SECTION 232113 – HVAC PIPING SYSTEMS AND SPECIALTIES

Latest Update: 12-17-2021 See Underlined Text for Edits.

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off "Underlines".)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes the requirements for HVAC pipe and specialties above ground within the building, below grade to five (5) feet outside the building and includes the following: <Delete piping and specialties not applicable to this project>

1. Steel water pipe and fittings.
2. Copper water pipe and fittings.
3. Refrigerant pipe and fittings.
4. Joining materials.
5. Dielectric connections.
6. Air control devices.
7. Hydronic piping specialties.
8. Refrigerant specialties.
9. Pressure regulators – natural gas.
10. Steam traps.
11. Flexible connectors.
12. Cleaning and flushing.

1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, and warranty information.

B. LEED Submittals: <Delete if not a LEED project>

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
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. Delegated-Design Submittal: <Delete if not required for this project>

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

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:

B. Suspended ceiling components.

1. Other building services.
2. Structural members.

C. Qualification Data: For Installer.

D. Welding certificates.

E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

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. 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.

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. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

E. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

F. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

G. ASME Compliance: Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.7 FIELD CONDITIONS

A. Interruption of Existing HVAC Systems: Interruption of HAVC systems in facilities occupied by Owner or others shall not be permitted unless approved by CM and UMB – PM. under the following conditions and then only after arranging to provide temporary HVAC services according to requirements indicated:

1. Notify the Construction Manager and the no fewer than five (5) days in advance of proposed interruption of the HVAC systems.
2. Do not interrupt HVAC services without Construction Manager's written permission.

1.8 WARRANTY/GUARANTEE

A. See Division 23, Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Material Design and Selection: HVAC water pipe, fittings, and specialties shall be designed and selected, for the intended use, in accordance with the sizes on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Acceptable manufacturers shall be as follows:

1. Steel Piping Systems: All steel pipe and fittings shall be by one (1) manufacturer.

   a. Pipe: Mueller Industries, Wheatland Tube Company.
   b. Grooved Pipe: Victaulic.
   c. Fittings: Anvil, Victaulic.

2. Copper Tube Piping Systems:

   a. Solder Joint Copper Tube and Fittings: All copper tube and/or fittings for solder joint application shall be by one manufacturer.

      1) Mueller Industries

   b. Press Type Copper Piping Systems: The basis of design is Viega ProPress copper piping system. Other acceptable manufacturers are:

      1) Elkhart Products Corporation – Apollo XPress.

3. Dielectric Connections:

   a. Flanges: Watts, Zurn and Capitol Manufacturing Company.
   b. Insulating Kits: Pipeline Seal and Insulator Company, Calpico, Inc.

4. Air Control Devices:

   a. Manual Air Vents: Armstrong, Bell and Gossett, Hoffman.
   b. Automatic Air Vents: Armstrong, Bell and Gossett, Hoffman.
   c. Bladder Type Expansion Tanks: Amtrol, Taco and Bell and Gossett.
   d. Air Separator: Amtrol, Taco and Bell and Gossett.
   e. Air Purge: Amtrol, Taco and Bell and Gossett.

5. Hydronic Specialties:

   a. Y Strainers: Mueller, Spirax Sarco, Hoffman, and Armstrong.
   b. Basket Strainers: Mueller, Spirax Sarco, Hoffman, and Armstrong.
   c. Pump Suction Diffusers: By the pump manufacturer.

6. Natural Gas Pressure Regulator:

   a. Service Pressure Regulators: American Meter Company, Fisher Control Valves and Regulators and Richards Industries.
   b. Line Pressure Regulator: American Meter Company, Fisher Control Valves and Regulators and Richards Industries.

c. Appliance Pressure Regulator: Canadian Meter Company, Eaton Corporation – Controls Division, Harper Wyman Company.

7. Stream Traps:

a. F & T Traps: Mueller, Spirax Sarco, Hoffman, and Armstrong.
b. Inverted Bucket Traps: Mueller, Spirax Sarco, Hoffman, and Armstrong.

