



This draft specification is for hydronic radiant heating systems using PEX tubing in slab, floor, wall and ceiling applications, and as distribution piping. Roth Industries supplies these systems under the name Roth Radiant Heating Systems.

This draft specification is provided as a guide for the architect/engineer in developing final specifications and is not intended as a substitute for sound architectural/engineering judgment. The architect/engineer is ultimately responsible for creating the final specification that meets the functional and aesthetic needs of his/her client, as well as complying with all applicable codes.

This draft specification follows the format of CSI MasterFormat 2011. Section numbers and titles may be revised to suit project requirements, specification practices and section content.

Draft Specification – PEX tubing

Section 23 83 16

Radiant-Heating Hydronic Piping

(Roth Radiant Heating Systems)

PART 1 – GENERAL

1.01 SUMMARY

- A. Hydronic radiant heating systems using PEX tubing in slab, floor, wall and ceiling applications, and as distribution piping.
- B. The work described in this section includes, but is not limited to, the following:
 - 1. Complete hydronic radiant heating system including tubing, manifolds, fittings, tubing, installation systems, fasteners and controls.
 - 2. Coordination with the selection and installation of circulation pumps and distribution piping.
 - 3. Coordination with system controls and automation.
 - 4. System commissioning and startup service.
- C. Related Sections
 - A. The following sections, though not exhaustive, may have an impact on installation of the hydronic radiant heating system:
 - a. 03 06 00 Schedule for concrete
 - b. 06 06 00 Schedule for Wood, Plastic & Composites
 - c. 07 21 00 Thermal Insulation
 - d. 07 26 00 Vapor Retardation
 - e. 09 30 00 Tiling

- f. 09 50 00 Ceilings
- g. 09 60 00 Flooring
- h. 22 06 00 Schedules for Plumbing
- i. 22 35 00 Domestic Water Heating Exchangers
- j. 23 06 00 Schedule for HVAC
- k. 23 21 00 Hydronic Piping & Pumps
- l. 23 52 00 Heating Boilers
- m. 26 06 00 Schedule for Electrical

1.02 REFERENCES

A. Abbreviations and Acronyms

- 1. PEX – Crosslinked polyethylene
- 2. PEX-c – PEX tubing using the post extrusion electron beam method for crosslinking
- 3. EVOH – Ethyl Vinyl Alcohol (oxygen barrier compound)
- 4. SDR 9 - Standard Dimension Ratio 9 The SDR is the ratio of pipe diameter to wall thickness. SDR 9 – Outside diameter of pipe is 9x the wall thickness of pipe

B. Reference Standards

- 1. ASTM – American Society for Testing and Materials
 - a. ASTM F876 *Standard Specification for Crosslinked Polyethylene (PEX) Tubing*
 - b. ASTM F877 *Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems*
 - c. ASTM 1807-11ae1 *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*
- 2. ASTM F2098-08 *Standard Specification for Stainless Steel Clamps for Securing SDR9 Cross-linked Polyethylene (PEX) Tubing to Metal Insert and Plastic Insert Fittings*
- 3. DIN – German Institute for Standardization
 - a. DIN 4726 *Warm water surface heating systems and radiator connecting systems - Plastics piping systems and multilayer piping systems (used to evaluate oxygen diffusion performance)*
- 4. PPI – Plastic Pipe Institute
 - a. PPI TR-3 *Policies and Procedures for Developing Hydrostatic Design (SDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe*
 - b. PPI TR-4 *Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Piping and Fitting Compounds*

1.03 SUBMITTALS

A. General

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

B. Product Data

1. Submit manufacturer's product submittal forms, brochures, technical data sheets, catalog pages and installation manuals for each product listed in this section.
2. Submit data in sufficient detail to indicate compliance with the contract documents.

C. Shop Drawings

1. Submit detailed design report including room by room heat load data, design temperature, maximum supply temperature, total flow rate, maximum head loss, zone plan, manifold summary including zone name, zone area, indoor air temperature requirement, installation type, tubing size and spacing, loop lengths, manifold and loop flow rates, head losses and supply temperatures, balance valve settings.
2. Submit installation drawings indicating tubing layout, manifold locations, distribution piping and zoning requirements.
3. Submit drawings showing details of manifold installation. If manifolds are installed on a wall, then the details should include all fastening details. If the manifolds are installed in wall cavities, then provide details on all fasteners and access. If manifolds are to be placed in manifold cabinets, then provide details of fastening cabinets to walls, floors or wall cavities.
4. Submit detailed piping schematic including heat source, piping, valves, pumps, mixing devices, oxygen removal devices, expansion tanks, gauges, circuit setters, etc. Indicate type and size where necessary.
5. Provide sectional drawings indicating tubing and accessory installation method(s).
i.e. in-slab, in-joist, above floor sleeper, radiant panels

D. Certificates

1. Submit contractor(s) certification statement(s) that the hydronic radiant system has been installed in accordance with this specification.

