

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and Divisions 00 and 01, apply to this Section.
- B. Related Sections:
 - 1. Division 07.
 - 2. Division 22.
 - 3. Division 23.

1.2 SUMMARY

- A. This Section includes complete installation of the following piping systems:
 - 1. Heating Water
 - 2. Chilled Water
 - 3. Condenser Water
 - 4. Heat Recovery Water
 - 5. Auxiliary Condenser Water
 - 6. Central Cooling Water
 - 7. Refrigerant Relief Vent
 - 8. Engine Coolant

1.3 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: Provide submittals of the following:
 - 1. Press-Connect Mechanical Joint Fitting Piping System
 - 2. Grooved Mechanical Joint Piping System
 - 3. Radiant Heat Materials
 - 4. Circuit Balancing Valves
 - 5. Pressure-Reducing Valves
 - 6. Safety Relief Valves
 - 7. Automatic Flow-Control Valves
 - 8. Automatic Flow-Control Coil Piping Package
 - 9. Automatic Air Vents
 - 10. Expansion Tanks
 - 11. Air Separators
 - 12. Chemical Feeders
 - 13. Site Glasses
 - 14. Y-Pattern Strainers
 - 15. Basket Strainers
 - 16. Braided Hose Flexible Connectors (specified in 23 05 00)
 - 17. Rubber Flexible Connectors (specified in 23 05 00)
 - 18. Flexible Expansion Joints (specified in 23 05 00)
 - 19. Glycol Solution Feed System
 - 20. Glycol

- 21. Water Treatment Chemicals
 - C. Shop Drawings: In addition to requirements set forth in Section 23 05 00, shop drawings for the listed systems shall also include detailing of pipe anchors, special pipe support assemblies, alignment guides, and expansion joints and loops. Provide submittals of the following piping systems [within mechanical equipment rooms] [within the entire building]:
 - 1. Heating Water
 - 2. Chilled Water
 - 3. Condenser Water
 - 4. Heat Recovery Water
 - 5. Auxiliary Condenser Water
 - 6. Central Cooling Water
 - 7. Refrigerant Relief Vent
 - 8. Engine Coolant
 - D. Reports and Certificates: Provide submittals of the following:
 - 1. Hydrostatic Pressure Test Report
 - 2. Pipe Flushing and Cleaning Report
 - 3. Chemical Treatment Analysis
- 1.4 CODES AND STANDARDS
 - A. Codes and Standards shall be the current version adopted by the Authority Having Jurisdiction.
- 1.5 QUALITY ASSURANCE
 - A. ASME Compliance: Comply with the following provisions:
 - 1. ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
 - 2. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 01.
 - 3. Welding Standards: Qualify welding processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."
- 1.6 COORDINATION
 - A. Coordinate layout and installation of piping with equipment and with other installations.
 - B. Coordinate pipe sleeve installation for foundation wall penetrations.
 - C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 07 Sections.
 - D. Coordinate pipe fitting pressure classes with products specified in related Sections.
 - E. Coordinate size and location of concrete housekeeping pads. Cast anchor-bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 03 Sections.

- F. Coordinate installation of pipe sleeves for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 07 for firestopping.

1.7 EXTRA MATERIALS

- A. Maintenance Stock: Furnish a sufficient quantity of chemicals [and glycol] for initial system startup and for preventive maintenance for one year from Substantial Completion.

PART 2 – PRODUCTS

2.1 PIPING MATERIALS

- A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.2 COPPER TUBE AND FITTINGS

- A. Soldered End Connections: Copper alloys with silicone content greater than 0.005% are not allowed.
- B. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- C. Wrought-Copper Fittings: ASME B16.22.
- D. Wrought-Copper Unions: ASME B16.22.
- E. Solder Filler Metals: ASTM B 32, 95-5 tin antimony, lead free.
- F. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).
- G. Press-Connect Mechanical Joint Fitting Piping System
 - 1. General: Viega ProPress mechanical joint pipe fittings may be used as an option to soldered pipe joining methods as allowed in the Pipe Applications section. All Press-Connect mechanical fittings shall conform to local code approval.
 - 2. Sealing Element: EPDM compound sealing element, temperature operating range -4 degrees F to 250 degrees F.
 - 3. Press-Connect Mechanical Joint Fittings: Elbows, tees, adapters, caps, unions, couplings, reducers, manifolds, stub-outs, and cross-overs constructed of bronze or copper conforming to ASME B16.18, ASME B16.22, or ASME B16.51 and the performance requirements of IAPMO PS117. Unpressed fittings shall bypass the testing gas or liquid and leak during the two-step pre-test outlined in Part 3.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe, NPS 2 and Smaller: ASTM A 53, Type S (seamless), Grade B, Schedule 40, black steel, plain ends.
- B. Steel Pipe, NPS 2-1/2 through NPS 10: ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule 40, black steel, plain ends.

