



SECTION 23 83 00

RADIANT HEATING AND SNOW-MELTING SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hydronic radiant floor heating systems.
- B. Hydronic snow and ice melting systems.

1.2 RELATED SECTIONS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 06 10 00 - Rough Carpentry.
- C. Section 06 40 00 - Architectural Woodwork.
- D. Section 07 21 26 - Blown Insulation.
- E. Section 09 30 00 - Tiling.
- F. Section 09 62 19 - Laminate Flooring.
- G. Section 09 64 19 - Wood Composition Flooring.
- H. Section 09 68 16 - Sheet Carpeting.
- I. Section 23 05 00 - Common Work Results for HVAC.

1.3 REFERENCES

- A. ASTM International (ASTM):
 1. ASTM F 876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
 2. ASTM F 877 - Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems.
 3. ASTM F 1281-2005 - Standard Specification for Crosslinked Polyethylene/Aluminum/ Crosslinked Polyethylene (PEX AL PEX) Pressure Pipe.
 4. ASTM F 1807 - Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing.
 5. ASTM F 1960 - Standard Specification for Cold Expansion Fittings with PEX

- Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing.
6. ASTM F 2080 - Standard Specification for Cold-Expansion Fittings with Metal Compression-Sleeves for Cross-Linked Polyethylene (PEX) Pipe.
- B. Canadian Standards Association (CSA): CAN/CSA B137.5 - Cross-Linked Polyethylene (PEX) Tubing Systems for Pressure Applications.
 - C. German Institute for Standards/Deutsches Institut für Normung (DIN): DIN 4726 - Pipelines of Plastic Materials Used in Warm Water Floor Heating Systems; General Requirements.
 - D. International Code Council (ICC): PMG Listing 1053.
 - E. Plastics Pipe Institute (PPI):
 1. Technical Report TR-3 Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.
 2. Technical Report TR-4 Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Piping and Fitting Compounds.
 - F. Society of the Plastics Industry (SPI).

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets for each assembly specified, including but not limited to:
 1. Performance characteristics.
 2. Preparation instructions and recommendations.
 3. Storage and handling requirements and recommendations.
 4. Installation Instructions.
- C. Shop Drawings: Provide shop drawings showing details, including but not limited to tubing layouts, manifold locations, zoning requirements, manifold schedules, interface of the work of this section with the work of adjacent trades and indicating dimensions, tolerances and details required for installation of systems.
- D. System Schematics: Provide mechanical schematic indicating heat source, mechanical piping and accessories from heat source to manifolds, circulators, water tempering and zone controls; indicate supply water temperatures and flow rates to manifolds.
- E. Compliance Certificates: Manufacturer's documentation showing products and systems follow specified performance requirements including but not limited to ASTM F 877 and DIN 4726 (oxygen diffusion); test reports from recognized independent testing laboratories.
- F. Heat Loss Analysis: Detailed heat loss for the structure, and calculation output, surface temperature, water temperature and tubing/manifold pressure drops, calculated using software designed for radiant systems.
- G. Closeout Submittals:
 1. Warranty documentation.
 2. Operation and maintenance data.
 3. Final as-built tubing layout Drawing.
 4. Manufacturer's field inspection reports.
- H. Selection Samples: For each assembly type, two complete sets of samples

representing manufacturer's full range of available piping types.

- I. Verification Samples: For each finish product specified, two samples representing actual piping types specified.

1.5 QUALITY ASSURANCE

- A. Single Source Requirements: To the greatest extent possible, provide hydronic radiant flooring systems and ancillary products specified in this section from a single manufacturer.
- B. Installer Qualifications: Successfully engaged in installation of systems of similar size and complexity for at least 2 years.
- C. Manufacturer Requirements: Appoint a representative to visit and inspection site.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's original, unopened, undamaged containers and packaging with identification labels identifying product name and manufacturer intact.
- B. Deliver, store and handle materials and products in strict compliance with manufacturer's instructions and recommendations and industry standards. Protect from damage.
 - 1. Prevent dirt or foreign materials from entering tubing.
 - 2. Do not expose tubing to direct sunlight for more than 30 days; cover tubing exposed to direct sunlight if construction delays occur.

