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This specification is a manufacturer-specific proprietary product specification using the proprietary method of specifying applicable to project specifications and master guide specifications. Optional text is indicated by brackets [ ]; delete optional text in final copy of specification. Specifier notes typically precede specification text; delete notes in final copy of specification. Trade/brand names with appropriate symbols typically are used in specifier notes; symbols are not used in specification text. Metric conversion, where used, is soft metric conversion.

This specification is for hydronic radiant floor heating systems. These products are manufactured by Uponor, Inc. and marketed under the name Uponor Radiant Floor Heating Systems. Revise section number and title below to suit project requirements, specification practices and section content. Refer to CSI *2004 MasterFormat* for other section numbers and titles.

SECTION 23 83 16
RADIANT-HEATING HYDRONIC PIPING
(RADIANT FLOOR HEATING SYSTEM — PEX-AL-PEX)

PART 1 GENERAL

1.01 SUMMARY

Specifier Note: The work covered by this section includes materials required to supply, install and pressure test crosslinked polyethylene/aluminum/crosslinked polyethylene (PEX-AL-PEX) tubing manufactured by Uponor, Inc. as shown on drawings or as specified. For the purpose of this specification, Uponor, Inc. is hereby referred to as the PEX tubing manufacturer.

A. Section Includes: Radiant floor heating systems for various floor constructions and control strategies, using PEX-AL-PEX, manufactured by Uponor under the name Multi-layer Composite (MLC) Tubing (formerly MultiCor®) and applicable fittings.

Specifier Note: Article below may be omitted when specifying manufacturer's proprietary products and recommended installation. Retain References Article when specifying products and installation by an industry reference standard. If retained, list standard(s) referenced in this section. Indicate issuing authority name, acronym, standard designation and title. Establish policy for indicating edition date of standard referenced. Conditions of the Contract or Division 1 References Section may establish the edition date of standards. This article does not require compliance with standard. It is a listing of all references used in this section.

1.02 REFERENCES

A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

B. ASTM International

1. ASTM E814 Standard Test Method for Fire Tests of Through-Penetration Fire Stops
2. ASTM F1281 Standard Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe

C. International Conference of Building Officials (ICBO) Evaluation Services

1. Evaluation Report No. 5298

D. International Code Council (ICC)

1. International Mechanical Code

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. Southern Building Code Congress International, Inc. (SBCCI)

1. SBCCI PST and ESI 9829

G. International Conference of Building Officials (ICBO)

1. Uniform Mechanical Code.

H. Uponor

1. Complete Design Assistance Manual (CDAM), current edition
2. MLC Tubing (formerly MultiCor) Installation Guide, current edition
3. Uponor System Design Software (USDS) or Advanced Design Suite™ (ADS) Software

Specifier Note: Article below should be restricted to statements describing design or performance requirements and functional (not dimensional) tolerances of a complete system. Limit descriptions to composite and operational properties required to link components of a system together and to interface with other systems.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:

1. Standard Grade hydrostatic pressure ratings from Plastics Pipe Institute in accordance with TR-3 as listed in TR-4. The following four standard grade hydrostatic ratings are required.
    a. 200 degrees F (93 degrees C) at 100 psi (689 kPa)
    b. 180 degrees F (82 degrees C) at 125 psi (862 kPa)
    c. 140 degrees F (71 degrees C) at 160 psi (1102 kPa)
    d. 73 degrees F (23 degrees C) at 200 psi (1379 kPa)

B. Performance Requirements: Provide hydronic radiant floor heating system that is manufactured, fabricated and installed to comply with regulatory agencies and authorities with jurisdiction, and maintain performance criteria stated by the PEX tubing manufacturer without defects, damage or failure.

Specifier Note: Article below includes submittal of relevant data to be furnished by Contractor before, during or after construction. Coordinate this article with Architect's and Contractor's duties and responsibilities in Conditions of the Contract and Division 1 Submittal Procedures Section.

1.04 SUBMITTALS

A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.

B. Product Data: Submit manufacturer's product submittal data and installation instructions.

C. Shop Drawings

1. Provide installation drawings indicating tubing layout, manifold locations, zoning requirements and manifold schedules with details required for installation of the system.