- C. Steel Pipe, NPS 12 through NPS 18: ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, standard weight, 0.375-inch wall thickness, black steel, plain ends.
- D. Steel Pipe, NPS 20 and Larger: ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, standard weight, 0.375-inch wall thickness, black steel, plain ends.
- E. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless for NPS 2 and smaller and electric-resistance welded for NPS 2-1/2 and larger.
- F. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- G. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- H. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.
- I. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- J. Wrought -Steel Flanges and Flanged Fittings: ASME B16.5, Class 150 and 250, Material Group 1.1, welding neck, raised face type; include nuts and bolts.
- K. Grooved Mechanical Joint Piping System:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Victaulic Company.
 - b. Or Approved Equal.
 - 2. General: Grooved mechanical joint pipe couplings, fittings, and other specified grooved components may be used as an option to welding, threading, or flanged pipe joining methods as allowed in the Pipe Applications section. All grooved components shall be provided by one manufacturer, and conform to local code approval and/or as listed by ANSI-B-31.1, B-31.9 and ASME.
 - 3. Type: Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, coupling style, size and method of joining. Pipe ends to be grooved in accordance with manufacturer's current listed standards conforming to ANSI/AWWA C-606.
 - 4. Gaskets: Grade "EHP" EPDM compound conforming to ASTM D-2000. Temperature operating range -30 degrees F to 250 degrees F. Gaskets suitable for operation under negative pressure or suction side of pumps in open systems.
 - 5. Couplings: Constructed of ductile iron conforming to ASTM A-536, Grade 65-45-12; heat treated plated steel bolts and nuts conforming to ASTM A-449 and A-183.
 - a. Rigid Coupling, 2-inch to 8-inch: Victaulic Style 107 QuickVic Rigid Coupling.
 - b. Rigid Coupling, 10-inch to 12-inch: Victaulic Style 07, Zero-Flex Rigid Coupling
 - c. Rigid Coupling, 14-inch to 24-inch: Victaulic Style W07, Advanced Groove System Rigid Coupling
 - d. Flexible Coupling, 2-inch to 8-inch: Victaulic Style 177, QuickVic Flexible Coupling
 - e. Flexible Coupling, 8-inch to 12-inch: Victaulic Style 77, Standard Flexible Coupling

- f. Flexible Coupling, 14-inch to 24-inch: Victaulic Style W77 Advanced Groove System Flexible Coupling
- 6. Grooved Mechanical-Joint Fittings: Elbows, tees, laterals, wyes, reducers, caps, flange nipples, adaptor elbows and adaptor nipples furnished by grooved mechanical joint pipe manufacturer to match appropriate coupling. Constructed of ductile iron conforming to ASTM A-536, Grade 65-45-12, or ASTM A 53, Type F, E, or S, Grade B carbon steel.
- 7. Flange Adapters: For connection to ANSI Class 150 or 300 flanged components as required by system. Cast of ductile iron conforming to ASTM A-536, Grade 65-45-12; heat treated plated steel bolts and nuts conforming to ASTM A-449 and A-183.
- L. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- M. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.4 RADIANT HEAT MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Uponor.
 - 2. Weil-McLain.
 - 3. Or Approved Equal.
- B. Tubing: 1/2-inch diameter tubing constructed of internal and external layers of cross linked polyethylene with longitudinally overlapped welded aluminum core.
 - 1. Oxygen permeation rating of 0 grams/meters³/day.
 - 2. Suitable for embedding in concrete.
 - 3. Rated for 200 degrees F, 100 psig.
 - 4. Electronically traceable.
- C. Tubing Adaptor: As required to connect tubing to manifolds.
- D. Snap Rail: U-shaped track to properly position tubing where tubing is installed directly on concrete slab.

2.5 VALVES

- A. Gate, globe, check, ball, and butterfly valves are specified in Division 23 Section "General-Duty Valves for Mechanical Piping."
- B. Refer to Part 3 "Valve Applications" for specific uses and applications for each valve specified.
- C. Circuit Balancing Valves: 250-psig working pressure, 230 degrees F maximum operating temperature. Valves 2-inch and below shall be bronze body; 2-1/2-inch and above shall be ductile iron body. Provide with portable instrument connections for portable differential pressure meter with integral check valves and seals. Valves shall be multi-turn 360 degrees ad

justment with micrometer type indications located on the handwheel. Valves shall have hidden memory feature to lock valve position after system balancing. Valves 2-inch NPS and smaller shall have threaded connections and 2-1/2-inch NPS valves shall have flanged connections. Valves shall be sized for 1-psi pressure drop at design flow rate unless noted otherwise.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Tour & Andersson.
 - b. Armstrong Pumps, Inc.
 - c. Nibco.
 - d. Or Approved Equal.