1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.8 SEQUENCING AND SCHEDULING

- A. Conference: Convene a pre-installation conference to establish procedures to maintain optimum working conditions and to coordinate the work of this section work with related and adjacent work.
 - 1. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
 - 2. Verify project requirements, substrate conditions, floor coverings, manufacturer's installation instructions and warranty requirements.
 - 3. Review project construction timeline to ensure compliance or discuss modifications.
 - 4. Establish the frequency and construction phase during which the project engineer intends for site visits and inspections by the manufacturer's representative.

1.9 WARRANTY

- A. Manufacturer's Warranty: Standard transferable limited warranty against defects in materials and manufacturing.
 - 1. Warranty Period for Tubing: 30 years.
 - 2. Warranty Period for Manifolds and Fittings: 2 years.
 - 3. Warranty Period for Controls and Electrical Components: 2 years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: MrPEX Systems which is located at: 14799 Jackal Street NW, Suite100, Ramsey, MN 55303; Toll Free Tel: 800-716-3406; Tel: 800-716-3406 Fax: 952-423-6114; Email: [request info \(sales@mrpexsystems.com\)](mailto:sales@mrpexsystems.com); Web: www.mrpexsystems.com
- B. Substitutions: Not permitted.
- C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.2 HYDRONIC RADIANT FLOOR HEATING SYSTEMS

- A. Hydronic Radiant Floor Heating Systems: Components and accessories as manufactured by MrPEX Systems, Inc.
 - 1. Compliance: ICC ES PMG 1053.
 - a. Pressure Ratings: PPI TR-3, as listed in PPI TR-4.
 - 1) Hydrostatic Rating: 200 degrees F (93 degrees C) at 80 psi (551 kPa).
 - 2) Hydrostatic Rating: 180 degrees F (82 degrees C) at 100 psi (689 kPa).
 - 3) Hydrostatic Rating: 73.4 degrees F (23 degrees C) at 160 psi (1102 kPa).
 - 2. Thermostat: MrPEX Radiant Thermostat.
 - 3. Glycol and Water Solution: Inhibited propylene glycol; ethylene glycol is not acceptable.
 - a. Type: As indicated on Drawings.
 - b. Type: Premixed, concentrations in accordance with instruction of tubing, manifold, and boiler manufacturers.
 - c. Type: Site-mixed. concentrations in accordance with instruction of tubing, manifold, and boiler manufacturers
 - 4. Installation Accessory: MrPEX Foam Staples.
- B. Through-Penetration Firestopping: Rated through-penetration assemblies as scheduled or indicated on Drawings.
- C. Tubing:
 - 1. Tubing Type: As scheduled or indicated on Drawings.
 - 2. Tubing Type: PEX-a barrier tubing.
 - a. Compliance: ASTM F 876 and ASTM F 877 Pex pipes.
 - b. ICC PMG P1053.
 - c. Oxygen Barrier meets DIN 4726.
 - d. Rated PPI: 73.4 degree F: 160 PSI; 180 degree F: 100 PSI; 200 degree F: 80 PSI.
 - e. Certified by NSF (NSF-rfh).
 - f. CSA B137.5
 - 3. Tubing Type: PEX-AL-PEX tubing.
 - a. Compliance: ASTM F 1281-2005 Pex-Al-Pex Pipes.
 - b. CSA B137.10.
 - c. NSF (NSF pw & NSF rfh).
 - d. Complies with NSF/ANSI Standard 14 and 61 health effects requirements.
 - e. The tubing is in compliance with chlorine resistance test method ASTM F 2023 and carries cNSF and cNSFus mark.