8. Flexible Connectors: Metraflex Corporation or approved equal

2.2 HVAC PIPE MATERIAL APPLICATION

A. General Application: All pipe, fittings and joint methods shall be as specified below:

B. HVAC Pipe Material Application Schedule:

Pipe System	Pipe Material	Fitting Material	Joint Material
Campus Chilled Water Loop Piping	Steel Pipe 2-1/2 inch to 12 inch: ASTM A53, Grade B, Schedule 40, black steel pipe covered with filament wound, polyester reinforcement composite directly applied to the pipe	2-1/2 inch to 12 inch; ASTM A234, butt welded, long radius ells, and weld o lets. Flanges: ANSI B 16.5, weld neck, raised faced with gaskets. All fittings shall be jacketed in a chopped spray up polyester resin/fiberglass reinforcement composite directly applied to the pipe. The minimum thickness shall be 0.085 inches	Welded: Latest revision of Section IX, ASME Boiler Pressure Vessel Code, Filler material per AWS D10.12.
Campus Chilled Water Loop Piping	Steel Pipe 14 inch and up: ASTM A53, Grade B, Standard Weight, black steel pipe covered with a filament wound polyester resin/fiberglass reinforcement composite directly applied to the pipe.	14 inch and up; ASTM A234, butt welded, long radius ells, and weld o lets. Flanges: ANSI B 16.5, weld neck, raised faced with gaskets. All fittings shall be jacketed in a chopped spray up polyester resin/fiberglass reinforcement composite directly applied to the pipe. The minimum thickness shall be 0.085 inches	Welded: Latest revision of Section IX, ASME Boiler Pressure Vessel Code, Filler material per AWS D10.12.

Pipe System	Pipe Material	Fitting Material	Joint Material
Heating Water, Chilled Water, Process Water, Condenser Water, Glycol Solution Systems	2 inch and Smaller: Copper Tube: ASTM B88, Type 'L', Seamless, Water Tube, hard drawn temper.	2 inch and Smaller: Copper Tube: ASTME B16.22, wrought copper or copper alloy solder joint, 150 lb.	Soldered: ASTM B32, alloy Sb5 (95 percent tin, and 5 percent antimony), with 0.2% maximum lead content
		1/2 inch to 2 inch Viega ProPress copper fittings with EPDM seals. (Contractor Option)	Viega ProPress connection with EPDM sealing element. (Contractor Option)
	2-1/2 inch to 4 inch: Copper Tube: ASTM B88, Type 'L', Seamless, Water Tube, hard drawn temper (Contractors Option)	2-1/2 inch to 4 inch Viega ProPress XL-C copper fittings with EPDM seals. (Contractor Option)	Viega ProPress connection with EPDM sealing element. (Contractor Option)
Heating Water, Chilled Water, Process Water, Condenser Water, Glycol Solution Systems	2-1/2" and Larger: Steel Pipe: ASTM A53, Grade B, Schedule 40, black steel	2-1/2" and Larger: Steel; ASTM A234, butt welded, long radius ells, and weld o lets. Flanges: ANSI B 16.5, weld neck, raised faced with gaskets.	Welded: Latest revision of Section IX, ASME Boiler Pressure Vessel Code, Filler material per AWS D10.12.
	Pipe: 2-1/2 inch to 12 inch: Victaulic rolled grooved end schedule 40 black steel pipe, 150 lb. ANSI Class, ASTM F-1476 by Victaulic Corp. USA. (Contractors Option)	Fittings: Ductile Iron Grooved End Fittings for Elbows, Tees, Increasers, Reducers, 'Y' Fittings, conforming to ASTM A - 395, grade 65-45-15 (Contractors Option)	Joints: Vic Style 07 Zero - Flex Rigid Ductile Iron couplings with Grade 'E' EPDM gasket material, Carbon Steel Nuts and Bolts, conforming to ASTM A-395, Grade 65-45-15, ASTM A - 183. Vic Flange Adapters: Vic Style 743, Ductile Iron, conforming to ASTM A -536, grade 65-45-12. (Contractors Option)