- D. Pressure-Reducing Valves: Diaphragm-operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Conbraco Industries, Inc.
 - d. ITT Bell & Gossett; ITT Fluid Technology Co.
 - e. Watts Regulators.
 - f. Spence Engineering Co.
 - g. Or Approved Equal

- E. Safety Relief Valves: Brass or bronze body with brass and rubber, wetted, internal working parts; to suit system pressure and heat capacity; according to ASME Boiler and Pressure Vessel Code, Section IV.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Conbraco Industries, Inc.
 - d. ITT Fluid Technology Corp.; ITT McDonnell & Miller.
 - e. Kunkel Valves.
 - f. Spence Engineering Co.
 - g. Or Approved Equal

- F. Automatic Flow-Control Valves, 2-1/2-inch NPS and Smaller: Pressure independent accessible cartridge automatic flow control device with integral ball valve and portable instrument connections. Factory set to automatically control flow rates within plus or minus 5 percent design, while compensating for system operating-pressure differential. Certified flow test performed by independent laboratory shall be available upon request.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Griswold Controls.
 - b. Flow Design, Inc.
 - c. Or Approved Equal
2. Minimum Temperature/Pressure Rating: 250 degrees F and 275-psig.
 3. Construction Materials: Brass body, stainless steel flow limiting cartridge, stainless steel spring EPDM seals, Teflon ball seals and stainless steel ball.
 4. Connection Type: Threaded (FNPT) or sweat type with integral union on one end.
 5. Accessories: Metal identification tag with chain for each valve, factory marked with the zone identification, valve model number and flow rate.
- G. Automatic Flow-Control Valves, 3-inch to 20-inch NPS: Pressure independent automatic flow control device with integral portable instrument connections. Factory set to automatically control flow rates within plus or minus 5 percent design, while compensating for system operating-pressure differential. Certified flow test performed by independent laboratory shall be available upon request.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Griswold Controls.
 - b. Flow Design, Inc.
 - c. Or Approved Equal
 2. Minimum Temperature/Pressure Rating: 250 degrees F and 200-psig.
 3. Construction Materials: Steel or ductile iron body and stainless steel flow limiting cartridge.
 4. Connection Type: [Grooved-end][Flanged][Wafer].
 5. Accessories: Metal identification tag with chain for each valve, factory marked with the zone identification, valve model number and flow rate.
- H. Automatic Flow-Control Coil Piping Package: Complete coil connection package including supply water device with integral isolation ball valve, integral strainer, hose-end drain valve and portable instrument connection; return water device with isolation ball valve, pressure independent automatic flow limiting cartridge, automatic control valve, manual air vent and portable instrument connections. Factory set to automatically control flow rates within plus or minus 5 percent of design values, compensating for system operating-pressure differential. Certified flow test performed by independent laboratory shall be available upon request.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Griswold Controls.
 - b. Flow Design, Inc.
 - c. Or Approved Equal
 2. Minimum Temperature/Pressure Rating: 250 degrees F and 275-psig.
 3. Construction Materials: Forged brass bodies, stainless steel flow limiting cartridge, stainless steel spring EPDM stem seals, Teflon ball seals, stainless steel balls and stainless steel 20-mesh strainer.
 4. Automatic Control Valve: Characterized port equal percentage ball valve type, 90 rotation, minimum 100-psi close-off pressure. The actuator shall be furnished under Division 23 Section "Instrumentation and Control for HVAC."

5. Connections: Threaded.
6. Accessories: Minimum 18-inch long supply and return insulated hoses with each assembly, metal identification tag with chain for each valve, factory marked with the zone identification, valve model number and flow rate.