- f. Rated PPI: 73.4 degree F: 200 PSI; 180 degree F: 125 PSI; 200 degree F: 100 PSI.
 - 4. Materials: Crosslinked polyethylene (PEX) manufactured by PEX-a process.
 - 5. Pressure Ratings: Standard Grade hydrostatic design and pressure ratings as issued by the Plastics Pipe Institute (PPI), div. of the Society of the Plastics Industry (SPI).
 - 6. Minimum Bend Radius (Cold Bending): No less than four times the outside diameter. Use the PEX tubing manufacturer's bend supports if radius is less than stated.
 - 7. Barrier Tubing Type: MrPEX Barrier PEX Tubing.
 - a. Oxygen Diffusion Rate: Oxygen diffusion barrier does not exceed an oxygen diffusion rate of 0.10 grams per cubic meter per day at 104 degrees F (40 degrees C) water temperature in accordance with German DIN 4726.
 - b. Tubing Size (ASTM F 876):
 - 1) Nominal Inside Diameter: As scheduled or indicated on Drawings.
 - 2) Nominal Inside Diameter: 3/8 inch (9.53 mm).
 - 3) Nominal Inside Diameter: 1/2 inch (12.7 mm).
 - 4) Nominal Inside Diameter: 5/8 inch (15.88 mm).
 - 5) Nominal Inside Diameter: 3/4 inch (19.05 mm).
 - 6) Nominal Inside Diameter: 1 inch (25.4 mm).
- D. Manifolds: MrPEX Manifolds; residential and light commercial.
- 1. Materials: As scheduled or indicated on Drawings.
 - 2. Materials: Stainless Steel
 - 3. Size: 1-1/4-inch manifolds offered by tubing manufacturer.
 - 4. Use manifold mounting brackets offered by the PEX tubing manufacturer.
 - 5. Description: Provide individual flow control for manifold loops through valve actuators; manual visual flow balancing capability within the manifold body for balancing unequal loop lengths across manifolds.
 - 6. Compatibility: Support 3/8 inch to 5/8 inch tubing.
 - 7. System Design: Locate manifolds such that air can be manually vented from system from each manifold.
- E. Manifolds: MrPEX Manifolds; commercial.
- 1. Description: For use with an isolation valve or a combination isolation and balancing valve on each outlet.
 - 2. Type: As scheduled or indicated on Drawings.
 - 3. Type: 1-1/2 inch stainless steel manifolds.
 - 4. Type: 1-1/2 inch chrome plated Brass manifolds.
 - 5. Type: 1-1/2 or 2 inch copper manifolds manufactured from Type L copper material, offered by tubing manufacturer; support 5/8 inch or 3/4 inch tubing.
 - 6. System Design: Wall-hung or boxed applications.
 - 7. End Caps: Offers tapping for 1/8 inch FNPT and 1/4 inch FNPT for vent and drain.
 - 8. Configuration: As scheduled or indicated on Drawings.
 - 9. Configuration: Reverse-return, to ensure self-balancing.
 - 10. Configuration: Direct-return configuration
- F. Fittings: MrPEX Fittings.
- 1. Compliance: ASTM F 877 and CAN/CSA B137.5 requirements.
 - 2. Compression Fittings: MrPEX EK20, or other fittings as approved by manufacturer.
 - a. Fitting assembly manufactured from nickel-plated brass material.
 - b. Components: Barbed insert, compression ring and compression nut,