E. Closeout

1. Maintenance Contracts
 - a. Submit maintenance contract for system or any part in the system, as required.
2. Operation and Maintenance Data
 - a. Provide operational and maintenance data, as required
 - b. Final as-built tubing layout drawing.
3. Warranty Documentation
 - a. Submit final executed warranty document for system

1.04 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer

- a. Manufacturer shall have a minimum of ten years experience in similar systems.
 - b. Manufacturer shall provide products of consistent quality in appearance and physical properties.
2. Installers
 - a. Installers shall have demonstrated experience on projects of similar size and complexity and/or documentation proving successful completion of system training hosted/approved by the system manufacturer.

1.05 DELIVERY, STORAGE AND HANDLING

A. General

1. Comply with Section 01 60 00, Product Requirements

B. Delivery

1. Deliver materials in original, unopened, undamaged containers or packaging with manufacturer identification labels intact.

C. Storage

1. Store materials in dry, enclosed, well-ventilated area protected from exposure to harmful environmental conditions.
2. PEX tubing and manifold openings shall be covered or capped to prevent contaminants from entering.
3. Do not expose PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, cover the tubing to prevent exposure to direct sunlight.

D. Handling

1. PEX tubing shall be kept away from sharp objects and not be handled in a way as to cause damage and/or puncture.
2. Protect materials from damage by other trades.

1.06 WARRANTY

A. General

1. Comply with Section 01 78 36, Warranties

B. Manufacturer's Warranty

1. Provide manufacturer's standard warranty document.
 - a. PEX tubing shall be under warranty for a period of twenty five (25) years, non-prorated, against failure due to defect in material or workmanship beginning with successful pressurized water tests immediately following system installation.
 - b. Manifolds and fittings shall be under warranty for a period of two (2) years, non-prorated, against failure due to defect in material or workmanship beginning with successful pressurized water tests immediately following system installation.

- c. Electrical and control parts shall be under warranty for a period of two (2) years, non-prorated, against failure due to defect in material or workmanship beginning with successful pressurized water tests immediately following system installation.
2. Manufacturer's warranty is in addition to, and not a limitation of, other rights the Owner may have under contract documents.

PART 2 – PRODUCTS

2.01 MANUFACTURER

A. Acceptable Manufacturer:

Roth Industries, Inc.
268 Bellew Ave. S.
Watertown, NY 13601
(888) 266-8674 (315) 755-1011
Fax (315) 755-1013
Website: www.roth-america.com

B. Substitutions not permitted.

C. All components shall be supplied by one manufacturer.

2.02 MATERIALS

A. Tubing

1. All tubing shall be 5-layer PEX-c.
2. Layers shall consist of the following:
 - A. Inner PEX-c layer
 - B. Adhesive layer
 - C. EVOH layer
 - D. Adhesive layer
 - E. Outer PEX-c layer
3. Tubing shall conform to ASTM F876, ASTM F877 and CSA B137.5.
4. Pipe shall be rated for continuous operation of 100 psi gauge pressure at 180°F temperature (690 kPa at 82°C) and 80 psi gauge pressure at 200°F (550 kPa at 93°C).
5. EVOH layer shall be capable of limiting oxygen diffusion through the pipe to less than 0.32 mg/(m²/d) @ 104°F (40°C) water temperature, in accordance with DIN 4726.
6. The minimum bend radius for cold bending of the tubing shall be no less than six (6) times the outside diameter. Bends with a smaller radius shall require the use of manufacturer supplied metal bend supports.