2.6 HYDRONIC SPECIALTIES

- A. Manual Air Vents: Bronze body and nonferrous internal parts; 150-psig working pressure, 225 degrees F operating temperature; manually operated with screwdriver or thumbscrew; with 1/8-inch NPS discharge connection and 1/2-inch NPS inlet connection.
- B. Automatic Air Vents: Designed to vent automatically with float principle; bronze or brass body, nonferrous float, stainless steel linkage and Viton seal; 150-psig working pressure, 240 degrees F operating temperature; with 1/4-inch NPS discharge connection and 1/2-inch NPS inlet connection.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Machine Works.
 - b. ITT Fluid Technology Corp.; ITT Bell and Gossett Flow Design, Inc.
 - c. Hoffman Specialty ITT; Fluid Handling Div.
 - d. Spirax Sarco.
 - e. Spirotherm.
 - f. Or Approved Equal
- C. Expansion Tanks: Welded carbon steel for 125-psig working pressure, 240 degrees F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by a flexible diaphragm securely sealed into tank. Provide taps for pressure gage and air-charging fitting, and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Fabricate and test tank with taps and supports, and label according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 01. Pre-charge to pressure indicated.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Taco, Inc.
 - d. John Wood.
 - e. ITT Fluid Technology Corp.; ITT Bell and Gossett.
 - f. Wessels.
 - g. Or Approved Equal
- D. Air Separator: Coalescing type air eliminator and dirt separator capable of removing 100% of free air, 100% of entrained air and 99.6% of dissolved air, and 80% of dirt particles 30 microns and larger within 100 passes. Welded black steel body with copper or stainless steel coalescing medium; rated for 150-psig working pressure at 250 degrees F operating temperature; integral full port float actuated brass air vent; valved side tap to flush floating dirt and releasing large volumes of air during system fill, and valved dirt blowdown on bottom of unit. Flanged inlet and outlet piping connections. The coalescing medium shall fill the entire vessel. Separator shall include removable lower head to allow inspection and removal of the

coalescing medium. Note: Approved equal devices must have the same vessel volume as the basis of design.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Spirotherm or approved equal.
- E. Chemical Feeders: Provide bypass-type chemical feeders of 5-gallon capacity unless otherwise indicated, welded steel construction with steel support legs; fill, inlet, outlet, air vent and drain connections; minimum 125-psig working pressure. Provide with 1/4 turn positive seal closure and quick release cap for chemical fill, and inlet, outlet, and drain valve assemblies.
- F. Site Glasses: Double-wall site glass with acrylic/pyrex site material, temperature range of 32 to 180 degrees F, FNPT connections up to 1 1/2-inch pipe connection size, wafer connection 2-inch or greater.
- G. Y-Pattern Strainers: 125-psig working pressure, 350 degrees F maximum operating temperature; cast-iron body (ASTM A 126, Class B), flanged ends for 2-1/2-inch NPS and larger, threaded connections for 2-inch NPS and smaller, bolted cover, perforated Type 304 stainless-steel screen, and blowdown drain connection.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hoffman Specialty ITT; Fluid Handling Div.
 - b. Spirax Sarco.
 - c. Victaulic Co. of America.
 - d. Watts Regulator Co.
 - e. Nibco
 - f. Titan Flow Control, Inc.
 - g. Or Approved Equal
 2. 2-inch and Smaller: Screen size openings 0.032-inches maximum.
 3. 2-1/2-inch to 4-inch: Screen size openings 0.062-inches maximum.
 4. 6-inch and Larger: Screen size openings 0.125-inches maximum.
- H. Basket Strainers: 125-psig working pressure 350 degrees F maximum operating temperature; high-tensile cast-iron body (ASTM A 126, Class B), flanged end connections, bolted cover, perforated Type 304 stainless-steel basket, and bottom drain connection.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Metraflex Co.
 - c. Spirax Sarco.
 - d. Victaulic Company of America.
 - e. Titan Flow Control, Inc.
 - f. Or Approved Equal
 2. 2-Inches to 3-Inches: Screen size openings 0.045-inches maximum.
 3. 4-Inches and Larger: Screen size openings 0.125-inches maximum.

- I. Portable Instrument Connections: For insertable type pressure or temperature gauges, 500 psig working pressure; 275 degrees F maximum temperature; brass body and cap, 1/2-inch NPT connection size; Nordel valve core. Length suitable to provide suitable access outside of pipe insulation. Provide cap restraining strap.
- J. Glycol Solution Feed System:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ITT Bell & Gossett
 - b. J.L. Wingert, Co.
 - c. Neptune Chemical Pump
 - d. Wessels
 - e. General Treatment Products, Inc. (GTP)
 - f. Or Approved Equal
 - g. General: Packaged automatic glycol solution feed system with tank, pump, expansion tank, controls and accessories manufactured to feed glycol solution to hydronic systems.
 2. Tank: Minimum 50-gallon translucent polyethylene tank with removable polyethylene cover and visible solution level scale marked in 5-gallon increments on the tank wall. Tank cover shall have any opening to accommodate the make-up water, relief valve discharge and manual test/circulation line. Tank shall be fully supported and restrained by painted steel bottom mount stand.
 3. Control Panel: NEMA 12 control panel with 120V power connection. The panel includes main power switch and light, pump cut-in/cut-out pressure control for glycol solution feed pump, red low level light, contacts for DDC low level alarm.
 4. Expansion Tank: Diaphragm type tank.
 5. Glycol Solution Feed Pump: Produce a minimum of 5 gpm flow rate at cut-out pressure. Pump suction piping includes piping from tank, ball valve isolation and y-strainer. Pump discharge tubing includes check valve, piping and 1/4-inch NPT tap pressure gauge. 120V open drip proof motor.
 6. Pressure Switch: 1/4-inch NPT pressure switch. Cut-in and cut-out pressures as indicated.
- K. Glycol: Corrosion inhibited propylene fluid suitable for use with all common metals used in HVAC systems. Operating range -50 degrees F to 325 degrees F. Dow Chemical Company DOWFROST HD or approved equal.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Chemical Company.
 - b. Or Approved Equal
- L. Water Treatment Chemicals: Specially formulated to prevent accumulation of scale and corrosion in closed-loop piping system and connected equipment; based on a water analysis of makeup water. Ferrous metal corrosion inhibitor with sodium nitrite and sodium hydroxide; non-ferrous metal corrosion inhibitor with tolytriazole; and biocides to prohibit biological growth within the closed system.