- O-ring
 - c. Compatible fittings ASTM F 1807, ASTM F 1960, and ASTM F 2080.
- G. Supply and Return Piping to the Manifolds: For above ground piping.
 1. Properly size supply and return distribution piping for the given volume and velocities required at system design.
 2. Use manufacturer approved distribution piping material (such as MrPEX Barrier PEX, type M copper) for supply fluid temperatures in systems with ferrous components.
 3. Use fittings compatible with piping material. Fittings must transition from distribution piping to system manifolds.
- H. Supply and Return Piping to the Manifolds: For below ground piping.
 1. Properly size supply and return distribution piping for the given volume and velocities required at system design.
 2. Use manufacturer approved distribution piping material (such as MrPEX Barrier PEX, type M copper) for supply fluid temperatures in systems with ferrous components.
 3. Use fittings compatible with piping material. Fittings must transition from distribution piping to system manifolds.
- I. Room Temperature Controls: MrPEX Radiant Thermostats.
 1. Zone Controllers: MrPEX Zone Controllers; supplies 24VAC to the thermostats and actuators. Built-in end-switch and pump output relays activate relays or controls.
 2. Description: Operate within a 1 degree F differential temperature incorporating pulse-width modulation action; digital display in each room or zone as required.
- J. Supply Water Temperature Control: Single temperature with floating action.
 1. Outdoor Reset Controller: Smart Comfort 110; controls tempering of supply water temperature to the radiant floor panel via a three-way or four-way valve.
 - a. Install the outdoor sensor on the north face of the building out of direct sunlight.

2.3 HYDRONIC SNOW AND ICE MELTING SYSTEMS

- A. Hydronic Snow and Ice Melting Systems: Components and accessories as manufactured by MrPEX Systems, Inc.
 1. Compliance: ICC ES PMG 1053.
 - a. Pressure Ratings: PPI TR-3, as listed in PPI TR-4.
 - 1) Hydrostatic Rating: 200 degrees F (93 degrees C) at 80 psi (551 kPa).
 - 2) Hydrostatic Rating: 180 degrees F (82 degrees C) at 100 psi (689 kPa).
 - 3) Hydrostatic Rating: 73.4 degrees F (23 degrees C) at 160 psi (1102 kPa).
 2. Snowmelt Controls:
 - a. MrPEX Automatic Snow Melt Control.
 - b. MrPEX Snowmelt Moisture and Temperature Sensor.
 - c. MrPEX Mounting Socket for Snow Melt Moisture and Temperature Sensor.
 3. Glycol and Water Solution: Inhibited propylene glycol; ethylene glycol is not acceptable.
 - a. Type: As indicated on Drawings.
 - b. Type: Premixed, concentrations in accordance with instruction of tubing, manifold, and boiler manufacturers.