B. Manifolds

1. Brass manifold sets

- a. Brass manifold sets shall be manufactured in the USA.
- b. A manifold set shall consist of one 1" supply and one 1" return manifold preassembled onto a mounting bracket.
- c. Manifolds shall be manufactured from extruded brass stock with threaded connections.
- d. Manifold sets shall contain visual flow gauge with built in flow adjustment and stop valves, integral valve assemblies for loop isolation and for mounting thermostat controlled valve actuators, manual air vent/fill valve and isolation valves on supply and return.
- e. Manifold sets shall have the following ratings:
 1. Maximum flow rate – 10gpm (37.9lpm)
 2. Maximum operating temperature - 180°F (82°C) continuous
 3. Maximum operating pressure – 150 psi (10.3 bar) continuous
- f. Manifold fittings shall be R20 (nominal 3/4") threaded brass compression fittings.
- g. Manifold sets shall accommodate 3/8", 1/2", 5/8" and 3/4" five layer PEX-c tubing.

2. Copper manifolds

- a. Manifolds shall have a 1 1/2" or 2" trunk, dependent upon design flow rates, with one end flared to receive copper tubing or add manifolds for additional loops.
- b. Manifolds shall have 6 - 3/4" branches.
- c. Manifolds shall include closed end cap with air vent and fill/drain valve.
- d. Manifolds shall have combination PEX-c compression fitting and isolation or a combination of balancing valve and isolation valve on each branch.
- e. Manifolds shall accommodate 1/2", 5/8" and 3/4" five layer PEX-c tubing.
 - a. Manifolds shall have isolation valves on supply and return.

3. High-Flow Brass Manifolds

- a. Manifolds shall have a 1 1/2" heavy-walled, corrosion resistant brass body with threaded connections.
- b. Manifolds shall have 2-6 branches with threaded ends for combining manifolds.
- c. Supply manifold branches shall have isolation valves and return manifold shall have flow valves and valve locks.
- d. Manifold branches shall have 3/4" PEX compression fittings.
- e. Manifolds shall have the following ratings:
 1. Maximum flow rate – 22gpm (83lpm)
 2. Maximum operating temperature - 180°F (82°C)
 3. Maximum operating pressure - 150°F (10.3 bar)

- f. Manifolds shall have manual vents with ball valves and mounting bracket with rubber vibration isolator pads.

D. Fittings

1. For system compatibility, use fittings offered by PEX-c manufacturer.
2. Fittings shall be third party certified to applicable standards ASTM F877 and CSA B137.5.

E. Manifold Cabinets

1. Manifold cabinets, if required, shall be constructed of 18 gauge steel with a gray primer coating.
2. Cabinets may be surface mount on wall or floor or recessed mount.
3. Cabinets shall have knockouts on each side and open at bottom or top for tubing.
4. Cabinets shall be lockable.

F. Distribution Piping (supply and return to manifolds)

1. Distribution piping shall be properly sized for the given volume and velocity required by system design.
2. When using 5-layer PEX-c tubing, do not exceed 200°F (93°C) at 80 psig (550kPa)
3. Fittings shall be compatible with piping material and transition to system manifolds.
4. If copper or black iron is imbedded in concrete or soil, insulate or protect with sleeves.

G. Controls

1. Room thermostats shall be low-voltage devices with electronic temperature sensing and shall be supplied by the manufacturer as part of a proven catalogued system.
2. Individual loop actuators shall be low-voltage thermo-electric design for actuation of valves on brass manifold with visual indication of position and built in end switch and supplied by the manufacturer as part of a proven catalogued system.
3. Individual loop actuators shall be electrically activated by the room thermostats via connection to a multi-zone relay module with the capability to attach an end switch module for activation of pump or heat source control and supplied by the manufacturer as part of a proven catalogued system.

Specifier Note: There are several control strategies that may apply to your specific project. You should consider your requirements and add control specifications to this section as required. Electronic Weather Compensating Mixing controls are recommended, as these match water supply temperature to heat loss, based on outdoor air temperature. Your local ROTH representative or corporate technical team can assist with design and specification of a control system. Please be aware of the need, in some cases, to regulate the supply water temperature to the radiant heating system so as not to exceed limits of flooring materials.

H. Accessories

- A. Use accessories with the installation of the hydronic radiant heating system as recommended by or available from the manufacturer.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verification of Conditions

1. Verify that site conditions are acceptable for installation of the hydronic radiant heating system.
 - a. Verify that work from other trades will not interfere with installation.
 - b. All installation areas shall be cleaned and free from all construction debris.
2. Do not proceed with installation of the hydronic radiant heating system until unacceptable conditions are corrected.

