

THE PENNSYLVANIA STATE UNIVERSITY  
OPP Specification Guideline  
HYDRONIC PIPING

File Name: 232113 Hydronic Piping w PPR Guidespec~~232113 – HYDRONIC PIPING GUIDESPEC~~  
Version Date: March 30, 2017~~September 25, 2013~~~~September 11, 2012~~

*General Notes:*

- 1. This guide specification is intended to provide the Design Professional with a basic guideline of minimum requirements for hydronic piping.*
- 2. The guide specification shall be carefully reviewed and edited with respect to application-specific project requirements. Proposed modifications shall be reviewed with OPP Staff.*
- 3. Finalized version shall be included in the project contract documents.*

*Editing Notes*

- 1. This OPP Guide specification must only be altered by notation (i.e. deleted text with strikethrough and additional text with double underline). This shall be accomplished by using Tools /Track Changes / Highlight Changes, and select "Track changes while editing" in MS Word or equivalent.*
- 2. The Review Submittal Specification section shall be provided in electronic form for OPP Review.*
- 3. Leave the following Note ("For Construction Document Review, Design Submittal") as part of the Review Submittal, to aid any Reviewer to understand WHY there are strikeouts and underlines. Also, leave any "DESIGNER NOTE" placed in this Guide Spec.*
- 4. AFTER comments are received from PSU and incorporated, the strikeouts and underlines shall be removed, and the REVIEWER NOTES deleted, before the spec is issued for Bidding.*

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.
- B. All sections of the project manual are directly applicable to this specification section. Should a conflict arise between specification sections or between specifications and drawings and/or code requirements, the contractor shall notify the Architect/Engineer of the conflict in writing. If direction is not provided prior to the submission of the bid, the contractor shall price the more extensive system.

1.2 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following piping systems. The contractor is responsible for all labor, materials, equipment and tools for the completion of these systems:

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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 (non-steam).
8. Blowdown-drain piping.
9. Air-vent piping.
10. Safety-valve-inlet and -outlet piping.

B. REFERENCE STANDARDS

1. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
2. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
3. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
4. ANSI/ASME Sec 9 Welding and Brazing Qualifications.
5. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
6. ANSI/ASME B16.3 Malleable Iron Threaded Fittings Class 150 and 300.
7. ANSI/ASME B16.9 – Factory-Made Wrought Butt welding Fittings.
8. ANSI/ASME B16.23 – Cast Copper Alloy Solder Drainage Fitting – DWV.
9. ANSI/ASME B16.29 – Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings – DWV.
10. ANSI/ASME B31.9 Building Services Piping.
11. ASME B36.1 – Standardization of dimensions of welded and seamless wrought steel pipe for high or low temperatures and pressures.
12. ANSI/AWS D1.1 Structural Welding Code.
13. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses.
14. ASTM A105 – Standard Specification for Carbon Steel Forgings for Pipe Applications.
15. ASTM A106 Grade B, Seamless piping.
16. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
17. ASTM A312 – Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipe.
18. ASTM A536 – Standard Specification for Ductile Iron Castings.
19. ASTM B88 – Standard Specification for Seamless Copper Water Tube.
20. ASTM F 2389-07 - Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems
21. CSA B137.11 - Polypropylene (PP-R) Pipe and Fittings for Pressure Applications
22. NSF/ANSI 14 – Plastic Piping System Components and Related Materials
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### 1.3 ACTION SUBMITTALS

#### A. Product Data:

1. Submit product data on pipe materials, pipe fittings, valves, and accessories. Clearly indicate make, model, type, size, and pressure rating for each device.
2. Submittal data for all fittings shall include a letter signed by an official of the manufacturing company certifying compliance with these Specifications.

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

#### B. 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: For Installer.

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

#### C. Welding certificates.

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

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

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

1. 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.
2. Grooved Piping Certification Training:
  - a. 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.
  - b. All installation professionals and pipe fitters must be able to provide proof of successful course completion upon request.
  - c. Application:

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- B. U.S. Steel: Use only steel products, rolled, formed, shaped, drawn, extruded, forged, cast, fabricated, or otherwise similarly, processed, or processed by a combination of two or more of such operations, from steel made in the United States. The Contractor must submit certification which satisfies the Owner that the Contractor has fully complied with this provision.

