

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Hydronic system requirements.
- B. Hydronic piping materials.
- C. Hydronic piping fittings.
- D. Hydronic piping joining materials.

**1.02 ADMINISTRATIVE REQUIREMENTS**

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

**1.03 SUBMITTALS**

- A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.
- B. Reference Division 23 Section, "Basic Piping Materials and Methods" for additional submittal requirements.
- C. Reports as specified in Part 3 of this Section.

**1.04 QUALITY ASSURANCE**

- A. Comply with Division 23 Section, "Basic Piping Materials and Methods."
- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this Section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this Section, with minimum three years of documented experience.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with Division 23 Section, "Basic Piping Materials and Methods."

## **PART 2 - PRODUCTS AND MATERIALS**

### **2.01 HYDRONIC PIPING MATERIALS**

- A. Carbon Steel Pipe:
  - 1. NPS 2 inch and Smaller: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule 40, black steel, plain ends.
  - 2. NPS 2-1/2 inch through 10 inch: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule 40, black steel, plain or beveled ends.
  - 3. NPS 12 inch and Larger: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule STD, black steel, plain or beveled ends.
  
- B. Stainless Steel Pipe:
  - 1. NPS 2 inch and Smaller: ASTM A312, Type 304 or 316, Schedule 10S, plain ends.
  - 2. NPS 2-1/2 inch and larger: ASTM A312, Type 304 or 316, Schedule 10S, plain or beveled ends.
  
- C. Copper Tubing:
  - 1. Drawn Temper Tubing: ASTM B88, Type M.
  - 2. Drawn Temper Tubing: ASTM B88, Type L.
  - 3. Annealed Temper Tubing: ASTM B88, Type K.

### **2.02 HYDRONIC PIPING FITTINGS:**

- A. General: Fittings shall be of wall thickness, pressure rating, and material matching adjoining pipe.
  
- B. Reference Division 23 Section "Basic Piping Materials and Methods" for basic piping materials and fittings.
  
- C. Threaded:
  - 1. All threads shall conform to ASME B1.20.1.
  - 2. Malleable-Iron: ASME B16.3, standard pattern.
  - 3. Cast-Iron: ASME B16.4, standard pattern.
  - 4. Cast-Stainless Steel: ASTM A351, standard pattern.
  - 5. Galvanized: ASTM A197, standard pattern.
  
- D. Flanged:
  - 1. Cast-Iron Threaded: ASME B16.1, raised ground face, bolt holes spot faced.
  - 2. Cast-Bronze Flanges: ASME B16.24, raised ground face, bolt holes spot faced.

1. Galvanized Threaded: ASME B16.5, raised ground face, bolt hols spot faced.
  3. Wrought Cast-Iron, Forged Steel, and Stainless Steel: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connection, and facing:
    - a) Material Group: 1.1.
    - b) End Connections: Butt welding.
    - c) Facings: Raised face.
  4. Gaskets: ASME B16.21, non-metallic, asbestos free, 1/8 inch thick, full-face for cast-iron flanges and raised-face steel flanges, suitable for chemical and thermal conditions of piping system contents.
  5. Flange bolts and nuts: ASME B18.2.1, hex head carbon steel according to ASTM A307, Grade B.
- E. Welded:
  1. Carbon and Galvanized Steel: ASME B16.9, seamless weld conforming to ASTM A234.
  2. Wrought Stainless Steel: ASME B16.9, seamless weld conforming to ASTM A403.
- F. Solder-Joint: Wrought-copper, ASME B16.18 or B16.22, streamlined pattern.
- G. Brazed-Joint: Wrought-copper, ASME B16.50, streamlined pattern.
- H. Transition Fittings for plastic to metal piping shall be of the plastic material of the adjoining pipe, one-piece, with a threaded brass or copper insert and schedule 80 solvent cement or fusion end.

### **2.03 HYDRONIC PIPING JOINING MATERIALS:**

- A. Reference Division 23 Section “Basic Piping Materials and Methods” for basic joining materials.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION, GENERAL**

- A. Install products in accordance with manufacturer’s instructions.
- B. Install piping to ASME B31.9 requirements.
- C. Reference Division 23 Section “Basic Piping Materials and Methods” for general piping installation requirements.
- D. Do not install PVC or non-plenum rated CPVC piping in return air plenums.