3.02 INSTALLATION

A. General

1. Install system according to design parameters and final shop drawings. All installation notes shown on the drawings shall be followed.
2. Determine manifold locations before installing tubing.
3. Mount manifolds in previously prepared locations and/or in previously installed cabinets. Manifold should be installed as level and plumb as possible.
4. At connections and fittings, use a plastic tubing cutter to ensure square and clean cuts.
5. Tubing shall be dispensed using a suitable uncoiling device. Remove twists prior to securing tubing. Fasten tubing at no more than 3 feet intervals, being careful not to twist the tubing. In thin concrete or gypsum slabs, secure tubing every 2 feet. Use only fasteners supplied or approved by the PEX tubing manufacturer.
6. At time of installation of each loop of tubing, connect the tubing to the correct manifold outlet and record zone area serviced and tubing length for balancing. If manifold is not installed, cap the tubing ends and label the tubing's loop number along with S for supply and R for return and loop length.
7. Manufacturer of finished flooring shall be consulted to confirm maximum surface temperature, maximum increase of temperature rate during start up period, cure rates and any additional information important to maintaining flooring warranty.
8. The following precautions shall be taken in areas intended for carpet:
 - a. Notify carpet installer that radiant heating tubing has been installed.
 - b. Keep tubing six (6) inches from all wall baseplates.

- c. Install metal guards where tubing will pass through wall baseplates and where carpet tack strips will be installed.
8. The following precautions shall be taken in areas intended for hardwood flooring:
 - a. Notify hardwood installers that radiant heating tubing has been installed.
 - b. Ensure that nailing areas for hardwood flooring, if nailing is required, are clearly marked and known for hardwood installers.
9. If the radiant heating system substrate material (thermal mass) requires curing and/or has other limitations which can be influenced by the radiant heating system while in operation, then the radiant heating system shall not be put into operation until such time that the substrate material has fully cured or set according to the material requirements of the substrate manufacturer

B. Slab-on-Grade

1. Verify sub-grade is compacted, flat and smooth to prevent damage to pipe or insulation.
2. Approved vapor barrier and thermal insulation, according to design, shall be installed.
3. Reinforcing wire mesh, if required by structural design, must be flat and level.
4. Attach tubing to reinforcing wire mesh, rebar or foam insulation using approved fastener according to design.
5. Tubing shall be spaced according to design.
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. Tubing shall be sleeved with fully enclosed polyethylene conduit at penetration point of concrete.

C. Suspended Slab

- a. Verify subfloor meets structural and load requirements of installation.
- b. Approved vapor barrier and thermal insulation, according to design, shall be installed.
- c. Attach tubing to subfloor according to manufacturer's installation recommendations.
- d. Tubing shall be spaced according to design.
- e. 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. Tubing shall be sleeved with fully enclosed polyethylene conduit at penetration point of concrete.
7. Each tubing loop shall be labeled with loop number, loop length and name of zone. Supply and return ends shall be clearly marked.

D. Wood Floor Construction with a Lightweight Gypsum Topping

- a. Verify subfloor meets structural and load requirements of installation.

- b. Approved thermal insulation, according to design, shall be installed in the joist cavity below the floor.
- c. Install edge insulation if the heated panel directly contacts an exterior wall or panel.
- d. Attach tubing to subfloor according to manufacturer's installation recommendations.
- e. Tubing shall be spaced according to design.
- f. Gypsum topping shall be a minimum of 3/4" over outside wall of tubing.
- g. Tubing shall be sleeved with fully enclosed polyethylene conduit at penetration point of gypsum topping.

E. Wood Floor Construction with Above Floor Radiant Panels

- 4. Approved thermal insulation, according to design, shall be installed in the joist cavity below the floor.
- 5. Install radiant panels and tubing per manufacturer's installation guide.

F. Wood Floor Construction with Under Floor, In-Joist Heating

1. Joist Penetrations

- a. Comply with specification requirements when creating penetrations through joists.
- b. When drilling holes through joists, drill in middle third of joist vertically and keep a minimum of 12 inches from end of joist

2. Installation without Heat Transfer Plates

- a. Do not exceed 8 inches on center. Refer to design parameters.
- b. Route tubing into joist bays according to manufacturer's installation instructions.
- c. Attach tubing directly to or hang 1" from subfloor using manufacturer approved fasteners.
- d. Do not attach tubing to side of joists.
- e. Install reflective insulation, according to design, underneath tubing across full expanse of joist. Allow an air gap of 2 – 3" between subfloor and tubing.