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

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.

- C. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. 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.

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1.6 DELIVERY, STORAGE, AND HANDLING

- A. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.
- B. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproofing wrapping.
- C. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

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 (**consultant must calculate working pressure per project requirements**) and temperature unless otherwise indicated:

*DESIGNER NOTE: Hot water systems generated from Campus Steam Distribution systems are subject to elevated temperatures occasionally exceeding 250 degrees due to superheated campus steam and the relatively high probability of control malfunctions. Therefore, in those applications, the piping system including all associated material selections (gaskets, o-rings, pump seals, flexible connectors, valves, resilient seats, etc.) shall be rated for the maximum temperature that the system could see while pump system is operating (the associated temperature at the pressure relief valve setting). Edit the temperature ratings throughout the remainder of the section and other related sections accordingly.*

Plastic piping systems shall not be designed for hot water use. Temperature and pressure ratings listed below shall be rated on the maximum ambient temperature expected if the system is dormant.

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 250 deg F.

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2. Chilled-Water Piping: <Insert psig (kPa)> at ~~[250]~~~~250~~ [100] deg F (93 deg C) .
3. Dual-Temperature Heating and Cooling Water Piping: <Insert psig (kPa)> at 250 deg F (93 deg C).
4. Condenser-Water Piping: <Insert psig (kPa)> at 250 deg F (66 deg C) .
5. Water Source Heat Pump Piping: <Insert psig (kPa)> at 250 deg F (66 deg C) .
6. Glycol Cooling-Water Piping: <Insert psig (kPa)> at 150 deg F (66 deg C) .
7. Makeup-Water Piping: 80 psig (552 kPa) at 150 deg F (66 deg C) .
8. Condensate-Drain Piping: 150 deg F (66 deg C) .
9. Blowdown-Drain Piping: 200 deg F (93 deg C) .
10. Air-Vent Piping: 200 deg F (93 deg C) .
11. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

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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 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) .

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

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

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

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 one of 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.

- a. Victaulic Company.
- a-b. Anvil International - Gruvlok

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2. Grooved-End Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze casting.
3. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 250 deg F (110 deg C) for use with housing, and steel bolts and nuts.

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

D. 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 one of 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.

- a. Viega
- b. NIBCO
2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F (121 deg C).
6. Press-Joint Fittings: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B 16.22 and performance criteria of IAPMO PS 117. Fittings shall be designed such that sealing elements stays properly in its groove and does not roll out when inserting tube. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have a feature that assures leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.

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

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

## 2.3 STEEL PIPE AND FITTINGS

Piping type and fitting material taken from 2008 ASHRAE Systems and Equipment Chapter 45, Table 5.

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- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; Type, Grade, 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. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- F. 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.
- G. Grooved Mechanical-Joint Fittings and Couplings:

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 one of 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.

- a. Victaulic Company.
- a-b. Anvil International - Gruvlok

- 2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, 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.
- 4. All fittings, couplings valves and specialties shall be from a single manufacturer.
- 5. Gasket materials shall be suitable for the intended system service based on material, system chemistry, and an operating temperature of up to 250 deg F.



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6. Select proper gasket material that is compatible with fluid requirements. Gasket Lubricant shall be from the same manufacture as the couplings.
7. Pipe shall be grooved to manufactures recommended specifications. Grooving tools shall be from the same manufacture as the couplings.
8. All couplings shall be the rigid design except as needed or required.
9. All castings shall be date stamped for quality assurance and traceability
10. The Grooved mechanical coupling manufacturer shall have a factory trained field representative to be available to visit the job site. That representative shall provide training for contractor’s field personnel, and view installed product to promote conformance to installation requirements. The name and contact information of that representative should be part of the submittal package.

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#### 2.4 POLYPROPYLENE PIPE AND FITTINGS

##### A. Approved Manufacturers:

1. Aquatherm. Aquatherm “GreenBlue Pipe” PP-R
2. Nupi Americas “Niron”

##### B. Pipe:

1. Pipe shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in a three layer extrusion process. All pipe shall comply with the rated pressure requirements of ASTM F 2389 or CSA B137.11. All pipe shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.