### 3.02 PIPE APPLICATION SCHEDULE

- A. Mechanically Joined Hydronic Piping:
  - 1. Contractor may provide mechanically joined hydronic piping systems as an option in lieu of, in whole of, or in part of, the pipe fitting and joining methods for the specific systems indicated in Article "Pipe Applications." Reference Division 23 Section "Mechanically Joined Hydronic Piping Systems."
  - 2. Contractor shall not use mechanically joined hydronic piping systems for hydronic piping in lieu of welded, threaded or flanged piping methods.
    - a) Exception: Grooved couplings may be used at equipment connections where specified for vibration isolation control only.
- B. Heating Hot Water Piping, Above Grade:
  - 1. Acceptable Pipe Materials:
    - a) Carbon steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.
    - b) Type L copper with soldered, brazed, or flanged fittings.
    - c) Stainless steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.
  - 2. Fitting Pressure Class: Minimum rating of 150 psig.
- C. Chilled Water Piping, Above Grade:
  - 1. Acceptable Pipe Materials:
    - a) Carbon steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.
    - b) Type L copper with soldered, brazed, or flanged fittings.
    - c) Stainless steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.
  - 2. Fitting Pressure Class: Minimum rating of 150 psig.

### 3.03 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment using jointing system specified.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

### 3.04 PIPING INSTALLATION

- A. Provide long radius elbows with a minimum centerline radius of 1-1/2 times the pipe diameter. Short radius elbows with a minimum centerline radius of 1 times the pipe diameter may be used only where space does not permit the long radius elbows.
- B. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.
- C. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.
- D. Install branch connections to mains using Tee fittings in main with take-off out the top or side of the main unless otherwise shown on the drawings. Up-feed risers shall have take-off out the top of the main line.
  - 1. Tee-drilling is prohibited as a means for connecting branch taps into any main.
  - 2. Bull-head tees are prohibited. Do not install tee fittings in such a way that the flow through the branch leg equals the sum of the flows through the two main legs.
- E. Anchor piping to ensure proper direction of expansion and contraction. Expansion loops and joints are indicated on the Drawings and specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

### 3.05 PIPE HANGERS AND SUPPORTS APPLICATION

- C. Comply with the requirements of Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
  - A. Provide vibration isolation on piping as specified in Division 23 Section "Vibration Isolation for HVAC."
  - B. Install hangers with the following minimum rod sizes and maximum spacing:

| Nom. Pipe Size - In. | Steel Pipe Max. Span - Ft. | Copper Tube Max. Span - Ft. | Min. Rod Dia. - In.  |
|----------------------|----------------------------|-----------------------------|----------------------|
| Up to 3/4            | 7                          | 5                           | 3/8                  |
| 1                    | 7                          | 6                           | 3/8                  |
| 1-1/4                | 7                          | 7                           | 3/8                  |
| 1-1/2                | 9                          | 8                           | 3/8                  |
| 2                    | 10                         | 8                           | 1/2                  |
| 2-1/2                | 11                         | 9                           | 1/2                  |
| 3                    | 12                         | 10                          | 1/2                  |
| 4                    | 14                         | 12                          | 5/8 (1/2 for copper) |
| 5                    | 16                         | 13                          | 5/8 (1/2 for copper) |
| 6                    | 17                         | 14                          | 3/4 (5/8 for copper) |
| 8                    | 19                         | 16                          | 7/8 (3/4 for copper) |

|    |    |    |                      |
|----|----|----|----------------------|
| 10 | 20 | 18 | 7/8 (3/4 for copper) |
| 12 | 23 | 19 | 7/8 (3/4 for copper) |

- C. Support vertical runs at roof, at each floor, and at maximum 15-foot intervals between floors.
- D. Install a support within one foot of each change of direction.
- E. Space supports not more than five feet apart at valves, strainers, or piping accessories in piping larger than 2 inches.

### 3.06 PIPE JOINT CONSTRUCTION

- A. Reference Division 23 Section, “Basic Piping Materials and Methods” for basic pipe joint construction.
- B. Where more than one pipe material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
- C. Install non-conductive dielectric connections whenever joining dissimilar metals.
- D. Pipe-to-Valve and Pipe-to-Equipment Connection: Install flanges or unions between piping and valves and equipment for servicing. Do not use direct welded, brazed, or soldered connections unless specifically called for in the manufacturer’s installation instructions.

