SECTION 23 05 00

HVAC BASIC MATERIALS AND METHODS

PART 1 – GENERAL

1.01 Section Includes

A. Design-Build HVAC system(s).
   1. Design and installation of in-floor radiant heating system throughout entire building.
   2. Forced air split-system air conditioning and heating in all interior spaces under Mezzanine: See Drawings.

1.02 Provide: Any and/or all HVAC systems required by state and/or local codes and/or owner requirements. Provide all required drawings, certifications, and submittals required to acquire appropriate approvals and permits. Provide and submit HVAC plans and calculations to the State of Wisconsin DSPS for review and approval.

1.03 Submittals

A. Product Data: Provide for each HVAC equipment fixture.

B. HVAC Plans: Provide HVAC design plans and calculations designed by a certified Wisconsin HVAC Designer or Engineer.

1.04 Provide: Installation of all designed and approved systems

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

1.02 REFERENCES

A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 1996 (Reaffirmed 2002).

1.03 SUBMITTALS

A. Comply with requirements of Division 1.

B. Product Data: Provide manufacturers catalog literature for each product required.

C. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Brady Corporation.

B. Champion America, Inc.

C. Seton Identification Products.

2.02 IDENTIFICATION – EQUIPMENT NAMEPLATES

A. Description: Laminated three-layer plastic with engraved letters.
   1. Letter Color: White.
   2. Letter Height: 1/2 inch.
   3. Background Color: Black.

PART 3 EXECUTION

3.01 INSTALLATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

C. Identify air handling units and fans with plastic nameplates.

END OF SECTION

SECTION 238316

RADIANT-HEATING HYDRONIC PIPING

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 Section.

1.2 SUMMARY

A. Section includes radiant-heating piping, including pipes, fittings, water regulators, temperature actuated water mixing valves, and piping specialties.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. PEX: Crosslinked polyethylene.

C. PEX/AL/PEX: Crosslinked polyethylene/aluminum/crosslinked polyethylene.

D. PTFE: Polytetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data for piping, fittings, manifolds, specialties, and controls; include pressure and temperature ratings, oxygen-barrier performance, fire-performance characteristics, and water-flow and pressure-drop characteristics.

B. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.

1. Shop Drawing Scale: 1/4 inch = 1 foot (1:50)

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which radiant-heating piping will be attached.
3. Items penetrating finished ceiling, including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.

4. Perimeter moldings.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For radiant-heating piping valves and equipment to include in operation and maintenance manuals.

1.7 WARRANTY

.Manufacturer's Special Warranty on Domestic Products: Conbraco Industries, Inc. warrants products to be free of defects in workmanship or material for a period of five years. This warranty applies to Apollo brand products with "Made in the USA" markings only. Conbraco will correct such defects by suitable repair or replacement at Conbraco's discretion.

B. Manufacturer's Special Warranty on International Products: APOLLO INTERNATIONAL products will be free of defects in workmanship or material for a period of two years. Conbraco will correct such defects by suitable repair or replacement at Conbraco's discretion.

C. Elkhart Products Corporation warranties our fittings to be free from defects in materials and workmanship for a period of fifty (50) years. The Elkhart Product Corporation Water Heater hoses carry a two (2) year warranty against defects in materials and workmanship. Any fitting which proves to be defective will be replaced or a credit issued, but no incidental labor charges, expenses or damages will be allowed.

PART 2 - PRODUCTS

2.1 PEX PIPE AND FITTINGS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Apollo International, Conbraco Industries, Inc.; [94XLF valve] [Tectite 210 Series valve] [210-3 Series valve] [Tectite 200 Series fittings] and Elkhart Products Corporation 900 Series Copper Loc non-removable pressure fittings, or comparable product by one of the following:

1. FlorHeat Company (The).
2. Heat Innovations Inc.
3. Zurn Industries, LLC.

B. Pipe Material: PEX plastic according to ASTM F 876.

C. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F (40 deg C) according to DIN 4726.

D. Fittings: ASTM F 1807, metal insert and copper crimp rings, ASTM F 1960, cold expansion fittings and reinforcing rings

E. Pressure/Temperature Rating: Minimum 100 psig (690 kPa) and 180 deg F (82 deg C).

2.2 PEX/AL/PEX PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Heat Innovations Inc.
2. IPEX USA LLC.
3. Uponor.
4. Viega LLC.
5. Watts Radiant; a Watts Water Technologies company.