PART 3 – EXECUTION

3.1 PIPE APPLICATIONS

- A. Heating Water, Chilled Water, Heat Recovery Water and Central Cooling Water, 2-inch NPS and Smaller: Type L drawn-temper copper tubing with soldered joints and wrought-copper fittings. [Press-Connect Mechanical Joint Fitting Piping System may be used at the Contractor's option for pipe joints].
- B. Heating Water, Chilled Water, Heat Recovery and Central Cooling Water, 2-1/2-inch and Larger NPS: Schedule 40 steel pipe with welded joints and Schedule 40 wrought-steel butt-welding fittings; flanged joints where indicated, at equipment connections and where pipe removal for equipment access is required, with Class [150] [300] wrought-steel flanges. [Grooved Mechanical-Joint Piping System may be used at the Contractor's option for pipe joints, except joints in enclosed shafts or above ceilings].
- C. Condenser Water, 2-inch NPS and Smaller: Type L drawn-temper copper tubing with soldered joints and wrought-copper fittings. [Press-Connect Mechanical Joint Fitting Piping System may be used at the Contractor's option for pipe joints].
- D. Condenser Water 2-1/2-inch NPS and Larger: Schedule 40 steel pipe with welded joints and Schedule 40 wrought-steel butt-welding fittings; flanged joints where indicated, at equipment connections and where pipe removal for equipment access is required, with Class [150] [300] wrought-steel flanges. [Grooved Mechanical-Joint Piping System may be used at the Contractor's option for pipe joints, except joints in enclosed shafts or above ceilings].
- E. Auxiliary Condenser Water, 2-inch NPS and Smaller: Type L drawn-temper copper tubing with soldered joints and wrought-copper fittings. [Press-Connect Mechanical Joint Fitting Piping System may be used at the Contractor's option for pipe joints].
- F. Auxiliary Condenser Water, 2-1/2-inch NPS and Larger: Schedule 40 steel pipe with welded joints and Schedule 40 wrought-steel butt-welding fittings. Grooved Mechanical-Joint Piping System may be used for pipe routed in Mechanical Equipment Rooms, rooms without ceilings and above accessible lay-in grid ceilings. [Grooved Mechanical-Joint Piping System may be used at the Contractor's option for pipe joints, except joints in enclosed shafts or above ceilings].
- G. Engine Coolant, 2-inch NPS and Smaller: Schedule 40 steel pipe with threaded joints and Class 150 malleable-iron fittings.
- H. Engine Coolant, 2-1/2-inch and Larger: Schedule 40 steel pipe with welded joints, Schedule 40 wrought-steel welding fittings, and Class 150 wrought-steel flanges.
- I. Refrigerant Vent, 2-inch and Smaller: Type L drawn-temper copper tubing with brazed joints and wrought-copper fittings.
- J. Refrigerant Vent, 2-1/2-inch and Larger: Schedule 40 steel pipe with welded joints, Schedule 40 wrought-steel fittings, and Class 150 wrought-steel flanges.