2. 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.

D. Samples: Submit selection and verification samples of piping.

E. Quality Assurance/Control Submittals: Submit the following.

1. Test Reports: Upon request, submit test reports from recognized testing laboratories.

2. Documentation: Submit the following.

a. Manufacturer's certificate indicating products comply with specified requirements.

b. Manufacturer's detailed room-by-room heat-loss analysis for the structure.

c. Documentation indicating the installer is trained to install the manufacturer's products.

F. Closeout Submittals: Submit the following.

1. Warranty documents specified herein.

2. Operation and maintenance data.

3. Manufacturer's field reports specified herein.

4. Final as-built tubing layout drawing.

Specifier Note: Article below should include statements of prerequisites, standards, limitations and criteria that establish an overall level of quality for products and workmanship for this section. Coordinate article below with Division 1 Quality Assurance Section.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Use an installer with demonstrated experience on projects of similar size and complexity and possessing documentation proving successful completion of radiant floor heating training by the PEX tubing manufacturer.

Specifier Note: Paragraph below should list obligations for compliance with specific code requirements particular to this section. General statements to comply with a particular code are typically addressed in Conditions of the Contract and Division 1 Regulatory Requirements Section. Avoid repetitive statements.

B. Regulatory Requirements and Approvals: Provide radiant floor heating system that complies with the following requirements:
   1. International Mechanical Code (IMC)
      a. ICBO Evaluation Service Evaluation Report No. 5298
   2. Building Officials and Code Administrators International (BOCA)
      a. BOCA National Building Code
   3. Southern Building Code Congress International (SBCCI)
      a. SBCCI PST and ESI 9829
   4. Uniform Mechanical Code (UMC)

C. Certifications: Provide letters of certification as follows.
   1. Installer is trained by the PEX tubing manufacturer to install the radiant floor heating system.
   2. Installer uses skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed tradesperson.

Specifier Note: Retain paragraph below if pre-installation meeting is required.

D. Pre-installation Meetings
   1. Verify project requirements, substrate conditions, floor coverings, manufacturer's installation instructions and warranty requirements.
   2. Review project construction timeline to ensure compliance or discuss modifications as required.
   3. Interface with other trade representatives to verify areas of responsibility.
   4. Establish the frequency and construction phrase the project engineer intends for site visits and inspections by the PEX tubing manufacturer's representative.

Specifier Note: Article below should include specific protection and environmental conditions required during storage. Coordinate article below with Division 1 Product Requirements Section.

1.06 DELIVERY, STORAGE & HANDLING

A. General: Comply with Division 1 Product Requirement Section.

B. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

D. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

1. Store PEX-AL-PEX tubing in cartons or under cover to avoid dirt or foreign material from entering the tubing.
2. Do not expose PEX-AL-PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, cover the tubing that is exposed to direct sunlight.

Specifier Note: Coordinate article below with Conditions of the Contract and with Division 1 Closeout Submittals (Warranty) Section. Use this article to require special or extended warranty or bond covering the work of this section.

1.07 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer's Warranty: Submit, for owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights owner may have under contract documents.

1. Warranty covers the repair or replacement of any tubing or fittings proven defective.
2. Warranty may transfer to subsequent owners.

Specifier Note: Coordinate subparagraph below with manufacturer's warranty requirements.

3. Warranty Period for PEX-AL-PEX Tubing: 30-year non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion when installed by a factory-trained Uponor Home Comfort Team (HCT) contractor.
4. Warranty Period for Manifolds and Fittings: 5 year non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion when installed by a factory-trained Uponor HCT contractor.
5. Warranty Period for Controls and Electrical Components: 2 year non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion when installed by a factory-trained Uponor HCT contractor.
6. If a factory-trained Uponor HCT contractor does not install the system, then the most recent limited warranty published by the PEX tubing manufacturer takes precedence.

Specifier Note: List requirements applicable to startup of the various systems. Include requirements for instruction of owner's personnel in the operation of equipment and systems.