- c. Type: Site-mixed. concentrations in accordance with instruction of tubing, manifold, and boiler manufacturers.
 - 4. Installation Accessory: MrPEX Foam Staples.
- B. Through-Penetration Firestopping: Rated through-penetration assemblies as scheduled or indicated on Drawings.
- C. Tubing:
 - 1. Tubing Type: As scheduled or indicated on Drawings.
 - a. Compliance: ASTM F 876 and ASTM F 877 Pex pipes.
 - b. ICC PMG P1053.
 - c. Oxygen Barrier meets DIN 4726.
 - d. Rated PPI: 73.4 degree F: 160 PSI; 180 degree F: 100 PSI; 200 degree F: 80 PSI.
 - e. Certified by NSF (NSF-rfh).
 - f. CSA B137.5
 - 2. Tubing Type: PEX-AL-PEX tubing.
 - a. Compliance: ASTM F 1281-2005 Pex-Al-Pex Pipes.
 - b. CSA B137.10.
 - c. NSF (NSF pw & NSF rfh).
 - d. Complies with NSF/ANSI Standard 14 and 61 health effects requirements.
 - e. The tubing is in compliance with chlorine resistance test method ASTM F 2023 and carries cNSF and cNSFus mark.
 - f. Rated PPI: 73.4 degree F: 200 PSI; 180 degree F: 125 PSI; 200 degree F: 100 PSI.
 - 3. Materials: Crosslinked polyethylene (PEX) manufactured by PEX-a process.
 - 4. Pressure Ratings: Standard Grade hydrostatic design and pressure ratings as issued by the Plastics Pipe Institute (PPI), div. of the Society of the Plastics Industry (SPI).
 - 5. Minimum Bend Radius (Cold Bending): No less than four times the outside diameter. Use the PEX tubing manufacturer's bend supports if radius is less than stated.
 - 6. Barrier Tubing Type: MrPEX Barrier PEX Tubing.
 - a. Oxygen Diffusion Rate: Oxygen diffusion barrier does not exceed an oxygen diffusion rate of 0.10 grams per cubic meter per day at 104 degrees F (40 degrees C) water temperature in accordance with German DIN 4726.
 - b. Tubing Size (ASTM F 876):
 - 1) Nominal Inside Diameter: As scheduled or indicated on Drawings.
 - 2) Nominal Inside Diameter: 3/8 inch (9.53 mm).
 - 3) Nominal Inside Diameter: 1/2 inch (12.7 mm).
 - 4) Nominal Inside Diameter: 5/8 inch (15.88 mm).
 - 5) Nominal Inside Diameter: 3/4 inch (19.05 mm).
 - 6) Nominal Inside Diameter: 1 inch (25.4 mm).
- D. Manifolds: MrPEX Manifolds; residential and light commercial.
 - 1. Materials: As scheduled or indicated on Drawings.
 - 2. Materials: Brass.
 - 3. Materials: Stainless steel.
 - 4. Size: 1-1/4-inch manifolds offered by tubing manufacturer.
 - 5. Use manifold mounting brackets offered by the PEX tubing manufacturer.
 - 6. Description: Provide individual flow control for manifold loops through valve actuators; manual visual flow balancing capability within the manifold body for balancing unequal loop lengths across manifolds.

7. Compatibility: Support 3/8 inch to 5/8 inch tubing.
 8. System Design: Locate manifolds such that air can be manually vented from system from each manifold.
- E. Manifolds: MrPEX Manifolds; commercial.
1. Description: For use with an isolation valve or a combination isolation and balancing valve on each outlet.
 2. Type: As scheduled or indicated on Drawings.
 3. Type: 1-1/2 inch stainless steel manifolds.
 4. Type: 1-1/2 or 2 inch copper manifolds manufactured from Type L copper material, offered by tubing manufacturer; support 5/8 inch or 3/4 inch tubing.
 5. System Design: Wall-hung or boxed applications.
 6. End Caps: Offers tapping for 1/8 inch FNPT and 1/4 inch FNPT for vent and drain.
 7. Configuration: As scheduled or indicated on Drawings.
 8. Configuration: Reverse-return, to ensure self-balancing.
 9. Configuration: Direct-return configuration
- F. Fittings: MrPEX Fittings.
1. Compliance: ASTM F 877 and CAN/CSA B137.5 requirements.
 2. Compression Fittings: MrPEX EK20, or other fittings as approved by manufacturer.
 - a. Fitting assembly manufactured from nickel-plated brass material.
 - b. Components: Barbed insert, compression ring and compression nut, o-ring.
 - c. Compatible fittings ASTM F 1807, ASTM F 1960, and ASTM F 2080.
- G. Supply and Return Piping to the Manifolds: For above ground piping.
1. Properly size supply and return distribution piping for the given volume and velocities required at system design.
 2. Use manufacturer approved distribution piping material (such as MrPEX Barrier PEX, type M copper) for supply fluid temperatures in systems with ferrous components.
 3. Use fittings compatible with piping material. Fittings must transition from distribution piping to system manifolds.
- H. Supply and Return Piping to the Manifolds: For below ground piping.
1. Properly size supply and return distribution piping for the given volume and velocities required at system design.
 2. Use manufacturer approved distribution piping material (such as MrPEX Barrier PEX, type M copper) for supply fluid temperatures in systems with ferrous components.
 3. Use fittings compatible with piping material. Fittings must transition from distribution piping to system manifolds.
- I. Snowmelt Controls:
1. MrPEX Automatic Snow Melt Control.
 2. MrPEX Snowmelt Moisture and Temperature Sensor.
 3. MrPEX Mounting Socket for Snow Melt Moisture and Temperature Sensor.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Prepare substrates using the methods recommended by the manufacturer for achieving best result for the substrates under project conditions.