3. Installation with Sheet Style Aluminum Heat Transfer Plates

- a. Do not exceed 8 inches on center. Refer to design parameters.
- b. Route tubing into joist bays according to manufacturer's installation instructions. Loosely attach tubing at "U" bend to allow easier installation of plates.
- c. Plates shall be installed end to end with a minimum of 1/4" gap between ends to allow for expansion.
- d. Snap tubing into groove in plate and staple or screw plate onto subfloor. Plates shall be fastened to subfloor on both sides and approximately 3/4" from groove.
- e. Install insulation, according to design, underneath tubing across full expanse of joist. Insulation shall be placed up against aluminum plate.

4. Installation with Extruded Aluminum Transfer Plates

- a. Do not exceed 8 inches on center. Refer to design parameters.
- b. Install plates onto subfloor using screws end to end with a minimum of 1/4" gap to allow for expansion.
- c. Route tubing into joist bays according to manufacturer's installation instructions.
- d. Snap tubing into plate.
- e. Install insulation, according to design, underneath tubing across full expanse of joist. Insulation shall be placed up against aluminum plate.

G. Walls and Ceilings

a. Installation using Sleeper Method

- a. Install vapor barrier and insulation, according to design, in stud or joist cavity.
- b. Fasten 1" x 4" furring strips perpendicular to stud or joist 6" or 8" on center leaving space for tubing bends at the end of panel.
- c. Fasten single groove aluminum heat transfer plate to furring strips with staples or screw on both sides of groove.
- d. Route tubing back and forth, snapping into plates.
- e. Cover assembly with appropriate wallboard.

b. Installation using Radiant Panel

- i. Install vapor barrier and insulation, according to design, in stud or joist cavity.
- ii. Attach radiant panel system to stud or joist per manufacturer installation instructions.
- c. Route tubing back and forth, snapping into plates.
- d. Cover assembly with appropriate wallboard.

H. Glycol and Water Solution

- a. Glycol and water solution, if required by design, shall be pre-mixed at designated concentration before entering the system.
- b. Refer to boiler manufacturer for recommendations and restrictions on the use of glycol and water solutions.

3.03 FIELD QUALITY CONTROL

A. Air Leak Testing

1. Completed system shall be leak tested by applying air pressure to a minimum of 60 psig. (do not exceed 150psig)
2. Use liquid leak detector or soap solution to check for leakage at manifold connections.

B. System Filling and Purging

1. System shall be filled with required fluid, as determined by design, and purged of air.

C. Liquid Leak Testing

1. Perform a preliminary leak test by pressurizing the system to the greater of 1.5 times the maximum operating pressure or 100psig for 30 minutes.
 - a. As tubing expands, restore pressure, first at 10 minutes into the test and again at 20 minutes.
 - b. At the end of the 30-minute preliminary test, pressure shall not fall by more than 8 psig from the maximum, and there shall be no leakage.
 2. After successfully performing the preliminary leak test, perform the main leak test immediately.
 - a. The test pressure shall be restored and continued as the main test for 2 hours.
 - b. The system pressure shall not fall more than 3 psig after 2 hours.
 - c. No leakage shall be detected.
 3. Test pressure shall be maintained and monitored during installation of thermal mass (slab).
 - a. If a leak is detected during installation of thermal mass, leak shall be found immediately and the area cleared for repair using manufacturer's approved repair coupling and heat shrink material.
 - b. Retest before covering repair.
 4. If liquid leak test is performed with water, precautions must be taken to prevent freezing until project is complete.
 5. If liquid leak test is performed with water and operating fluid is a glycol and water solution, system must be purged with air before filling with solution.
- D. Complete and furnish leak test reports to owner or general contractor, as required.

3.04 SYSTEM ADJUSTING

- A. Loop Flow Balancing
 1. Equalize the flow in each loop of a manifold. Perform this function for each individual manifold.
- B. Manifold Flow Adjusting
 1. Adjust flow to each individual manifold with the use of a flow control or circuit setter device. Flows determined by design requirements.
- C. Floor Surface Temperatures
 1. Once system is operating at full temperature, verify floor surface temperatures are within design and flooring manufacturer limits.

3.05 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.

3.06 DEMONSTRATION

- A. Demonstrate operation of system to Owner or Owner's personnel.
- B. Instruct Owner or Owner's personnel in type, concentration and maintenance of the water and glycol solution, if present.
- C. Provide Owner or Owner's personnel with manufacturer's installation, operation and maintenance instructions for installed components within the system.

3.07 PROTECTION

- A. Protect installed work from damage by subsequent construction activity on the site.
- B. Provide Owner with photos and drawings of completed work.