##### C. Fittings:

1. Fittings shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.

##### D. Joining Methods:

1. Plastic to plastic:
  - a. Electrofusion
    - 1) Fittings shall be listed and labeled for the piping system installed.
    - 2) Fittings shall have scannable bar-code for use with an automatic electrofusion machine. Manual timing for this method is prohibited.
  - b. Socket Welding
  - c. Butt Fusion
2. Plastic to steel:
  - a. Steel piping should be avoided when installing a plastic piping system. Elimination of steel piping reduces the need for chemical treatment in the system.
  - b. Steel piping connections shall be large diameter piping only (2-1/2” and larger).
  - c. Flanged connections rated for the working pressure of the system.

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3. Plastic to copper:
  - a. Brass impregnated threaded fittings.

E. Valves:

1. Refer to the PSU valve guideline for valve selection. Plastic valves may be used for general isolation if prior written approval is obtained from PSU Engineering Services.
2. Plastic Valves:
  - a. Valves shall be manufactured in accordance with the manufacturer's specifications and shall comply with the performance requirements of ASTM F 2389 or CSA B137.11. The valves shall contain no rework or recycled thermoplastic materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.

F. Fire and Smoke Ratings:

1. All interior piping above ceiling requires a Plenum-rated Piping System. The plenum rated pipe shall be wrapped with a foil barrier and then insulated with standard pipe insulation, field installed. The pipe wrap and insulation shall meet the requirements of CAN/ULC-S102.2-03 or ASTM E84. The system shall have a Flame Spread Classification of less than 25 and Smoke Development rating of less than 50.

G. Insulation:

1. Glass Fiber:
  - a. Glass fiber is acceptable for use with plastic piping. Due to the overall exterior dimensions of the piping, standard preformed insulation may not fit appropriately in all sizes. Coordinate insulation method prior to installation.
2. Flexible Elastomeric:
  - a. Flexible elastomeric installation is acceptable for use with plastic piping systems only. Due to flame and smoke spread restrictions, insulation thickness must be coordinated to meet both the energy code, as well as safety requirements, and therefor may deviate from the standard insulation thickness schedule.

H. UV Protection:

1. All pipe above the roof level, and all pipe that will be exposed to direct UV light for more than 30 days, shall be provided with a field applied, UV-resistant coating or alternative UV protection.

I. Warranty:

1. Manufacturer shall warrant pipe and fittings for 10 years to be free of defects in materials or workmanship.
2. B. Warranty shall cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or workmanship.

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Pressure seal fittings are for use in plain-end pipe. Penn State uses rolled groove, welded fittings or flanges in connecting plain end piping. Pressure-Seal fittings should only be used in emergency applications, not new installations.

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While there may be a specific project use for plastic or fiberglass piping, Penn State should not promote the installation of these materials within buildings. The consultant can propose the use of these materials where applicable.

~~2-42.5~~ JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents. Maximum operating temperature of 250 deg F.
  - 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.

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

- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. 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.

~~2-52.6~~ 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: shall not be used.

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 one of the following :
  - a. Matco-Norca.
  - b. Watts Regulator Co.

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c. [Zurn Industries, LLC](#).

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: 300 psig (2070 kPa) .
- 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 one of the following :
  - a. [Advance Products & Systems, Inc.](#)
  - b. [Calpico, Inc.](#)
  - c. [Pipeline Seal and Insulator, Inc.](#)

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) .
- c. Gasket: Neoprene or phenolic.
- d. Bolt Sleeves: Phenolic or polyethylene.
- e. Washers: Phenolic with steel backing washers.

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

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 one of the following :
  - a. [Grinnell Mechanical Products.](#)
  - b. [Precision Plumbing Products, Inc.](#)

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- c. Victaulic Company.
- 2. Description:
  - a. Standard: IAPMO PS 66.
  - b. Electroplated steel nipple, 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 250 deg F (107 deg C) .
- d. End Connections: Male threaded or grooved.
- e. Lining: Inert and noncorrosive, propylene.

## 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. Closed-loop hydronic cooling or condenser piping (Chilled Water, Condenser Water, Heat Recovery Run-Around loops, or similar systems), aboveground:
  - 1. NPS 2 (DN 50) and smaller, 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.