- B. Do not proceed with installation until substrates have been prepared using the methods recommended by the manufacturer and deviations from manufacturer's recommended tolerances are corrected. Commencement of installation constitutes acceptance of conditions.
- C. If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

3.2 INSTALLATION - GENERAL

- A. Install products in accordance with manufacturer's instructions and recommendations.
 - 1. Testing: Prior to covering hydronic radiant floor heating systems perform a system pressure test and inspect for leaks; test electrical controls.
 - 2. System circulators must operate continuously for a minimum of 30 days after the system is filled to ensure glycol and water do not separate in static system.
 - 3. For Direct-Return Configuration: Install and balance flow setters on the return leg of each manifold to the mains.
 - 4. Multiple-Zone Control: Install loops per zone and install individual valve actuators on respective loops at the manifold.
- B. Site Visits and Inspections: By manufacturer's representative to visit and inspection site; according to schedule establish in pre-installation meeting.
- C. Glycol and Water Solution: Premixed.
- D. Glycol and Water Solution:
 - 1. Site-mixed, inhibited propylene glycol; ethylene glycol is not acceptable.
 - 2. Mixed before entering system, to concentrations in accordance with instruction of tubing, manifold and boiler manufacturers.
- E. Through-Penetration Firestopping: Ensure compatibility of 1- and 2-hour rated through-penetration assemblies.

3.3 INSTALLATION - SLAB-ON-GRADE

- A. Installation: Slab-on-grade.
 - 1. Fasten tubing to flat mesh or reinforcing bars in accordance with the manufacturer's installation recommendations.
 - 2. Use closer tubing on-center distances along exterior walls. Increase tubing on-center distances as the installation moves away from the exterior wall.
 - a. Do not exceed 12 inches (305 mm) on center for residential use applications.
 - b. Do not install tubing within 6 inches (152 mm) of walls.
 - 3. If the design requires under-slab insulation, the structural engineer determines the vertical compressive strength of the high-density extruded board insulation. The radiant floor design determines the required insulation resistance value (R-value).
 - 4. When using high-density board insulation, staple tubing to insulation board with manufacturer's foam staples.
 - 5. Use edge insulation when the heated panel directly contacts an exterior wall or panel.
 - 6. Install tubing at a consistent depth below the surface elevation as determined by the project engineer. Ensure sufficient clearance to avoid control joint cuts.
 - 7. In areas where tubing must cross metal expansion joints in the concrete, ensure the tubing passes below the joints. Depending on the manufacturer's

and structural engineer's recommendation, fibrous expansion joints may tolerate penetration.

8. For tubing that exits the slab in a 90-degree bend, use bend supports.

3.4 INSTALLATION - PRE-CAST PLANK CONSTRUCTION WITH CAP POUR

- A. Installation: Pre-cast plank construction with a cap pour.
 1. Fasten the tubing to flat wire mesh or reinforcing bar, or snap into PEX rails in accordance with the manufacturer's installation recommendations.
 2. Use closer tubing on-center distances along exterior walls. Increase tubing on-center distances as the installation moves away from the exterior wall.
 - a. Do not exceed 12 inches (305 mm) on center for residential use applications.
 - b. Do not exceed 9 inches (229 mm) on center for tile or linoleum covered floors.
 - c. Do not install tubing within 6 inches (152 mm) of walls.
 - d. Refer to the submitted radiant floor design layout.
 3. If the design requires under-slab insulation, the structural engineer determines the vertical compressive strength of the high-density extruded board insulation. The radiant floor design determines the required insulation resistance value (R-value).
 4. Use edge insulation when the heated panel directly contacts an exterior wall or panel.
 5. Install tubing at a consistent depth below the surface elevation as determined by the project engineer. Ensure sufficient clearance to avoid control joint cuts.
 6. Depending on the manufacturer's and structural engineer's recommendation, fibrous expansion joints may tolerate penetration.
 7. For tubing that exits the slab in a 90-degree bend, use bend supports.