3.2 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

1. Shutoff Duty: Use ball or butterfly valves.
 2. Throttling Duty: Use globe, ball, and butterfly valves.
- B. Install shutoff-duty valves at each branch connection to supply mains, at supply connections to each piece of equipment, and elsewhere as indicated.
- C. Install throttling-duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- D. Install [circuit balancing valves] [automatic flow control valves] on the outlet of each heating or cooling element and elsewhere as required to facilitate system balancing. Valve size shall be based on manufacturers recommended size for flow control, not on pipe size. Provide pipe transitions upstream and downstream of valve if pipe size is larger than valve connections. Install per manufacturer's recommended methods.
- E. Install hose end drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.
- F. Install check valves on each pump discharge and elsewhere as required to control flow direction.
- G. Install safety relief valves on hot water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge to floor drain without valves. Comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 01, for installation requirements.
- H. Install pressure-reducing valves on hot water generators and elsewhere as required to regulate system pressure.
- I. Install automatic flow-control valves per the manufacturer's recommendations.
- J. At the Contractor's option, automatic flow-control coil piping packages can be used on terminal coil, heating water unit heater and cabinet heater connections in lieu of field installed isolation valves, strainers, drain valves, air vents, automatic control valves and portable instrument connections. Select and install devices per the manufacturer's recommendations. Valve actuators shall be provided under Division 23 Section "Instrumentation and Control for HVAC," sized for actual system requirements.
- K. Install pressure independent flow control valves per the manufacturer's recommendations. Valve actuators furnished under Division 23 Section "Instrumentation and Control for HVAC," sized for actual system requirements. Provide pipe reducers and increasers to adjust for transition from pipe size to valve size.
- L. Install control valves per manufacturer's recommendations.

3.3 PIPING INSTALLATIONS

- A. Install piping according to Division 23 Section "Common Mechanical Materials and Methods."
- B. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

- C. 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 and cleaning/flushing activity.
- D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- E. Reduce pipe sizes using concentric reducers for up to and including 2-1/2-inch NPS and eccentric reducer fitting installed with level side up for 3-inch NPS and larger.
- F. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- G. Install unions in pipes 2-inch NPS and smaller, adjacent to each valve, at final connections of each piece of equipment, and elsewhere as indicated. Unions are not required at flanged connections.
- H. Install flanges on valves, apparatus, and equipment having 2-1/2-inch NPS and larger connections.
- I. Install flexible expansion loops where indicated.
- J. Install rubber flexible connectors at inlet and discharge connections to pumps unless indicated otherwise and at fractional horsepower circulating pumps; and at other vibration-producing equipment.
- K. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- L. Anchor piping to building structure where indicated. Anchors shall be designed by a structural engineer.
- M. Install dielectric fittings between dissimilar pipe and/or tubing materials.

3.4 HANGERS AND SUPPORTS

- A. General: Pipe hangers and supports are specified in Division 23 Section "Hangers and Supports for Mechanical Piping and Equipment." Pipe seismic bracing requirements are specified in Division 23 Section "Vibration and Seismic Control for Mechanical Piping and Equipment." Conform to requirements below for maximum spacing of supports.
- B. In addition to the requirements of Division 23 Section "Hangers and Supports for Mechanical Piping and Equipment" provide the following:
 - 1. Heating Water and Engine Coolant pipe 2-inch NPS and smaller with suspended individual horizontal runs 60 feet or longer: Use Adjustable MSS Type 1 Adjustable Steel Clevis Hanger; and MSS Type 48 Spring Hanger on rod supports for the horizontal pipe within 20 feet of a vertical change in pipe direction that is greater than 6-feet.
 - 2. Heating Water and Engine Coolant pipe 2-1/2-inch NPS and larger with suspended individual horizontal runs 20 feet or longer: Use MSS Type 43 Adjustable Roller Hanger; with MSS Type 51 or Type 53 Variable Spring Hanger on the rod supports for the hori

zontal pipe within 30 feet of a vertical change in pipe direction that is greater than 6-feet.

3. Heating Water and Engine Coolant pipe 2-1/2-inch NPS and larger supported from below with horizontal runs 20 feet or longer: Use MSS Type 44 Pipe Roll Stand or MSS Type 46 Adjustable Pipe Roll Stand, with MSS Type 52 Variable Spring Base Support within 30 feet of a vertical change in pipe direction that is greater than 6-feet.
 4. Horizontal Pipe within 50 feet of spring mounted pumps: Use MSS Type 51 or Type 53 Variable Spring Hanger on the rod supports.
 5. Valves and Pipe-Mounted Equipment: Provide pipe supports within 12-inches of all pipe connections to valves or pipe-mounted equipment. Supports shall be on both sides of the valve or equipment, allowing removal of valve or equipment without additional temporary pipe support.
- C. Vertical Piping Support:
1. Support vertical copper piping and tubing at base and at each floor and at maximum distance of 10-feet (whichever is less).
 2. Support vertical steel piping at base and at each floor and at maximum distance of 15-feet (whichever is less).
- D. Install hangers for steel piping and copper tubing with the following minimum rod sizes and maximum spacing in accordance with MSS SP-69.

Nom. Pipe Size (Inches)	Steel Pipe Max. Span (Feet)	Copper Tube Max. Span (Feet)	Min. Rod Diameter (Inches)
Up to 3/4	7	5	1/4
1	7	6	1/4
1-1/4	7	6	3/8
1-1/2	9	8	3/8
2	10	8	3/8
2-1/2	11	9	3/8
3	12	10	3/8
4	14	12	1/2
6	17	14	1/2
8	19	16	5/8
10	20	18	3/4
12	23	19	7/8
14	25	N/A	1
16	27	N/A	1
18	28	N/A	1-1/4
20	30	N/A	1-1/4

- E. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 PIPE JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Common Mechanical Materials and Methods" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping.