1.08 SYSTEM STARTUP

A. [Specify system startup requirements.]

1.09 OWNER'S INSTRUCTIONS

A. Instruct owner's personnel about operation and maintenance of installed system. Provide manufacturer's installation, operation and maintenance instructions for installed components within the system.

PART 2 PRODUCTS

Specifier Note: Retain article below for proprietary method specification. Add product attributes, performance characteristics, material standards and descriptions as applicable. Use of such phrases as "or equal" or "or approved equal" or similar phrases may cause ambiguity in specifications. Such phrases require verification (procedural, legal and regulatory) and assignment of responsibility for determining "or equal" products.

2.01 HYDRONIC RADIANT FLOOR HEATING SYSTEM

Specifier Note: Paragraph below is an addition to CSI *SectionFormat*. Retain, edit or delete paragraph below to suit project requirements and specifier practice.

A. Manufacturer: Uponor, Inc.

1. Contact: 5925 148th Street West, Apple Valley, MN 55124; Telephone: (800) 321-4739, (952) 891-2000; Fax: (952) 891-1409; Website: www.uponor-usa.com.

Specifier Note: Edit Article below to suit project requirements. If substitutions are permitted, edit text below. Add text to refer to Division 1 Project Requirements (Product Substitutions Procedures) Section.

2.02 PRODUCT SUBSTITUTIONS

A. All products, components, etc., specified herein are manufactured by and/or available from the PEX tubing manufacturer.

B. Alternative equipment manufacturers must submit required data for all electrical, mechanical, structural, engineering, etc. revisions for an equivalent system for approval 15 days prior to bid.

C. Alternative equipment manufacturers must submit completed radiant floor design layout to the project engineer for approval. Plagiarism of another manufacturer's design is unacceptable.

Specifier Note: Specify materials to be furnished. This article may be omitted and the materials can be included with the description of a manufactured unit, equipment, component or accessory.

2.03 HYDRONIC RADIANT FLOOR HEATING SYSTEM MATERIALS

A. Tubing

1. Material: Crosslinked polyethylene (PEX) manufactured by PEX-b method.

2. Material Standard: Manufactured in accordance with ASTM F1281 and tested for compliance by an independent third-party agency.

3. Pressure Ratings: Standard Grade hydrostatic design and pressure ratings as issued by the Plastics Pipe Institute (PPI), a division of the Society of the Plastics Industry (SPI).

4. Minimum Bend Radius.

a. [½ inch has a minimum radius of 3.2 inches.]

b. [⅝ inch has a minimum radius of 4.0 inches.]

c. [¾ inch has a minimum radius of 5.0 inches.]

d. [1 inch has a minimum radius of 6.0 inches.]

5. Uponor MLC tubing does not allow the diffusion of oxygen molecules through the tubing wall.
6. Nominal Inside Diameter: Provide tubing with nominal inside diameter in accordance with ASTM F1281 as indicated.
    a. ½ inch [12.7mm]
    b. ⅝ inch [15.88mm]
    c. ¾ inch [19.05mm]
    d. 1 inch [25.4mm]

Specifier Note: Retain, edit or delete paragraph below to suit project requirements and specifier practice. Article lists manifold requirements for residential and light commercial applications. Manifold can support multiple zoning (thermostats) from each manifold location. Delete this article if this type of manifold is not utilized.

B. Manifolds (residential and light commercial, valved brass).
    1. For system compatibility, use 1 1/4-inch manifolds with dezincification resistant brass material, offered by the respective PEX tubing manufacturer.
    2. Use manifold mounting brackets offered by the respective PEX tubing manufacturer.
    3. Manifolds must provide individual flow control for each loop of the manifold through valve actuators available from the manifold supplier.
    4. Manifolds must feature manual flow balancing capability within the manifold body for balancing unequal loop lengths across the manifold.
    5. Manifolds support ½-inch and ⅝-inch MLC tubing.
    6. Each manifold location should have the ability to vent air manually from the system.

Specifier Note: Retain, edit or delete paragraph below to suit project requirements and specifier practice. Article lists valved copper manifold requirements for commercial applications. Manifold designed to support single zoning from each manifold location. Delete this article if this type of manifold is not utilized.