3.5 INSTALLATION - WOOD FLOOR CONSTRUCTION WITH LIGHTWEIGHT GYPSUM POURED UNDERLAYMENT

- A. Installation: Wood floor construction with a lightweight gypsum poured underlayment.
 1. Staple tubing to the wood subfloor in accordance with the manufacturer's installation recommendations. The attachment method should not cause abrasions on the tubing.
 2. Use closer tubing on-center distances along exterior walls. Increase tubing on-center distances as the installation moves away from the exterior wall.
 - a. Do not exceed 9 inches (229 mm) on center for types of floor coverings.
 - b. Do not install tubing within 6 inches (152 mm) of walls.
 - c. Refer to the submitted radiant floor design layout.
 3. Ensure the depth of the lightweight pour is a minimum of 3/4 inch (19 mm) over the outside dimension of the PEX tubing.
 4. Install reinforcing mesh within the pour for finished flooring of tile or linoleum.
 5. Install wood sleepers along the room perimeter and between the tubing to provide a nailing surface for finished wood floors or carpet tack strips as required.
 6. Use lightweight gypsum concrete material for radiant floor heating applications.
 7. Allow lightweight gypsum concrete pour to cure naturally in accordance with the applicator's instructions. Once cured, seal the surface of the poured floor to protect from moisture.
 8. Install insulation in the joist cavity below the floor in accordance with the submitted radiant floor design.

9. Install edge insulation if the heated panel directly contacts an exterior wall or panel.

3.6 INSTALLATION - WOOD FLOOR CONSTRUCTION WITH JOIST HEATING

- A. Installation: Wood floor construction with joist heating, tubing suspended in the joist bay.
 1. Install tubing within the joist cavity in accordance with the PEX tubing manufacturer's recommendations. The attachment method should not cause abrasions to the tubing.
 2. Do not exceed 8 inches (203 mm) on center.
 3. Do not allow tubing within the joist cavity to contact the wood subfloor.
 4. Refer to the PEX tubing manufacturer's installation procedures on proper joist drilling.
 5. Install insulation in the lower portion of the joist cavity. Allow an air gap of 2 inches to 3 inches (51 mm to 76 mm) between the wood subfloor and the top of the insulation.
 6. Use the recommended amount of insulation in the joist cavity below the floor in accordance with the submitted radiant floor design.
 - a. To compute insulation amount, the manufacturer recommends as a guideline a minimum of 5:1 ratio in R-value of the joist insulation to upward resistance.
 7. Use edge insulation if the heated panel directly contacts an exterior wall or panel.

3.7 INSTALLATION - WOOD FLOOR CONSTRUCTION WITH C-FIN PLATES

- A. Installation: Wood floor construction with C-fin plates.
 1. Attach C-Fin panels to wood subfloor in joist cavity according to manufacturer's recommendations.
 2. Do not exceed 8 inches (203mm) on center.
 3. Secure the C-Fin panels to the underside of the wood subfloor and then install the tubing into the C-Fin panel.
 4. Refer to manufacturer's procedures for proper joist drilling.
 5. Install insulation within the joist cavity snugly against the C-Fin panels. Do not allow any air gap between the wood subfloor and the top of the insulation.
 6. Use the recommended amount of insulation in the joist cavity below the floor in accordance with the submitted radiant floor design.
 - a. To compute insulation amount, the manufacturer recommends as a guideline a minimum of 5:1 ratio in R-value of the joist insulation to upward resistance.
 7. Use edge insulation if the heated panel directly contacts an exterior wall or panel.