Pipe System	Pipe Material	Fitting Material	Joint Material
Heating Water, Chilled Water, Process Water, Condenser Water, Glycol Solution Systems	Steel Pipe 14 inch and up: ASTM A53, Grade B, Standard Weight, black steel pipe	14" and up; ASTM A234, butt welded, long radius ells, and weld o lets. Flanges: ANSI B 16.5, weld neck, raised faced with gaskets	Welded: Latest revision of Section IX, ASME Boiler Pressure Vessel Code, Filler material per AWS D10.12.
Condenser Water Piping exposed to the atmosphere	All Piping: FRP Red Thread II Pipe with flanges, ANSI B 16.5 by Smith Fiberglass or approved equal unless otherwise noted.	All Fittings: match the pipe material using either compression molded or spray up/contact molded method. Field Installed Flanges: gasketed and accessed per ASTM A307	All Joints: Provide adhesive bonded matched tapered bell and spigot or flanged.
Condenser Water Equalizing Line and Tower and System Drain Piping	All Piping: 2 inch to 16 inch, Schedule 80 PVC Pipe with plain ends ASTM D 1784, ASTM D 1785, by Charlotte Pipe or equal	All Fittings: match the pipe material using either threaded connections or molded connections.	All Joints: Provide threaded, cemented or flanged joints.

Pipe System	Pipe Material	Fitting Material	Joint Material
Steam, Steam Condensate, Steam Drains, and Steam Vents	Steel Pipe: 2 inch and Smaller: ASTM A53, Grade B, Schedule 80, black steel	2 inch and Smaller: Malleable Iron Threaded: ANSI B 16.3, Class 150. Threads per ANSI b.1.20.1 and thread-o-lets.	Threaded: American Standard for Pipe Threads ANSI B2.1
		2-1/2 inch and Larger: Steel; ASTM A234, butt welded, long radius ells, and weld o lets. Flanges: ANSI B 16.5, weld neck, raised faced with gaskets.	Welded: Latest revision of Section IX, ASME Boiler Pressure Vessel Code, Filler material per AWS D10.12.
Natural Gas: (Non – Laboratory Use)	Steel Pipe: 3 Inch and Smaller: ASTM A53, Grade B, Schedule 40, black steel.	3 Inch and Smaller: Malleable Iron Threaded: ANSI B 16.3, Class 150. Threads per ANSI b.1.20.1 and thread-o-lets.	Threaded: American Standard for Pipe Threads ANSI B2.1
		3 inch and Larger: Steel; ASTM A234, butt welded, long radius ells, and weld o lets. Flanges: ANSI B 16.5, weld neck, raised faced with gaskets.	Welded: Latest revision of Section IX, ASME Boiler Pressure Vessel Code, Filler material per AWS D10.12.
		3 Inch and Smaller: Viega Mega Press G Carbon Steel Fittings with HNBR seals. (Contractor Option)	Press connection with HNBR sealing element. (Contractor Option)

Note: Natural Gas Piping System (NGPS) in HSF-3: The existing NGPS in HSF-3 is a Viega Copper ProPress G Piping System which is no longer available from Viega. All new piping must comply with the application schedule above and paragraph 2.3 below.

Pipe System	Pipe Material	Fitting Material	Joint Material
Compressed Air (Non – Laboratory Use)	Copper Tube: 1/2 inch and Larger: ASTM B280, 'ACR' Type 'L', Seamless, hard drawn soft annealed seamless, factory cleaned and capped prior to shipping.	Copper Tube: ASTME B16.22, wrought copper or copper alloy solder joint, 200 lb	Brazed: AWS A5.8, Classification BCuP-3 (Silver) filler material.
Air Conditioning Condensate and Equipment Drains	Copper Drainage Tube; DWV, ASTM B306	Wrought copper and Bronze drainage fittings, ASNI B16.29	Soldered: ASTM B32, alloy Sb5 (95 percent tin, and 5 percent antimony), with 0.2% maximum lead content
Refrigerant Piping System	Copper Tube: ASTM B280, 'ACR' Type 'L', Seamless, hard drawn soft annealed seamless, factory cleaned and capped prior to shipping.	ASNI B16.22, wrought copper fittings.	Brazed: AWS A5.8, Classification BCuP-3 Brazed (Silver) filler material.

2.3 COPPER TUBE FITTINGS

A. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.

1. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
2. 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 230°F for use with housing, and steel bolts and nuts.

B. Copper or Bronze Pressure-Seal Fittings:

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

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

E. Natural Gas Piping System (NGPS) in HSF-3: Provide the following fittings for new connections to existing piping:

1. Piping Two (2) Inch and Smaller: Provide a Viega Copper Adapter Model 2911.1ZL with a male thread end and a solder end.

2. Piping Two and One Half (2) Inch and Larger: Provide flanged connections with a solder end connection and a threaded end or plain connection and approved gasket material for natural gas service.
3. See Execution Part 3 for installation requirements.

