 2. Install feeder in minimum NPS 3/4 (DN 20) bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
 3. Install NPS 3/4 (DN 20) pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.
- C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
- D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.
- E. Fill systems that have antifreeze or glycol solutions with the following concentrations:
 1. Hot-Water Heating Piping: Minimum of <Insert number> percent [ethylene] [propylene] glycol.
 2. Chilled-Water Piping: Minimum of <Insert number> percent [ethylene] [propylene] glycol.
 3. Dual-Temperature Heating and Cooling Water Piping: Minimum of <Insert number> percent [ethylene] [propylene] glycol.
 4. Glycol Cooling-Water Piping: Minimum of <Insert number> percent [ethylene] [propylene] glycol.

3.8 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to 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 shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety 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:

Procedures in subparagraphs below are paraphrased from ASME B31.9.

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 shall not 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, "Building Services Piping."
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.

C. 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 DEMONSTRATION AND TRAINING

- A. On-Site Training: For contractor's field personnel in use of grooving tools and installation of product shall be provided by coupling manufacturer's factory-trained representative. (Distributor's representative is not considered qualified to conduct the training.)
- B. Job Site Visitation: Manufacturer's representative shall periodically visit jobsite to ensure best practices in grooved product installation are being followed.

END OF SECTION 232113