- a. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
- b. Type F (CW) – Grade A, or E (ERW) - Grade B, Schedule 40 (STD), 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.
- b-c. Polypropylene, random copolymer polypropylene, PP-R or PP-RCT, Polypropylene (PP-R) piping in SDR 7.4, 9, 11, or 17.6 based on the required

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minimum pressure rating and use temperature, in accordance with manufacturer's instructions and ASTM F2389.

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

2. NPS 2-1/2 (DN 65) thru 10", 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.

- a. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- b. Type E (ERW), Grade B, Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- ~~c.~~ Type E (ERW), Grade B, Schedule 40 (STD) steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- d. Polypropylene, random copolymer polypropylene, PP-R or PP-RCT, Polypropylene (PP-R) piping in SDR 7.4, 9, 11, or 17.6 based on the required minimum pressure rating and use temperature, in accordance with manufacturer's instructions and ASTM F2389.
- ~~e.~~

3. NPS 12" and larger 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.

- a. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- b. Type E (ERW), Grade B, Standard (STD) Weight (0.375" thick) steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- ~~c.~~ Type E (ERW), Grade B, Standard (STD) Weight (0.375" thick) steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- d. Polypropylene, random copolymer polypropylene, PP-R or PP-RCT, Polypropylene (PP-R) piping in SDR 7.4, 9, 11, or 17.6 based on the required minimum pressure rating and use temperature, in accordance with manufacturer's instructions and ASTM F2389.
- ~~e.~~

- B. Closed-loop hydronic heating piping (Heating Hot Water, Dual Temperature, or similar systems), aboveground:

1. NPS 2 (DN 50) and smaller, shall be any of the following:

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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.

- a. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
- b. Type F (CW) – Grade A, or E (ERW) - Grade B, Schedule 40 (STD), 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.

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

2. NPS 2-1/2 (DN 65) thru 10", 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.

- a. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- b. Type E (ERW), Grade B, Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

3. NPS 12" and larger 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.

- a. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- b. Type E (ERW), Grade B, Standard (STD) Weight (0.375" thick) steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

Type E (ERW), Grade B, Standard (STD) Weight (0.375" thick) steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints. Retain "either of" option in first paragraph below to allow Contractor to select piping materials from those retained.

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

- C. Open loop Condenser-water piping, aboveground:
  1. NPS 2 (DN 50) and smaller, shall be any of] the following:

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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.

- a. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
- b. ~~Polypropylene, random copolymer polypropylene, PP-R or PP-RCT, Polypropylene (PP-R) piping in SDR 7.4, 9, 11, or 17.6 based on the required minimum pressure rating and use temperature, in accordance with manufacturer's instructions and ASTM F2389.~~
- a. \_\_\_\_\_

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

2. NPS 2-1/2 (DN 65) thru 10" 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.

- a. Type E (ERW), Grade B, Schedule 40, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- b. Type E (ERW), Grade B, Schedule 40, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- c. ~~Polypropylene, random copolymer polypropylene, PP-R or PP-RCT, Polypropylene (PP-R) piping in SDR 7.4, 9, 11, or 17.6 based on the required minimum pressure rating and use temperature, in accordance with manufacturer's instructions and ASTM F2389.~~
- b. \_\_\_\_\_

3. NPS 12" (DN 65) and larger, 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.

- a. Type E (ERW), Grade B, Standard (STD) Weight (0.375" thick) steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- b. Type E (ERW), Grade B, Standard (STD) Weight (0.375" thick) steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- c. ~~Polypropylene, random copolymer polypropylene, PP-R or PP-RCT, Polypropylene (PP-R) piping in SDR 7.4, 9, 11, or 17.6 based on the required minimum pressure rating and use temperature, in accordance with manufacturer's instructions and ASTM F2389.~~
- b. \_\_\_\_\_



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

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

D. Makeup-water piping installed aboveground shall be 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) , drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

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

E. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

F. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

G. 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.~~ ~~2.~~ Outlet: Type K (Type A), annealed-temper copper tubing with soldered or flared joints.

H. 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.

### 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. Contractor is responsible for coordination with other trades and systems.

C. Piping shall be located as close as possible to the location shown on the drawings. Should conflicts or unforeseen conditions arise, the contractor shall either submit a proposed alternate routing for approval, or contact the Engineer for further direction.