B. Pipe Material: PEX plastic bonded to the inside and outside of a welded aluminum tube according to ASTM F 1281.

C. Oxygen Barrier: Limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F (40 deg C) according to DIN 4726.

D. Fittings: ASTM F 1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).

E. Flame-Spread and Smoke-Developed Indices: 25 and 50 or less, respectively, tested according to ASTM E 84.

F. Pressure/Temperature Rating: Minimum 100 psig (690 kPa) and 210 deg F (99 deg C).

2.3 EPDM PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Watts Radiant; a Watts Water Technologies company.

B. Pipe Material: Crosslinked EPDM inner and outer tubes.

C. Wall Thickness: Minimum 0.125 inch (3.2 mm).

D. Oxygen Barrier: Ductile aluminum foil layer applied to the inner tube to limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F (40 deg C) according to DIN 4726.

E. Reinforcing Braid: Braided-aluminum wire between the inner and outer tube.

F. Fittings: ASTM F 1807, copper with stainless-steel crimps or clamps.

G. Pressure/Temperature Rating: Minimum 100 psig (690 kPa) and 210 deg F (99 deg C).

2.4 DISTRIBUTION MANIFOLDS

A. Manifold: Minimum NPS 1 (DN 25), [brass] [copper] [modular plastic] [or] [stainless steel].

B. Main Shutoff Valves:

1. Factory installed on supply and return connections.
2. [Two] [Three]-piece body.
3. Body: Brass or bronze.
4. Ball: Chrome-plated bronze.
5. Seals: PTFE.
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 225 deg F (107 deg C).

C. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Key furnished with valve, or screwdriver bit.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/8 (DN 6).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 225 deg F (107 deg C).

D. Balancing Valves:

1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
6. Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
7. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
8. CWP Rating: Minimum 125 psig (860 kPa).
9. Maximum Operating Temperature: 250 deg F (121 deg C).

E. Zone Control Valves:

1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.

5. Actuator: Replaceable electric motor.
6. CWP Rating: Minimum 125 psig (860 kPa).
7. Maximum Operating Temperature: 250 deg F (121 deg C).

F. Thermometers:

1. Mount on supply and return connections.
2. Case: Dry type, metal or plastic, 2-inch (50-mm) diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, connecting element and pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Black metal.
7. Window: Plastic.
8. Connector: Rigid, back type.
9. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.
10. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

G. Mounting Brackets: Copper, or plastic- or copper-clad steel, where in contact with manifold.

2.5 PIPING SPECIALTIES

A. PEX Tools:

1. Basis-of-Design Product: Subject to compliance with requirements, provide ApolloPEX, Conbraco Industries, Inc.; 68PX Series Tool Sets, or comparable product by one of the following:

B. Cable Ties:

1. Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
2. Minimum Width: 1/8 inch (3 mm).
3. Tensile Strength: 20 lb (9 kg), minimum.
4. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

C. Floor Mounting Staples:

1. Steel, with corrosion-resistant coating and smooth finish without sharp edges.
2. Minimum Thickness: 3/32 inch (2.4 mm).
3. Width: Minimum, wider than tubing.

D. Floor Mounting Clamps:

1. Two bolts, steel, with corrosion-resistant coating and smooth finish without sharp edges.
2. Minimum Thickness: 3/32 inch (2.4 mm).
3. Width: Minimum, wider than tubing.

E. Floor Mounting Tracks:

1. Aluminum or plastic channel track with smooth finish and no sharp edges.
2. Minimum Thickness: 1/16 inch (1.6 mm).
3. Slot Width: Snap fit to hold tubing.
4. Slot Spacing: 2-inch (50-mm) 3-inch (75-mm) intervals.

F. Channeled Subfloor:

1. Plywood, APA-rated subfloor panel, composed of premium, tongue-and-groove, seven-layer, Douglas fir structural subfloor panels.
2. Particleboard manufactured to comply with Federal Housing Authority standards of less than 0.3-ppm formaldehyde.
3. Clad panel with minimum 0.025-inch- (0.635-mm-) thick aluminum recessed in the grooves sized to maintain contact with radiant piping.

G. Modular Interlocking Blocks:

1. Polypropylene snap-together blocks with grooves to support piping.
2. Galvanized sheet metal or aluminum emission plates.
3. Natural mineralboard cover panel.

H. Heat-Emission Plates:

1. Formed aluminum suitable for radiant-heating piping.
2. Minimum Thickness: 1/16 inch (1.6 mm).
3. Slot Width: Snap fit to maintain pressure fit on tubing.

2.6 WATER PRESSURE-REDUCING VALVES

A. Water Regulators

1. Basis-of-Design Product: Subject to compliance with requirements, provide Apollo, Conbraco Industries, Inc.; 36E Series, or comparable product by one of the following:

    a. Watts; a Watts Water Technologies company.
    b. Zurn Industries, LLC.