2.4 STEEL PIPE FITTINGS

A. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

B. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

C. 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.

D. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

E. 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.

F. Grooved Mechanical-Joint Fittings and Couplings:

1. 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.
2. Couplings: Ductile- or malleable-iron housing and [EPDM] [or] [nitrile] gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

G. Steel Pressure-Seal Fittings:

1. Housing: Steel.
2. O-Rings and Pipe Stop: EPDM.
3. Tools: Manufacturer's special tool.
4. Minimum 300-psig working-pressure rating at 230°F.

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

2.5 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, one eighth (1/8) inch maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

C. 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.

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

2.6 DIELECTRIC CONNECTIONS

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 Connections: Provide dielectric connections where nonferrous metal is joined to ferrous metal as follows:

1. Piping Two (2) Inch and Smaller: Provide Schedule 40 unlined type 316 stainless steel nipples, four (4) inches long with thread ends.

2. Piping Two and One Half (2-1/2) Inch and Larger: Provide Type ‘E’ Full Flanged Isolation Gasket Kits with Dialectic Insulators for the pipe flanges. End connections to match piping systems.

a. Pressure Ratings:
1) Hydronic Pressure Rating: 125 psig minimum at 180°F.
2) Steam Pressure Rating: 150 psig minimum at 225°F.

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

2.7 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225°F.

B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240°F.

C. Diaphragm Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375°F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. Tangential-Type Air Separators:

1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375°F maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
4. Blowdown Connection: Threaded.

5. Size: Match system flow capacity.

E. Air Purgers:

1. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
2. Maximum Working Pressure: 150 psig.
3. Maximum Operating Temperature: 250°F.

2.8 HYDRONIC PIPING SPECIALTIES

A. Pipe Flange Gasket Materials - Not Steam Systems: Suitable for the chemical and thermal conditions of the piping system contents:

1. ASME B16.21, nonmetallic, flat, asbestos free, one eighth (1/8) inch (3mm) maximum thickness, except where thickness or specific material is 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.

2. ASME B16.20 for grooved, ring-joint, steel flanges.
3. AWWA C110, rubber, flat face one eighth (1/8) inch (3 mm) thick, except where other thickness are indicated, and full-face or ring type, except where type is indicated.

B. Pipe Flange Gasket Materials - Steam Systems:
1. ASTM B16, metallic, raised face, spiral wound 304 stainless steel Grafoil Filler API Standard 601 Class to match flange.

C. Flange Bolts and Nuts:

1. Non-Steam Systems: ASME B18.2.1, carbon steel, except where other material is indicated.
2. Steam Systems: ASTM A193, B7, Hex Head Bolts; ASTM A194, 2H, Hex Nuts.

D. Unions: ANSI B16.39, Class 150, malleable iron; female pattern; brass to iron seat; ground joint. Threads shall conform to ANSI B1.20.1.

E. Y-Pattern Strainers:

1. Non-Steam and Condensate (Copper Piping two (2) inch and smaller)

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mueller Model 352M or comparable product by one (1) of the acceptable manufacturers.

b. Body: ASTM A 126, Class B, cast bronze body with bolted cover and bottom drain connection.
c. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
d. Strainer Screen: 304 Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
e. CWP Rating: 125 psig.
f. Blow-down drain with plugged valve and threaded hose connection

2. Non-Steam and Condensate (Copper Piping two and one half (2-1/2) inch and larger)

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mueller Model 758, or comparable product by one (1) of the acceptable manufacturers.
b. Body: ASTM A 126, Class B, cast iron body with bolted cover and bottom drain connection.
c. End Connections: Flanged ends for NPS 2-1/2 and larger.
d. Strainer Screen: 304 Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket. Screens for four (4) inch strainers shall have .062 size perforated openings. Screen for five (5) inch and larger strainers shall have .125 perforated openings.
e. Blow-down drain with plugged valve and threaded hose connection
f. CWP Rating: 200 psig.

3. Non-Steam and Condensate (Steel Piping two and one half (2-1/2) inch and larger)

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mueller Model 758, or comparable product by one (1) of the acceptable manufacturers.
b. Body: ASTM A 126, Class B, cast iron body with bolted cover and bottom drain connection.
c. End Connections: Flanged ends for NPS 2-1/2 and larger.
d. Strainer Screen: 304 Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket. Screens for four (4) inch strainers shall have .062 size perforated openings. Screen for five (5) inch and larger strainers shall have .125 perforated openings.
e. Blow-down drain with plugged valve and threaded hose connection
f. CWP Rating: 200 psig.