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- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Piping shall not pass exposed through electrical rooms or be erected over any switchboard or other electrical gear.
  - 1. Where conflicts are unavoidable, stainless steel drain pans with drain lines piped to an approved waste receptor may be provided, pending written approval from the Owner.
- F. 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.
- G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- H. No pipe shall pass in front of or interfere with any openings, door or window. Head room in front of openings and doors shall in no case be less than the top of the opening.
- I. Install piping to permit valve servicing.
- J. Install piping free of sags and bends.
- ~~K.~~ Install fittings for changes in direction and branch connections.
  - ~~K.1.~~ All branch connections to main shall include isolation valves, supply strainer with service valves, and balancing valves as coordinated per engineer's balancing plan.
- L. Install piping to allow application of insulation. Provide 2-inch clearance between insulated piping and other obstructions.
- M. Unions:
  - 1. No union shall be placed in a location which will be inaccessible.
  - 2. Unions, grooved, or flanged fittings shall be installed adjacent to all equipment for repair and replacement. Installation of fitting must facilitate maintenance and removal access without dismantling or draining the piping system beyond the equipment isolation valves. Select system components with pressure rating equal to or greater than system operating pressure.
- N. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- O. Install manual air vents at all locations that form local air traps to facilitate system fill.
- P. Install automatic air vents with isolation valve at the highest point in each system. Air vent shall be rated for the system temperature, pressure and water chemistry. Where feasible, automatic air vents installed in glycol systems must be routed to the main recovery tank.
- Q. All piping shall be arranged to completely drain the system. Drain locations shall be located at all system low points. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short

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NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

- R. Reduced pressure principal back flow preventers shall be installed on all make-up water lines.
- S. Bull-heading tee connections are prohibited. Main fluid flows shall not enter the side of a tee fitting and then diverge.
- T. Correct leaks in piping immediately, using new materials. Leak-sealing compounds or preening is not permitted.
- U. Install piping at a uniform grade of 0.2 percent, upward in direction of flow for supply, downward in direction of flow for return.
- V. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
- W. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the top of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- X. Install valves according to other specification section for General-Duty Valves for HVAC Piping.
- Y. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Z. Install flanges or grooved fittings in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
- AA. Install shutoff valve immediately upstream of each dielectric fitting.
- BB. 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.
- CC. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- DD. 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.

- EE. 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."
- FF. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

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### 3.3 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing. Electrolysis control between dissimilar materials shall be achieved through the use of dielectric nipples and a non-dielectric union. Dielectric unions shall not be used.
- B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples .
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100) : Use dielectric nipples.
- D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

### 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.
- B. 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.
- C. Maximum copper and steel piping hanger spacing shall be per the latest version of the International Mechanical Code.
- D. 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.
- E. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

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### 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. 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.
- E. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
  - 1. Schedule 40 pipe shall not be welded with less than three (3) passes including one stringer/root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four (4) passes including one stringer/root, two filler and one lacer. In all cases, however, the weld must be filled before the cap weld is added.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

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

- G. Grooved Joints:
  - 1. General: All grooved piping shall be installed and supported in strict adherence to the grooved manufactures latest written installation and pipe supporting instructions. No exceptions. 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. Add cleaning type, lubricant type, etc.
  - 2. **Prohibited Applications:**
    - a. Grooved joints shall be prohibited on hot water heating systems.
    - b. Grooved joints shall be prohibited on any piping to be installed in tight enclosures or other inaccessible locations that would make inspection or repairs impractical or impossible without demolition of other construction.
    - c. The following grooved joint fittings and accessories are prohibited:
      - 1) Flange adaptors (Victaulic styles 741 or similar) designed for attaching a flange connection with a gasket to the end of a grooved pipe system.

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Instead, use a regular solid flange adaptor nipple with a length of pipe with a grooved end.

- 2) Abrupt reducing couplings. Use smooth transition reducer fittings, concentric or eccentric as applicable.
- 3) Butterfly valves with elastomer encapsulated discs.
- 4) Butterfly valves with elastomer seats that cannot be replaced.
- 5) Assemblies of multiple flexible couplings and pipe nipples intended as flexible pipe connector or expansion joints.