2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
4. Size: TBD NPS (DN)>.
5. Design Flow Rate: TBD gpm (L/s)>.
6. Design Inlet Pressure: TBD psig (kPa)>.
7. Design Outlet Pressure Setting: TBD psig (kPa)>.
8. Body: Bronze for applications other than potable water; and LF Bronze for use in potable-water applications.
9. Valves for Booster Heater Water Supply: Include integral bypass and diaphragm rated to 180 deg F (82 deg C).
10. End Connections: PEX.

2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Apollo, Conbraco Industries, Inc.; [34ALF] [34BLF] [34A] [34B] Series or comparable product by one of the following:

    a. Watts; a Watts Water Technologies company.
    b. Zurn Industries, LLC.

2. Pressure Rating: 125 psig (860 kPa).
3. Type: Thermostatically controlled, water mixing valve.
4. Material: Bronze or lead free bronze body with corrosion-resistant interior components.
5. Connections: PEX,[union] inlets and outlet.
6. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
7. Tempered-Water Setting: TBD deg F (deg C)>.

B. Multiple Fixture, Water Tempering Valves

1. Basis-of-Design Product: Subject to compliance with requirements, provide Apollo, Conbraco Industries, Inc. [34BLF] [34B] Series, or comparable product by one of the following:

    a. Watts; a Watts Water Technologies company.
    b. Zurn Industries, LLC.

2. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
3. Body: Bronze or lead free bronze body with corrosion-resistant interior components.
4. Temperature Control: Adjustable.
5. Inlets and Outlet: PEX union.
6. Finish: Rough bronze.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: TBD deg F (deg C)>.

2.8 CONTROLS

A. Temperature-control devices and sequence of operations are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Danfoss Inc.
2. HeatLink Group Inc.
3. Honeywell Building Solutions; Honeywell International, Inc.
4. Infloor Radiant Heating Inc.

5. IPEX USA LLC.
6. Oventrop Corporation.
7. REHAU.
8. Slant/Fin Corp.
9. tekmar Control Systems, Ltd.
10. Uponor.
11. Vanguard Piping Systems, Inc.
12. Viega LLC.
13. Watts Radiant; a Watts Water Technologies company.
14. Zurn Industries, LLC.

C. Wall-Mounted Thermostat:

1. Minimum temperature range from [50 to 90 deg F (10 to 32 deg C)]
2. Manually operated with on-off switch.
3. Day and night setback and clock program with minimum four periods per day.
4. Operate pumps or open zone control valves if room temperature falls below the thermostat setting, and stop pumps or close zone control valves when room temperature rises above the thermostat setting.

D. Heated-Panel Thermostat:

1. Remote bulb unit with adjustable temperature range from 50 to 90 deg F (10 to 32 deg C).
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected pump or zone control valve.
3. Remote bulb on capillary tube, resistance temperature device, or thermistor for directly sensing radiant-panel temperature.
4. Stop pump or close zone control valves if heated-panel thermostat setting is exceeded.
5. Corrosion-resistant, waterproof control enclosure.

E. Heated-Panel Thermostat with Outdoor Temperature Reset:

1. Remote bulb unit with adjustable temperature range from 50 to 90 deg F (10 to 32 deg C)
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected pump or zone control valve.
3. Remote bulb on capillary tube, resistance temperature device, or thermistor for directly sensing radiant-panel and outdoor-air temperature.
4. Operate zone control valves to reset supply-water temperature inversely with outdoor-air temperature as follows:

    a. Low outdoor-air temperature, zero deg F (minus 18 deg C) high supply-water temperature 110 deg F (43 deg C)
    b. High outdoor-air temperature, 60 deg F (16 deg C) with low supply-water temperature 70 deg F (21 deg C)

5. Corrosion-resistant, waterproof control enclosure.

F. Precipitation and Temperature Sensor:

1. [Microprocessor-based] [Automatic] control with manual on, automatic, and standby/reset switch.
2. Precipitation and temperature sensors shall sense the surface conditions of pavement and shall be programmed to operate pump and zone control valves as follows:

    a. Temperature Span: 34 to 44 deg F (1 to 7 deg C)
    b. Adjustable Delay Off Span: 30 to 90 minutes.
    c. Start Pump or Open Zone Control Valves: Following two minute delay if ambient temperature is below set point and precipitation is detected.
    d. Stop Pump or Close Zone Control Valves: On detection of a dry surface plus time delay.