3.8 INSTALLATION - WOOD FLOOR CONSTRUCTION USING ALUMINUM HEAT EMISSION PLATES

- A. Installation: Wood floor construction using aluminum heat emission plates.
 1. Attach the aluminum heat emission plates to the wood subfloor in the joist cavity according to the PEX tubing manufacturer's recommendations.
 2. Do not exceed 8 inches (203mm) on center.
 3. Pull the tubing through the joist cavity. Install the aluminum plates over the tubing and secure to the wood subfloor.
 4. Refer to manufacturer's installation procedures about proper joist drilling.
 5. Install insulation within the joist cavity snugly against the aluminum panels. Do not allow any air gap between the wood subfloor and the top of the insulation.
 6. Use the recommended amount of insulation in the joist cavity below the floor

in accordance with the submitted radiant floor design.

- a. To compute insulation amount, the manufacturer recommends as a guideline a minimum of 5:1 ratio in R-value of the joist insulation to upward resistance.
7. Use edge insulation if the heated panel directly contacts an exterior wall or panel.

3.9 SNOWMELT INSTALLATION - SLAB ON GRADE OR BELOW GRADE

- A. Installation: Tubing embedded in a concrete slab poured on grade. Tubing is fastened to under slab insulation with plastic foam staples or tied to wire mesh or rebar. Comply with manufacturer's recommendations including the following:
1. Install vapor barrier if required in accordance with approved submittals.
 2. Install foam insulation and tape seams
 3. Route the tubing along the supply path and attach it with foam staples, clips or ties to the wire mesh every 2- 3 feet on the straights as necessary and every 1 foot on the bends. Secure the tubing enough so that it does not float up to the surface during the slab pour.
 4. Embed top of tube in the slab at a minimum of 2 inches (50 mm) below the surface.
 5. Complete loop and test for proper operation.

3.10 SNOWMELT INSTALLATION - PAVERS ON GRADE

- A. Installation: Tubing embedded in a sand layer with pavers on top. Tubing is fastened to high density insulation with plastic foam staples or tied to wire mesh or rebar. Comply with manufacturer's recommendations including the following:
1. Install vapor barrier if required in accordance with approved submittals.
 2. Install foam insulation and tape seams.
 3. Route the tubing along the supply path and attach it with foam staples, clips or ties to the wire mesh every 2- 3 feet on the straights as necessary and every 1 foot on the bends.
 4. Embed top of tube in the sand layer at a minimum of 2 inches (50 mm) below the surface.
 5. Complete loop and test for proper operation.

3.11 FIELD QUALITY CONTROL

- A. Site Tests: To ensure system integrity, pressure test the system before covering tubing in concrete or when other trades are working in the vicinity of the tubing. Test all electrical controls in accordance with respective installation manuals.

3.12 ADJUSTING

- A. Balancing Across the Manifold:
1. Balance loops across manifolds for equal flow resistance based on actual loop lengths and total manifold flow; accomplished with flow control device installed on return piping leg from manifold when direct return piping is used for supply and return mains.
 2. Balancing is unnecessary when loop lengths across the manifold are within 3 percent of each other in length. Install supply and return piping to manifold in reverse-return configuration to ensure self-balancing.

3.13 DEMONSTRATION, TRAINING AND MAINTENANCE

- A. Demonstrate operation of hydronic radiant floor heating system to Owner or Owner's designated personnel.

- B. Maintenance: Advise Owner or Owner's representative about need to establish a maintenance program to monitor glycol solution effectiveness and type, concentration of glycol and water solution used.

3.14 CLEANING AND PROTECTION

- A. Clean installed products in accordance with manufacturer's instructions.
 - 1. Remove temporary coverings and protection of adjacent work areas.
 - 2. Remove construction debris from project site and legally dispose of debris.
- B. Touch-up, repair or replace damaged products before Substantial Completion.
- C. Protect installed products and finishes from damage during construction.

END OF SECTION