4. Steam and Condensate (Steel Piping one half (1/2) inch to two (2)inch)

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mueller Model 11M, or comparable product by one (1) of the acceptable manufacturers.
b. Body: ASTM A 126, Class B, cast iron body with bolted cover and bottom drain connection.
c. End Connections: Flanged ends for NPS 2-1/2 and larger.
d. Strainer Screen: 304 Stainless-steel, 30-mesh strainer, or perforated stainless-steel basket. Screens for four (4) inch strainers shall have .062 size perforated openings. Screen for five (5) inch and larger strainers shall have .125 perforated openings.
e. Blow-down drain with plugged valve and threaded hose connection
f. CWP Rating: 250 psig.

5. Steam and Condensate (Steel Piping one half (1/2) inch to two (2) inch and larger)

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mueller Model 752, or comparable product by one (1) of the acceptable manufacturers.
b. Body: ASTM A 126, Class B, cast iron body with bolted cover and bottom drain connection.
c. End Connections: Flanged ends for NPS 2-1/2 and larger.
d. Strainer Screen: 304 Stainless-steel, 30-mesh strainer, or perforated stainless-steel basket. .045 perforated openings.
e. Blow-down drain with plugged valve and threaded hose connection
f. CWP Rating: 250 psig.

F. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: flanged ends for NPS 2-1/2.
3. Strainer Screen: 40-mesh startup strainer, and perforated 304 stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.
5. Blow-down drain with plugged valve and threaded hose connection

G. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250°F.

H. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250°F.

I. Expansion Fittings: Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping. Section "Expansion Fittings and Loops for HVAC Piping."

J. Diverting Fittings: cast iron body with threaded ends or wrought copper with solder ends; 125 psig working pressure, 250ºF maximum operating temperature. Indicate flow direction on fitting.

K. Pump Suction Diffusers:

1. Provide as manufactured by the pump manufacturer.
2. Cast-iron body, with threaded connections for two (2) inch and smaller, flanged connections for two and one half (2-1/2) inch and larger; 175 psig working pressure, 300ºF maximum operating temperature; and complete with the following features:
   a. Inlet vanes with length two and one half (2-1/2) times pump suction diameter or greater.
   b. Cylinder strainer with three sixteenths (3/16) inch diameter openings with total free area equal to or greater than five (5) times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
   c. Disposable fine start-up mesh strainer to fit over cylinder strainer.
   d. Permanent magnet, located in flow stream, removable for cleaning.
   e. Adjustable foot support, designed to carry weight of suction piping.
   f. Blow-down tapping in bottom; gage tapping in side.

2.9 REFRIGERANT SYSTEM SPECIALTIES

A. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275°F.

B. Moisture/Liquid Indicators:

1. Body: Forged brass.

2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240°F.

C. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Retain first subparagraph below for heat pumps.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Retain first subparagraph below for suction-line filter dryers.
8. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
9. Maximum Pressure Loss: [2 psig] <Insert value>.
10. Rated Flow: <Insert tons.>
11. Working Pressure Rating: 500 psig.
12. Maximum Operating Temperature: 240°F.

D. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Retain first subparagraph below for heat pumps.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Retain first subparagraph below for suction-line filter dryers.
8. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
9. Maximum Pressure Loss: [2 psig] <Insert value>.
10. Rated Flow: <Insert tons.>
11. Working Pressure Rating: 500 psig.
12. Maximum Operating Temperature: 240°F.

2.10 PRESSURE REGULATORS NATURAL GAS

A. General Requirements:

1. Single stage and suitable for natural gas.

2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Overpressure protection device is optional feature. See Evaluations.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150% of design discharge pressure at shutoff.
9. Overpressure protection device is optional feature. See Evaluations.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: [2 psig] [5 psig] [10 psig] <Insert pressure>.

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Body and Diaphragm Case: Die-cast aluminum.

2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber.
5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
8. Maximum Inlet Pressure: [1 psig] [2 psig] [5 psig] <Insert pressure>.