### 3.07 FIELD QUALITY CONTROL

- A. Preparation for Testing:
  1. Prepare hydronic piping in accordance with ASME B31.9.
  2. Leave joints, including welds, uninsulated and exposed for examination during the test.
  3. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
  4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
  5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.
- B. Pressure Testing:

1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
2. Use vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system. Use drains installed at low points for complete removal of the 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 a hydrostatic test pressure which at every point in the system is 1.5 times the maximum system design pressure but not less than 100 psi. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix I of ASME B31.9, Code For Pressure Piping, Building Services Piping.
5. After the hydrostatic test pressure has been applied for at least 15 minutes examine piping, joints, and connections for leaks. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.
6. Provide test reports summarizing the test procedures and results of the tests.

C. Flushing:

1. After satisfactory pressure test is obtained, flush piping system using a minimum velocity of 4 FPS through all portions of the system.
2. Make all provisions required to isolate HVAC equipment, coils, control valves, automatic flow control valves, pressure independent control valves, and balance valves during flushing.
3. Provide temporary valves, connections, and bypasses where required.
4. System pumps may be used for flushing. Where system pumps are not used, provide temporary pumps with temporary connections.
5. Continue flushing until discharge water shows no discoloration and strainers are no longer collecting dirt and other foreign materials.
6. Upon completion of flushing, drain all water from system at low points, and remove, clean, and replace strainers.
7. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.

D. Fluid Testing: After filling the system as described under Paragraph "Startup", perform the following fluid test procedures:

1. Circulate the fluid for a minimum of 24 hours with all pumps operating and with shutoff valves and control valves in wide open position to ensure thorough mixing of the antifreeze or glycol solution throughout the system.
2. Remove fluid from a minimum of three different locations and test fluid samples at an independent testing agency for percentage of antifreeze or

glycol. Coordinate with the testing agency for amount of sample needed for proper testing.

3. If any sample does not meet the specified percentages, remove sufficient fluid from the system, add antifreeze or glycol as required to achieve the specified percentage and repeat the circulation and testing procedures specified above. Coordinate with the water treatment supplier.
4. After the samples meet the specified percentages, submit to the Owner and Engineer signed and dated test report(s) from independent testing agency that document the location of the sample and the results of the fluid test.
5. One month prior to end of the warranty period, Contractor shall submit samples to an independent testing agency to test the fluid for percentage of antifreeze or glycol. If the test samples have the specified percentage, submit copies of the test reports to the Owner and Engineer as described above in Paragraph 4. If any sample does not meet the specified percentage, Contractor shall perform the work described above in Paragraphs 3 and 4.

### **3.08 ADJUSTING AND CLEANING**

- A. After installation of entire system, fill, clean, and treat systems. Refer to Section 232500 HVAC Water Treatment for additional requirements.
- B. Cleaning Agent Concentration:
  1. Use neutralizer agents on recommendation of system cleaner supplier and approval of Engineer.
- C. Hot Water Heating Systems:
  1. Apply heat while circulating, slowly raising temperature to 160 F and maintain for 12 hours minimum.
  2. Remove heat and circulate to 100 F or less, drain systems as quickly as possible.
  3. Refill with clean water and circulate for 6 hours at design temperatures, then drain.
  4. Refill with clean water and repeat until system cleaner is removed.
- D. Chilled Water Systems:
  1. Circulate for 48 hours, then drain systems as quickly as possible.
  2. Refill with clean water, circulate for 24 hours, then drain.
  3. Refill with clean water and repeat until system cleaner is removed.
- E. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.
- F. Remove and clean or replace strainer screens.
- G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.



- H. After cleaning system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.
- I. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- J. Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.
- K. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

### **3.09 STARTUP**

- A. Fill system and perform initial chemical treatment. For systems with antifreeze or glycol, fill systems with specified percentages. Refer to Division 23 Section "HVAC Water Treatment" for chemical treatment.
- B. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:
  - 1. Heating Hot-Water Piping: Minimum 30 percent.
  - 2. Chilled-Water Piping: Minimum 30 percent.
- C. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
- D. Before operating the system perform these steps:
  - 1. Open valves to full open position. Close coil bypass valves.
  - 2. Remove and clean strainers.
  - 3. Check pump for proper direction of correct improper wiring.
  - 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) or to bleed air completely (manual type).
  - 6. Set temperature controls so all coils are calling for full flow.
  - 7. Check operation of automatic bypass valves.
  - 8. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
  - 9. Lubricate motors and bearings.

**END OF SECTION**

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