- B. Mechanical Joints: Assemble joints according to fitting manufacturer's written instructions.
- C. Press-Connect Mechanical Joint Fitting Piping System: Use as allowed by Pipe Applications section. Install system per manufacturer's written instructions.
 - 1. Installers shall attend a Viega ProPress installation training class.
 - 2. Tube ends shall be cut on a right angle (square) to the tube. Tube ends shall be reamed and chamfered, all grease, oil or dirt shall be removed from the tube end with a clean rag. Visually examine the fitting sealing element to insure there is no damage, and it is properly seated into the fitting. Insert tube fully into the fitting. Make a mark with a felt tip pen on the tube wall at the face of the fitting. Always examine the tube to insure it is fully inserted into the fitting prior to pressing the joint.
 - 3. Fittings shall be joined using Rigid ProPress Tools and shall be installed according to the most current edition of the Viega installation guidelines.
 - 4. Sealing elements shall be verified for the intended use.
- D. Grooved Mechanical-Joint Piping System: Use as allowed by Pipe Applications section. Install system per manufacturer's written instructions. Use rigid couplings unless indicated otherwise.
 - 1. Three flexible coupling joints within close proximity of the suction and discharge side of a floor mounted vertical split coupled or vertical close coupled pump can be used in lieu of rubber flexible connectors.
 - 2. Use flexible couplings where grooved mechanical joint system couplings are indicated for pipe expansion.
- E. Mechanically Formed Copper Tube Tee Fittings: Mechanically formed tee fitting, as created by T-Drill Industries, Inc. is an acceptable method of installation. Installers shall be trained and certified in using this technique. Limited to applications where the branch line is smaller than the main line. Form tee in copper tube according to equipment manufacturer's written instructions. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar. Soft solder joints shall not be permitted.

3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in system, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents where high point vent is located over 14'-0" above the floor and where indicated. Pipe discharge to drain. Install with shut-off valve at inlet.
- C. Install air separator where indicated. Install blow-down piping with ball valve; extend to nearest drain.
- D. Install Chemical Feeders in each hydronic system where indicated; in upright position with top of funnel not more than 48 inches above floor. Install ball valves on each side of feeder. Pipe drain, with ball valve, to nearest floor drain.
- E. Install Expansion Tanks as indicated. Line from pipe system to tank shall be connected to system pipe at 90-degrees from vertical. Vent and purge air from hydronic system, and charge tank with proper air charge. Tank shall be charged to indicated pressure prior to initial system fill.

- F. Install Portable Instrument Connections on inlet and outlet of all hydronic system pumps, filters, strainers, coils, heat exchangers, chillers, hot water boilers and where indicated. Mount in 1/2-inch NPT pipe collar welded to pipe.
- G. Install Y-Pattern strainers and basket strainers with ball valve on blow down connection. Above ceilings, terminate with hose end drain connection.

3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Piping size for supply and return shall be same size as equipment connections, unless indicated differently.
- B. Install control valves in accessible locations close to equipment.
- C. Install circuit balancing valves in accessible locations close to equipment.
- D. Install portable instrument connections at supply and return connections to each coil.

3.8 RADIANT HEAT TUBING INSTALLATION

- A. Install radiant heat tubing per manufacturer's recommendation.
- B. Staple tubing to rigid insulation board in areas where tubing is located over new slab. Secure tubing with snap rails, adhered to concrete, on 3'-0" spacing where tubing is located over existing slab.
- C. Loop tubing in maximum 300 feet lengths from supply manifolds to be evenly spaced.

3.9 FIELD QUALITY CONTROL

- A. Testing Preparation: 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 that is not subjected to test pressure from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Flanged joints where blinds are inserted to isolate equipment need not be tested.
 - 4. Install safety relief valve set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
 - 5. Perform a two-step pre-test as follows: Test the system with air or nitrogen at 0.5 psi and 45 psi, or water at 15 psi and 85 psi and examine pressure gauge to determine any system pressure loss. If the system does not hold pressure, walk the system and check for un-Press-Connect mechanical joint fittings. Insure for any un-pressed fitting/s that the pipe is fully inserted into the fitting and press the fitting. After appropriate repairs have been made, proceed to testing procedures.
- B. Testing: Test hydronic piping as follows:

1. Use ambient temperature water as testing medium, except where there is risk of damage due to freezing. Another liquid may be used if it is safe for workers and compatible with piping system components.
2. Use vents installed at the high points of system to release trapped air while filling system. Use drains installed at low points for complete removal of liquid.
3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low-pressure filling lines are disconnected.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the maximum operating pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Check to verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing and submit.
7. Testing shall be witnessed by the Owner or Owner's designated representative. Minimum seven days notice is required.