C. Manifolds (commercial, valved copper)
    1. For system compatibility, use 2-inch valved copper manifolds manufactured from Type L copper material, offered by the respective PEX tubing manufacturer.
    2. Install valved copper manifolds primarily for wall-hung or boxed applications.
    3. Use manifolds with an isolation valve or a combination isolation/balancing valve on each outlet.
    4. The manifolds support the use of ⅝ inch or ¾ inch MLC tubing.
    5. Ensure manifold end cap offers tapping for ⅛ inch FNPT and ½ inch FNPT for vent and drain.
    6. Install supply and return piping to the manifold in a reverse-return configuration to ensure self-balancing.
    7. If the supply and return piping is in direct-return configuration, install and balance flow setters on the return leg of each manifold to the mains.

D. Fittings

1. For system compatibility, use fittings offered by the PEX tubing manufacturer.
2. Uponor QS-style Compression Fittings
    a. Fitting assembly manufactured from UNS C3600 series brass material.
    b. The fitting assembly consists of a barbed insert, a compression ring and a compression nut. The barbed insert is manufactured with an o-ring to facilitate air pressure testing.

Specifier Note: Retain, edit or delete paragraph below to suit project requirements and specifier practice.

E. Supply and Return Piping to the Manifolds (above ground piping).

1. Properly size supply and return distribution piping for the given volume and velocities required at system design.
2. Use suitable distribution piping material (i.e., MLC tubing, metric dimensional Wirsbo hePEX™, type M copper or black iron piping) for all supply fluid temperatures in systems with ferrous components.
    a. When using MLC tubing, do not exceed 200 degrees F (93 degrees C) at 100 psi (689 kPa).
    b. When using 32mm through 63mm dimension Wirsbo hePEX tubing, do not exceed 194 degrees F (90 degrees C) at 58 psi (400 kPa).
3. Do not expose MLC and metric dimensional Wirsbo hePEX tubing to direct sunlight or install near overhead fluorescent lighting. If either tubing is exposed, install suitable pipe insulation around the exposed tubing.
4. Use fittings compatible with piping material. Fittings must transition from distribution piping to system manifolds.

Specifier Note: Retain, edit or delete paragraph below to suit project requirements and specifier practice.

F. Supply and Return Piping to the Manifolds (below ground piping).

1. Properly size supply and return distribution piping for the given volume and velocities required at system design.
2. Use suitable distribution piping material (i.e., MLC tubing, metric dimensional Wirsbo hePEX, type K copper or black iron piping) for all supply fluid temperatures in systems with ferrous components.
    a. When using MLC tubing, do not exceed 200 degrees F (93 degrees C) at 100 psi (689 kPa).
    b. When using 32mm through 63mm dimensional Wirsbo hePEX tubing, do not exceed 194 degrees F (90 degrees C) at 58 psi (400 kPa).
3. If copper or black iron piping is embedded in concrete or soil, insulate or protect with sleeves.
4. Use fittings compatible with piping material. Fittings must transition from distribution piping to system manifolds.

G. Room Temperature Controls

1. All thermostats must operate within a 1 degree F differential temperature incorporating pulse-width modulation action.
2. Install an Uponor Heat-only Thermostat with digital display in each room or zone as required.
3. Install an Uponor Heat-and-cool Thermostat with digital display for one room or heating zone and one cooling zone. Centrally locate the thermostat for the respective heating and cooling zones.
4. For multiple zoning control, install the loop(s) per zone and install the individual valve actuators on the respective loop(s) at the manifold.
5. The Uponor Zone Control Module supplies 24VAC to the thermostats and actuators. With end-switch capability, the Zone Control Module activates other relays or controls as required by system control strategy.

Specifier Note: Retain, edit or delete paragraph below to suit project requirements and specifier practice.