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

H. Pressure-Sealed Joints:

1. Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.
2. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. Copper press fittings shall be installed using the proper tools, actuator, jaws and rings as instructed and approved by the press fitting manufacturer.
3. Installer shall be a qualified installer, licensed within the jurisdiction, and familiar with the installation of copper press joint systems.
4. Follow all installation instructions of manufacturer of press-joint fitting to ensure quality, leak-tight seal. To prevent distortion of the pipe, be sure to stringently maintain the minimum distance between fittings depending on tubing diameter as directed by manufacturer. Failure to provide this distance may result in an improper seal, and installer shall be held liable for all associated costs of required repairs.
5. The installing contractor shall insure that sealing elements are properly in place and free from damage. For Sizes 2-1/2" to 4", installer should insure that the stainless steel grip ring is in place.
6. Provide unions and arrangement of sufficient length of removable sections of tubing at valves and equipment connections to allow for easy removal and reinstallation for repairs without having to redo press connections.

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I. FUSION WELDING OF JOINTS

1. Install fittings and joints using socket-fusion, electrofusion, or butt-fusion as applicable for the fitting or joint type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
2. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
3. Prior to joining, the pipe and fittings shall be prepared in accordance with F 2389 and the manufacturer's specifications.
4. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.

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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. 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."
- C. Provide unions and arrangement of sufficient length of removable sections of tubing at valves and equipment connections to allow for easy removal and reinstallation for repairs without having to redo press connections.
- D. Make piping connections to coils and equipment with offsets provided with screwed or flanged unions so arranged that the equipment can be serviced or removed without dismantling the piping. Do not screw unions directly to coil or tube header piping connections.

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3.7 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. Grooved, mechanical joint fittings and couplings:
    - a. ~~A manufacturer's factory trained inspector (direct employee) shall visit the job site and review grooved joint products installation. The installing contractor shall remove and replace any improperly installed products.~~
    - b. ~~2. Upon completion of the manufacturer's inspection of the installation, the manufacturer will supply the owner with an extended warranty.~~
      - 1) ~~<10> years.~~
    - c. ~~3. All grooved components shall conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-31.9, ASME, UL/ULC, FM, IAPMO or BOCA.~~
  - a. ~~A minimum of 5% of pipe grooves must be inspected by the owner or manufacturer's representative. Sample selection must represent each major piping branch and terminal device type in the system. Documentation of inspection shall be submitted with the project closeout documentation.~~
  - b. ~~Inspected connections shall be tagged with a brass valve tag viewable after insulation is installed.~~
- 3. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
- 4. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
- 5. All hot and chilled water systems shall be chemically cleaned after all items of equipment have been connected to the system and all piping has been completed. Cleaning shall be done prior to installing chemical treatment or glycol, and prior to acceptance by the University. See 23 25 00 for ~~more information~~cleaning requirements:

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OPP Specification Guideline  
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- a. Notify the University at least one week in advance of the date and time that system cleaning is to take place. The University or designated representative shall observe the system cleaning process.
6. 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.
- ~~7.~~ 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.
- ~~8.~~ Fire stopping shall be provided to both be compatible with the Aquatherm Piping and meet the requirements of ASTM E 814 or ULC S115, "Fire Tests of Through-Penetration Firestops". Pipe insulations or fire resistive coating shall be removed where the pipe passes through a fire stop and, if required by the firestop manufacturer, for 3 inches beyond the firestop outside of the fire barrier.
- ~~7.9.~~

B. Perform the following tests on steel and/or copper 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, or 100 psi, whichever is greater. 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 successfully applied for at least ~~10 minutes~~2 hours, contact owner's representative for 15 minute inspection period.~~e~~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, with owner's representative signature verifying 15 minutes with zero pressure loss.

C. Perform the following tests of polypropylene piping:

- ~~1.~~ While still accessible all piping shall be pressure/leak tested to the manufacturer's standards. Tests shall be carried out using water. The test pressure shall be 1.5 times the operating pressure or 100 psi, whichever is greater. Any leaks detected shall be repaired at the contractor's expense by removing the leaking part and replacing with new parts welded per the pipe manufacturer's guidelines.
- ~~2.~~ Pressure testing listed above is based on minimum performance of the piping system, which may require pressures up to 150 psi. The contractor is obligated to test the system per the manufacturer's requirements to achieve full system warranty.
- ~~6.~~

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C.D. 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.

END OF SECTION 232113