2.11 STEAM TRAPS

A. Float and Thermostatic Traps:

1. Body and Bolted Cap: ASTM A 126, cast iron.
2. End Connections: Threaded.
3. Float Mechanism: Replaceable, stainless steel.
4. Head and Seat: Hardened stainless steel.
5. Trap Type: Balanced pressure.
6. Thermostatic Bellows: Stainless steel or monel.
7. Thermostatic air vent capable of withstanding 45°F of superheat and resisting water hammer without sustaining damage.
8. Retain "Vacuum Breaker" Subparagraph below for optional vacuum breaker.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless-steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.
11. Select trap with a 3:1 safety factor

B. Inverted Bucket Traps:

1. Body and Cap: Cast iron.
2. End Connections: Threaded.
3. Head and Seat: Stainless steel.
4. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
5. Bucket: Brass or stainless steel.
6. "Strainer" and "Air Vent" subparagraphs below are optional features for inverted bucket traps.
7. Strainer: Integral stainless-steel inlet strainer within the trap body.
8. Air Vent: Stainless-steel thermostatic vent.
9. Pressure Rating: 250 psig.

2.12 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellows, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of three quarter (3/4) inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250°F.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

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

M. Install piping at a uniform grade of 0.2 % upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch pipe connections off the top of the main pipe or on a 45-degree upward angle. Branch connections off the bottom of the main pipe are not acceptable.

P. Install valves according to Division 23 Specification Section "Valves for HVAC Piping Systems."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Comply with requirements in Division 23 Specification Section "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

U. Comply with requirements in Division 23 Specification Section "Identification for HVAC Piping and Equipment" for identifying piping.

V. Install pipe sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Specification Section "Sleeve, Sleeve Seals and Escutcheons for HVAC Piping."

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

W. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Specification Section "Sleeve, Sleeve Seals and Escutcheons for HVAC Piping."

3.2 NON LABORATORY NATURAL GAS PIPING ISTALLATION

<Edit for project or delete if not required>

A. General: Conform to the requirements of NFPA 54 - National Fuel Gas Code.
B. Concealed Locations: Except as specified below, install concealed gas piping in an air-tight conduit constructed of Schedule 40, seamless black steel with welded joints. Vent conduit to the outside and terminate with a screened vent cap.

C. Drips Legs: Install a drip leg at points where condensate may collect, at the outlet of the natural gas meter, and in a location readily accessible to permit cleaning and emptying. Do not install drips where condensate is likely to freeze.

1. Construct drips and sediment traps using a tee fitting with the bottom outlet plugged or capped. Use a minimum of three (3) pipe diameters in length for the drip leg. Use same size pipe for drip leg as the connected pipe.

D. Install natural gas piping at a uniform grade of one quarter (1/4) inch in fifteen (15) feet, upward in direction of the risers.

E. Pipe Joint Construction:

1. Threaded Joints: Refer to NFPA 54, for guide for number and length of threads for field threading steel pipe.

F. Terminal Equipment Connections:
1. Install shut-off valve upstream and within six (6) feet of gas appliance. Install a union or flanged connection downstream from the gas cock to permit removal of controls.
2. Drip Legs: Install a tee fitting with the bottom outlet plugged or capped as close to the inlet of the gas appliance as practical. Drip leg shall be a minimum of three (3) pipe diameters in length.

G. Flexible pipe connections shall not be permitted. All connections shall be hard piped.

H. Natural Gas Piping System (NGPS) in HSF-3: Where parts of the existing NGPS in HSF-3 require new pipe connections comply with the following:

1. Piping Two (2) Inch and Smaller: Install a Viega propress adapter with a solder connection on one end and a male threaded connection on the other end.

a. Locate the adapter at least one and one half (1-1/2) pipe diameters away from the nearest pipe coupling and/or fitting.
b. Adapter Solder End: Braze the solder end of the adapter to the NGPS copper pipe in accordance with ANSI LC-4/CSA 6.32.
c. Adapter Threaded End: Provide a short section of black steel pipe with a female thread end on one end and a plan end on the other end. Connect the threaded end to the adapter and connect a carbon steel pipe coupling to the plan end.
d. Prior to brazing the adapter to the copper pipe wrap the nearest coupling and/or fitting with wet towels to prevent damage to the seals.