3.10 CHEMICAL TREATMENT

- A. Perform an analysis to determine the type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling. Perform analysis of local water supply if necessary. Submit results.
- B. Fill system and perform initial chemical treatment.

3.11 START-UP PROCEDURES

- A. Perform these steps before operating the system:
 1. Open valves to fully open position. Close coil bypass valves (3-way valves only).
 2. Check pump for proper direction of rotation.
 3. Verify expansion tank air charge is properly set.
 4. Set automatic fill valves for required system pressure.
 5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) and bleed air completely from manual type.
 6. Set temperature controls so all coils are calling for full flow.
 7. Check expansion tanks to determine that they are not air bound and that system is completely full of water.

3.12 CLEANING

- A. Preparation:
 1. System shall be operational prior to cleaning.
 2. Provide all isolation and drain valves to allow complete system flushing.
 3. Provide temporary piping connections, temporary pumps, and temporary water meter as required to properly accomplish cleaning entire system. If a temporary pump is required, it shall be sized to provide a minimum of 1.5 fps fluid velocity at all points in the system. Provide strainer with temporary pump.

B. Cleaning Sequence:

1. Initial Flush:

- a. Completely fill the system with fresh water and circulate (1st filling) for 4-hours minimum.
- b. Initial flushing shall be sufficient to remove all contaminants such as cuttings, filings, loose rust and scale, welding and soldering, residue and debris.
- c. Drain the entire system and refill with fresh water (2nd filling).

2. Condenser Water System with Open Cooling Tower:

- a. Add NALCO NALPREP III or approved equal per manufacturers recommendation to passivate metal surfaces.
- b. Circulate for duration recommended by chemical treatment manufacturer.
- c. Drain and flush system.
- d. Refill with fresh water and immediately start chemical treatment program

3. Cleaning:

- a. Use concentrated chemical cleaner in piping system(s). Cleaner shall be a phosphate wetting agent combined with an alkaline surfactant with a sodium carbonate type alkalinity supplement introduced as necessary to produce 600 PPM of phenolphthalein alkalinity. Chemicals shall be nontoxic.
- b. Circulate solution for the recommended time period that corresponds to the fluid temperature.
- c. Test solution for proper concentration.
- d. Partially close and reopen all manual valves several times.
- e. Completely drain the entire system
- f. Refill the system with fresh water (3rd filling). Then, with the circulation pump running:
 - 1) Open one or more drains as far downstream from the fill point as is possible. Be sure the makeup is sufficient to keep up with the drain so as to maintain full system.
 - 2) Partially close and reopen all manual valves several times.
 - 3) Blowdown all strainers, dead legs and low points in the system.
 - 4) Continue to flush the system in this manner until the drain water is of the same clarity as the makeup water and testing reveals no further traces of cleaning solution (minimum 1 hour).
- g. Following the fresh water flush, drain the entire system.
 - 1) Clean all strainers.
 - 2) Remove all startup strainers.
- h. Fill system (water systems):
 - 1) Fill system with clean water.
 - 2) Immediately start chemical treatment program
- i. Fill system (Glycol systems):

- 1) Fill system with required quantity of glycol (% by volume).
 - 2) Complete filling of system with clean water.
 - 3) Glycol solution must be added within 2 hours after final draining of the system.
 - 4) Upon completion of filling system with glycol solution, tag each system: "CAUTION THIS SYSTEM HAS BEEN 'CHARGED' WITH GLYCOL. DO NOT DILUTE SYSTEM WITH WATER OR DRAIN SYSTEM WITHOUT AUTHORIZATION."
4. Upon completion of cleaning and chemical treatment addition, tag each system so that tag is plainly visible as follows: "THIS SYSTEM HAS BEEN CHEMICALLY CLEANED AND TREATED."
 5. Field Reports: Submit field report indicating analysis of system's water after cleaning and after chemical treatment.

3.13 ADJUSTING

- A. Balance system. See Division 23 Section "Testing, Adjusting, and Balancing for Mechanical."

3.14 DEMONSTRATION

- A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- B. Preview data proposed to be included in the operation and maintenance manuals with the Owner.
- C. Schedule [4][8][] hours training with Owner, through Architect, with at least 14 days' advance notice.
- D. Demonstrate operation of systems. Conduct walking tour of the project. Briefly identify location and describe function, operation, and maintenance of each system.

END OF SECTION