H. Supply Water Temperature Control (Single-temperature with Floating Action).

1. Design the control strategy and install the components to meet or exceed the system performance requirements as stated in the system design.
2. Use PEX tubing manufacturer supply water temperature controls and sensors.
3. Temper supply water temperature to the radiant floor panel via a Three-way Floating Action Mixing Valve controlled by the Uponor proMIX™ 101.
4. The proMIX 101 resets the supply water temperature to the radiant floor system as it relates to outdoor temperature.
    a. Install the outdoor sensor (S4) on the north face of the building out of direct sunlight.
5. On receiving a heat demand, the proMIX 101 energizes the system circulator (P1).
6. The proMIX 101 initiates the boiler call for heat.
7. Install a 24VAC transformer to power the circuit between the Zone Control Module end switch and the mix demand terminal of the proMIX 101.
8. Install the outdoor sensor (S4), the system supply sensor (S1) and the boiler return sensor (S3) for proper operation of the control.
9. Review the proMIX 101 Installation Manual for testing, startup and application drawings.

Specifier Note: Retain, edit or delete paragraph below to suit project requirements and specifier practice.

I. Supply Water Temperature Control (Single-temperature with Variable-speed Injection).

1. Design the control strategy and install the components to meet or exceed the system performance requirements as stated in the system design.
2. Use PEX tubing manufacturer supply water temperature controls and sensors.
3. Temper supply water temperature to the radiant floor panel via a variable speed injection pump controlled by the Uponor proMIX 201.

4. The proMIX 201 resets the supply water temperature to the radiant floor system as it relates to outdoor temperature.
    a. Install the outdoor sensor (S4) on the north face of the building out of direct sunlight.
5. On receiving a heat demand, the proMIX 201:
    a. Energizes the system circulator (P1).
    b. Operates the variable speed injection pump (P4).
    c. Initiates the boiler call for heat.
6. Install a 24VAC transformer to power the circuit between the Zone Control Module end switch and the Mix Demand terminal of the proMIX 201.
7. Install the outdoor sensor (S4), the system supply sensor (S1) and the boiler return sensor (S3) for proper operation of the control.
8. Refer to the Uponor proMIX 201 Installation Manual for testing, startup and application drawings.

Specifier Note: Retain, edit or delete paragraph below to suit project requirements and specifier practice.

J. Supply Water Temperature Control (Single-temperature with Variable-speed Injection)
    1. Design the control strategy and install the components to meet or exceed the system performance requirements as stated in the system design.
    2. Use the PEX tubing manufacturer's supply water temperature controls and sensors.
    3. Temper supply water temperature to the radiant floor panel via a variable speed injection pump controlled by the Uponor proMIX 201.
    4. The proMIX 201 resets the supply water temperature to the radiant floor system as it relates to outdoor temperature.
        a. Install the outdoor sensor (S4) on the north face of the building out of direct sunlight.
    5. On receiving a heat demand, the proMIX 201:
        a. Energizes the system circulator (P1).
        b. Operates the variable speed injection pump (P4).
        c. Initiates the boiler call for heat.
    6. Install a 24VAC transformer to power the circuit between the Zone Control Module end switch and the Mix Demand terminal of the proMIX 201.
    7. Install the outdoor sensor (S4), the system supply sensor (S1) and the boiler return sensor (S3) for proper operation of the control.
    8. Refer to the Uponor proMIX 201 Installation Manual for testing, startup and application drawings.

Specifier note: Retain, edit or delete paragraph below to suit project requirements and specifier practice. Paragraph below lists the specification for the Uponor proMIX 212™ control.

K. Supply Water Temperature Control (Two-temperature with Variable-speed Injection)

1. Design the control strategy and install the components to meet or exceed the system performance requirements as stated in the system design.
2. Use the PEX tubing manufacturer's supply water temperature controls and sensors.
3. The variable speed injection pumps, controlled by the Uponor proMIX 212, provide two different supply water temperatures.
4. The proMIX 212 resets the supply water temperature to the radiant floor system as it relates to outdoor temperature.
    a. Install the outdoor sensor (S4) on the north face of the building out of direct sunlight.
5. On receiving a heat demand, the proMIX 212:
    a. Energizes the first system (P1) and the second system (P2) circulators as required.
    b. Operates the first variable speed injection pump (P4) and second variable speed injection pump (P5) as required.
    c. Initiates the boiler call for heat.
6. Install a 24VAC transformer to power the circuit between the Zone Control Module end switch and the Mix Demand terminal of the proMIX 212.
7. Install the outdoor sensor (S4), the first system supply sensor (S1), the second system supply sensor (S2) and the boiler return sensor (S3) for proper operation of the control.
8. Refer to the Uponor proMIX 212 Installation Manual for testing, startup and application drawings.