2. Piping Two and One Half (2) Inch and Larger: Install flanged connections to connect new black steel piping to the existing copper piping complying with the following:

a. Locate the solder end flange connection at least one and one half (1-1/2) pipe diameters away from the nearest pipe coupling and/or fitting.

b. Solder End Flange: Braze the solder end of the flange to the NGPS copper pipe in accordance with ANSI LC-4/CSA 6.32.
c. Install an approved gasket material for natural gas between the two flanges.
d. Threaded End Flange: Bolt to solder end flange and gasket. Connect new piping to thread end.
e. Plain End Flange: Bolt to solder end flange and gasket. Connect new piping to plain end with carbon steel fillings. (contractor option)

3.3 DIELECTRIC CONNECTION INSTALLATION

A. Install dielectric connections where piping of dissimilar metals and tubing are joined.

B. Dielectric Fittings for NPS 2 and Smaller: Use stainless steel threaded nipples.

C. Dielectric Fittings for NPS 2-1/2 and Larger: Use dielectric flange kits.

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section "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. Comply with requirements in Division 23 Specification Section "Vibration and Seismic Controls for HVAC" for seismic restraints.

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. 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.

I. 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 a ball valve around control valve. If parallel control valves are installed, only one (1) bypass is required.

D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Division 23 Specification Section "Meters and Gauges for HVAC Piping."

3.7 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from air separator, or air purger to expansion tank with a 2% upward slope toward tank.

<Retain one of first two paragraphs below according to air separator specified in Part 2.>

D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.

E. Install tangential air separator in pump suction. Install blowdown piping with full port ball valve; extend full size to nearest floor drain.

<Retain one of two paragraphs below.>

F. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.
2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

G. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

3.8 STEAM AND CONDENSATE PIPING SPECIALTIES INSTALLATION

A. Comply with requirements in Section "Steam and Condensate Piping Specialties" for installation requirements for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

3.9 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and 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 vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

3.10 REFRIGERANT SPECIALTY APPLICATIONS

A. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

B. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Edit list below for equipment required for Project.
2. Solenoid valves.
3. Thermostatic expansion valves.
4. Hot-gas bypass valves.
5. Compressor.

C. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

D. Consult refrigeration equipment manufacturer to determine the need for a receiver.

E. Install receivers sized to accommodate pump-down charge.

F. Install flexible connectors at compressors.

3.11 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. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

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

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

G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

H. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

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

3.12 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high and low pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in process cooling water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

3.13 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. 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.
4. 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:

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 ten (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.

3.14 CLEANING AND FLUSHING

A. General Requirement: The contractor shall secure the services of the water treatment company that is under service contract to UMB, to clean, flush and add chemical treatment to new piping systems that are required to be connected to existing piping systems serving the building or campus. The cost for labor and material for this work must be included in the contractors bid price. The contractor shall be responsible for the scope of work for the UMB water treatment company.

B. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris; repair damaged finishes, including chips, scratches, and abrasions.

C. Before adding chemicals to the system, isolate coils for heating and cooling equipment, and open bypasses.

D. Flushing portions of the system:

1. After a piping loop has been completed and prior to the installation of strainer baskets, flush that portion of the system. Connections shall be same size as piping being flushed, or one size smaller.
2. When a major section of the building has been completed, repeat the same procedure, except that pipe connections shall be limited to one and one half (1-1/2) inch.
3. Flushing shall remove sediment, scale, rust and other foreign substances.
4. After flushing, install strainers and pressure test system and make it tight.

E. Flushing building system: After the various portions of the piping system have been tested and flushed and system is substantially completed, fill the system completely with water, venting all trapped air, and operating the pump.

1. Provide temporary circulator for steam systems. <Delete if not applicable.>
2. Open a drain at the low point of the system while replacing the water through the make-up at the same rate.
3. Continue flushing until clean water shows at the drain, but for not less than two (2) hours.
4. After flushing, remove strainers and clean and replace them. Remove the bypass around the heat pump condensers and install control valves. <Delete heat pump requirement if not applicable to project.>

F. Chemical cleaning: Fill system with sufficient detergent and dispersant to remove dirt, oil, and grease.

1. Circulate for at least forty eight (48) hours.
2. Open a drain valve at the lowest point and bleed while the system continues to circulate. Assure that the automatic make-up valve is operating.
3. Continue until water runs clear and all chemicals are removed. Sample and test the water until pH is the same as pH of makeup water.
4. After chemical cleaning, remove strainers, clean and reinstall them.
5. Close bypasses and open valves to coils.

G. Submit certificate and test results to the UMB Project Manager.

END OF SECTION 232113