3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Minimum 30-A contactor to start pump and open valves.
5. Precipitation sensor shall be mounted in pavement.
6. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive radiant-heating piping for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Ensure that surfaces and pipes in contact with radiant-heating piping are free of burrs and sharp protrusions.
2. Ensure that surfaces and substrates are level and plumb.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Install the following types of radiant-heating piping for the applications described:
1. Piping in Interior Reinforced-Concrete Floors: [EPDM] [PEX] [PEX/AL/PEX].
2. Piping in Level Fill Concrete Floors (Not Reinforced): [EPDM] [PEX] [PEX/AL/PEX].
3. Piping in Ceilings: [EPDM] [PEX] [PEX/AL/PEX].
4. Piping in Subfloors: [EPDM] [PEX] [PEX/AL/PEX].
5. Piping below Wood Floors: [EPDM] [PEX] [PEX/AL/PEX].

3.3 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings or coordination drawings.

B. Install radiant-heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.

C. Connect radiant piping to manifold in a reverse-return arrangement.

D. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.

E. Install manifolds in accessible locations, or install access panels to provide maintenance access as required in Section 083113 "Access Doors and Frames."

F. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties" for pipes and connections to hydronic systems and for glycol-solution fill requirements.

G. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials according to Section 078413 "Penetration Firestopping."

H. Piping in Exterior Pavement:

1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
2. Space cable ties a maximum of 18 inches (457 mm) o.c. and at center of turns or bends.
3. Maintain 3-inch (75-mm) minimum cover.
4. Install a sleeve of 3/8-inch- (9.5-mm-) thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches (250 mm) on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
5. Maintain minimum 40-psig (275-kPa) pressure in piping during concrete placement and continue for 24 hours after placement.

I. Piping in Interior Reinforced-Concrete Floors:

1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
2. Space cable ties a maximum of 18 inches (457 mm) o.c. and at center of turns or bends.
3. Maintain 2-inch (50-mm) minimum cover.
4. Install a sleeve of 3/8-inch- (9.5-mm-) thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches (250 mm) on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
5. Maintain minimum 40-psig (275-kPa) pressure in piping during concrete placement and continue for 24 hours after placement.

J. Piping in Level Fill Concrete Floors (Not Reinforced):

1. Secure piping in concrete floors by attaching pipes to subfloor using tracks, clamps, or staples.
2. Space tracks, clamps, or staples a maximum of 18 inches (457 mm) o.c. and at center of turns or bends.
3. Maintain 3/4-inch (19-mm) minimum cover.
4. Install a sleeve of 3/8-inch- (9.5-mm-) thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches (250 mm) on each side of slab joints to

protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.

5. Maintain minimum 40-psig (275-kPa) pressure in piping during the concrete pour and continue for 24 hours during curing.

K. Piping in Ceiling:

1. Secure piping by attaching pipes to ceiling substrate using clamps or staples.
2. Space clamps or staples a maximum of 18 inches (457 mm) o.c. and at center of turns or bends.
3. Maintain 1-1/2-inch (38-mm) minimum plaster cover.
4. Maintain minimum 40-psig (275-kPa) pressure in piping during the plaster application and continue for 24 hours during curing.

L. Piping in Subfloor:

1. Secure piping by laying in subfloor channels or modular interlocking blocks.
2. Use straight channel panels or blocks in the center and curved channel panels or blocks at the ends.
3. Finish floor with mineralboard panel cover or finished floor surface.

M. Piping below Wood Floor:

1. Secure piping by attaching pipes to subfloor using heat-emission plates, clamps, or staples.
2. Space heat-emission plates, clamps, or staples a maximum of 4 inches (100 mm) o.c. and at center of turns or bends.
3. Install heat-emission plates on underside of wood subfloor with maximum space between plates, as noted above, to maintain pipe contact with floor.

N. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.

O. After system balancing has been completed, mark balancing valves to permanently indicate final position.

P. Perform the following adjustments before operating the system:

1. Open valves to fully open position.
2. Check operation of automatic valves.
3. Set temperature controls so all zones call for full flow.
4. Purge air from piping.

Q. After concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant-heating system as follows:

1. Start system heating at a maximum of 10 deg F (6 deg C) above the ambient radiant-panel temperature and increase 10 deg F (6 deg C) each following day until design temperature is achieved.
2. For freeze protection, operate at a minimum of 60 deg F (16 deg C) supply-water temperature.

3.4 FIELD QUALITY CONTROL

A. Prepare radiant-heating piping for testing as follows:

1. Open all isolation valves and close bypass valves.
2. Open and verify operation of zone control valves.
3. Flush with clean water and clean strainers.

B. Perform the following tests and inspections

1. Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig (690 kPa) Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Radiant-heating piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Protect hydronic piping system from damage during construction.

END OF SECTION