Specifier Note: Lower temperature radiant system supply water is tempered by a variable speed injection pump or a three-way floating action valve controlled by the Uponor SYSTEMpro™ 311. The SYSTEMpro 311 operates either tempering device but not both in the same installation.

L. Supply Water Temperature Control (High and Low Temperatures with Single-boiler Reset)
1. Design the control strategy and install the components to meet or exceed the system performance requirements as stated in the system design.
2. Use the PEX tubing manufacturer's supply water temperature controls and sensors.
3. The SYSTEMpro 311:
    a. Resets the supply water temperature to the radiant floor system as it relates to outdoor temperature.
    b. Resets the boiler supply water temperature as it relates to outdoor temperature.
4. Install the outdoor temperature sensor (S4) on the north face of the building out of direct sunlight.
5. The SYSTEMpro 311 features domestic hot water (DHW) priority. The DHW pump (P6) controls the flow to the indirect tank.
6. The SYSTEMpro 311 activates the high temperature system (P7) and the low temperature system (P1) circulators.
7. The SYSTEMpro 311 operates the variable speed injection pump (P4) or the three-way floating action valve.

8. The SYSTEMpro 311 controls the boiler activation.
9. Install a 24VAC transformer to power the circuit between the Zone Control Module end switch and the Mix Demand terminal of the SYSTEMpro 311.
10. Install the outdoor sensor (S4), the first system supply sensor (S1), the second system supply sensor (S2) and the boiler supply sensor (S3) for proper operation of the control.
11. Refer to the Uponor SYSTEMpro 311 Installation Manual for testing, startup and application drawings.

2.04 ACCESSORIES

A. Use accessories associated with the installation of the radiant floor heating system as recommended by or available from the PEX tubing manufacturer.

PART 3 EXECUTION

Specifier Note: Article below is an addition to the CSI *SectionFormat*. Revise article below to suit project requirements and specifier's practice.

3.01 MANUFACTURER'S INSTRUCTIONS

A. Comply with manufacturer's product data, including product technical bulletins, installation instructions and design drawings, including the following.
   1. Uponor Complete Design Assistance Manual (CDAM).
   2. MLC Tubing (formerly MultiCor) Installation Guide.

Specifier Note: Specify actions to physically determine that conditions are acceptable to receive primary products of the section.

3.02 EXAMINATION

A. Site Verification of Conditions
   1. Verify that site conditions are acceptable for installation of the radiant floor heating system.
   2. Do not proceed with installation of the radiant floor heating system until unacceptable conditions are corrected.

Specifier Note: Coordinate article below with manufacturer's recommended installation requirements.

3.03 INSTALLATION

Specifier Note: Retain, edit or delete paragraph below to suit project requirements and specifier practice. Article lists requirements for slab-on-grade installation. Delete this article if this type of installation is not utilized.

A. Slab-on-grade Installation
   1. Fasten the tubing to the flat mesh or reinforcing bar in accordance with the PEX tubing 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 (305mm) on-center for residential applications.

b. Do not exceed 9 inches (229mm) on-center for tile or linoleum covered floors.

c. Do not install tubing within 6 inches (152mm) of all walls.

d. Refer to the submitted radiant floor design layout.

3. If under-slab insulation is required by the design, the structural engineer determines the vertical compressive strength of the high-density extruded board insulation. The required insulation resistance value (R-value) is determined by the radiant floor design.

4. When high-density board insulation is used, staple the tubing to the insulation board with Uponor 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 metal or PVC bend supports.

Specifier Note: Retain, edit or delete paragraph below to suit project requirements and specifier practice. Article lists requirements for pre-cast plank construction with a cap pour. Delete this article if this type of installation is not utilized.

B. 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 PEX tubing 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 (305mm) on-center for residential applications.

b. Do not exceed 9 inches (229mm) on-center for tile or linoleum covered floors.

c. Do not install tubing within 6 inches (152mm) of all walls.

d. Refer to the submitted radiant floor design layout.

3. If under-slab insulation is required by the design, the structural engineer determines the vertical compressive strength of the high-density extruded board insulation. The required insulation resistance value (R-value) is determined by the radiant floor design.

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 metal or PVC bend supports.

Specifier Note: Retain, edit or delete paragraph below to suit project requirements and specifier practice. Article lists requirements for wood floor construction with a lightweight gypsum pour underlayment. Delete this article if this type of installation is not utilized.

C. Wood Floor Construction with a Lightweight Gypsum Poured Underlayment

1. Staple tubing to the wood subfloor in accordance with the PEX tubing 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 (229mm) on-center for all types of floor coverings.
    b. Do not install tubing within 6 inches (152mm) of all walls.
    c. Refer to the submitted radiant floor design layout.
3. Ensure the depth of the lightweight pour is a minimum of ¾ inch (19mm) 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.

Specifier Note: Retain, edit or delete paragraph below to suit project requirements and specifier practice. Article lists requirements for use of glycol/water solution in the system. Delete this article if glycol/water solution is not utilized.

D. Glycol/Water Solution

1. PEX tubing manufacturer recommends premixed glycol/water solutions.
    a. PEX tubing manufacturer allows site-mixed solutions if mixed to the proper concentration before entering the system.
    b. Mix the glycol/water solution to proper concentration levels to protect the system freezing during operation shutdown.

c. System circulators must operate continuously for a minimum of 30 days after the system is filled to ensure the glycol and water does not separate in a static system.

2. Do not use ethylene glycol due to toxicity issues. The PEX tubing manufacturer recommends the use of inhibited propylene glycol for hydronic radiant floor heating systems. Refer to the boiler manufacturer's recommendations.

Specifier Note: Retain, edit or delete paragraph below to suit project requirements and specifier practice. Article lists requirements for use of firestop for through-wall penetrations. Delete this article if through-wall penetrations are not utilized.

E. Through-penetration Firestop

1. Ensure one- and two-hour rated through-penetration assemblies are tested in accordance with ASTM E814.
2. Refer to the PEX tubing manufacturer for manufacturers that list PEX-AL-PEX tubing with their firestop systems.

Specifier Note: Specify the tests and inspections required for installed or completed work.

3.04 FIELD QUALITY CONTROL

A. Site Tests

1. 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.
2. Test all electrical controls in accordance with respective installation manuals.

Specifier Note: Specify the final actions required to prepare installed equipment or other completed work to properly function or perform.

3.05 ADJUSTING

A. Balancing Across the Manifold

1. Balance all loops across each manifold for equal flow resistance based on actual loop lengths and total manifold flow.
2. Balancing is unnecessary when all loop lengths across the manifold are within 3 percent of each other in length. Install the supply and return piping to the manifold in a reverse-return configuration to ensure self-balancing.

B. Balancing between manifolds is accomplished with a flow control device installed on the return piping leg from each manifold when direct return piping is used for the supply and return mains.

Specifier Note: Specify the final actions required to clean installed equipment or other completed work to properly function or perform. Coordinate article below with Division 1 Execution Requirements (Cleaning) Section.

3.06 CLEANING

A. Remove temporary coverings and protection of adjacent work areas.

B. Repair or replace damaged installed products.

C. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.

D. Remove construction debris from project site and legally dispose of debris.

Specifier Note: Specify requirements of the installer or manufacturer to demonstrate or train the owner's personnel in the operation and maintenance of equipment.

3.07 DEMONSTRATION

A. Demonstrate operation of hydronic radiant floor heating system to owner's personnel.

B. Advise the owner's representative about the type and concentration of glycol/water solution if used in the hydronic radiant floor heating system.

1. The owner monitors the solution effectiveness through an established maintenance program as outlined by the glycol manufacturer.

Specifier Note: Specify provisions for protecting work after installation but prior to acceptance by the owner. Coordinate article below with Division 1 Execution Requirements Section.

3.08 PROTECTION

A. Protect installed work from damage caused by subsequent construction activity on the site.

END OF SECTION