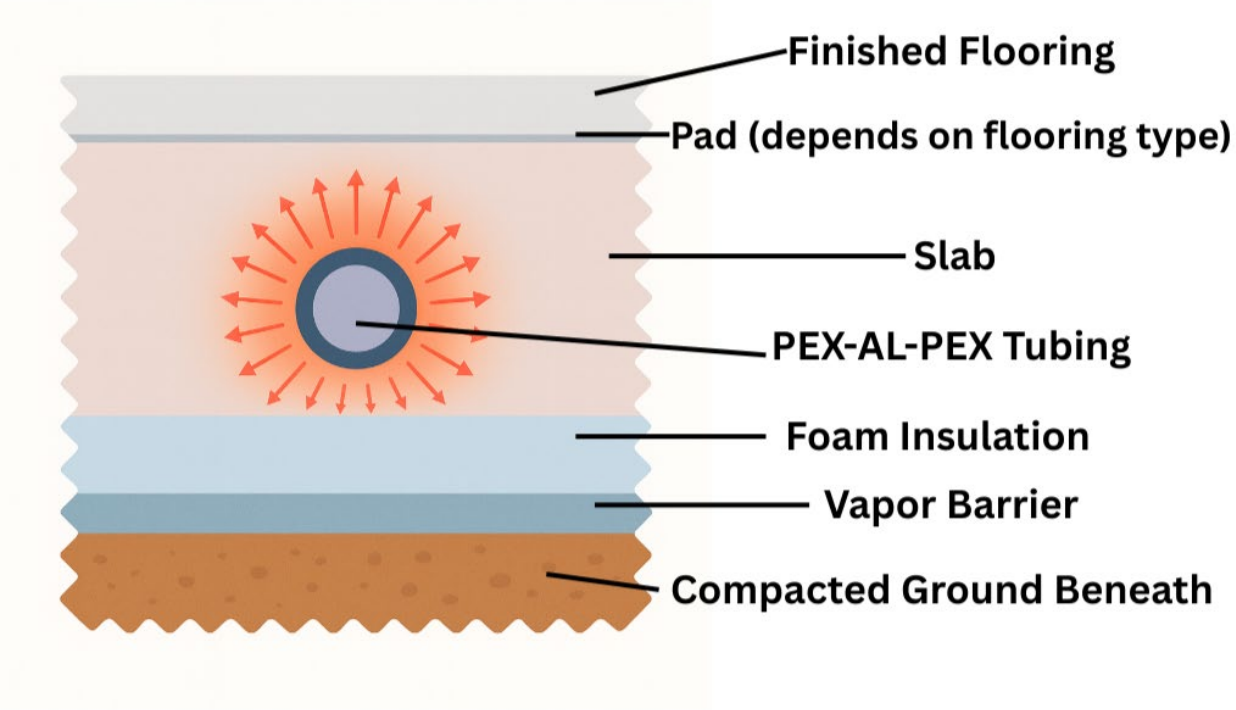
In-Slab Hydronic Radiant Heating — Installation Manual (Slab-on-Grade)



Intended Audience: Contractors, builders, HVAC, concrete, and flooring professionals
Applies To: Hydronic radiant tubing embedded in concrete slabs-on-grade for residential and light commercial projects.

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1. Purpose, Scope, and Responsibilities

This manual provides end-to-end instructions for planning, installing, testing, and commissioning in-slab hydronic radiant heating systems on concrete slabs-on-grade.

- **Installer responsibilities:** Follow all applicable building, plumbing, mechanical, electrical, and energy codes; observe manufacturer instructions for all components; comply with the structural engineer's details and the design professional's load calculations.

- **Design responsibilities:** Heat-loss calculations, loop layout and lengths, manifold zoning, pump selection, balancing targets, and control strategy are by the designer of record.
- **Safety:** Use appropriate PPE; lockout/tagout electrical; never pressure-test with flammable gas; follow confined-space and silica exposure rules.

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2. System Overview

A closed-loop hydronic system circulates tempered water through oxygen-barrier tubing embedded in the concrete slab. The slab stores and releases heat to the space, providing quiet, uniform comfort.

Key principles:

- **Insulation matters.** Continuous under-slab and edge insulation reduce heat loss and improve response.
- **Tube depth matters.** Keep tubing at or below mid-depth with adequate concrete cover (see Section 9).
- **Even surface temps.** Counterflow spirals and balanced loops help avoid hot/cold streaking.
- **Controls.** Outdoor reset or mixing controls limit supply temperature and protect floor coverings.

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3. Materials (Typical)

- **Tubing:** Oxygen-barrier PEX or PEX-AL-PEX, 3/8"–3/4". Residential slabs commonly use 1/2". Observe the manufacturer's minimum bend diameter and pressure/temperature ratings.
- **Manifolds:** Supply/return manifold with isolation valves, balancing flow meters, purge/drain points, and automatic air vent. Cabinet optional.
- **Fittings:** Eurocone-style or other compatible compression fittings matched to tubing size/type.
- **Fastening:** Plastic ties, wire ties, or clips compatible with reinforcement; concrete-rated anchors/stakes as required.

- **Insulation:** Rigid foam rated for the slab load (compressive strength per structural requirements); perimeter and field insulation per energy code/climate.
- **Vapor Retarder:** Polyethylene or composite membrane suitable for under-slab use; seams taped/sealed; penetrations sealed.
- **Reinforcement:** Welded wire reinforcement (WWR) and/or deformed bars per structural drawings; chairs/spacers to position steel mid-depth.
- **Penetration Protection:** Corrugated sleeves or conduit at slab entries and where tubing crosses joints; long-sweep elbows for vertical risers.
- **Controls & Heat Source:** Boiler or water heater, mixing valve or injection/mixing pump, thermostats/actuators, and safety devices per design.

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4. Tools & Equipment (Recommended)

- Tape measures, layout chalk, laser, marker paint
- Rebar/mesh chairs, tubing uncoiler, tie tools
- Pressure-test pump (water), calibrated pressure gauge
- Vacuum/purge assembly with drain/flush hoses
- IR thermometer or surface probe (for commissioning)
- PPE: safety glasses, gloves, hearing protection, silica-rated respirator as needed

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5. Pre-Install Coordination

- Confirm design package: room-by-room loads, target water temps, loop spacing, loop length limits, and manifold zoning.
- Review structural details: slab thickness, reinforcement, joint plan (control, expansion, isolation), and any thickened edges or FPSF (frost-protected) details.
- Confirm finished flooring: allowable floor surface temperature, max moisture, and radiant compatibility.
- Schedule: pressure test witness, pour day personnel, saw-cut timing, and inspection requirements.

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6. Sub-Base Preparation

- Grade and compact per geotechnical/structural requirements; provide a uniform, level support and capillary break where required.
- Remove debris and sharp objects that could damage the vapor retarder or insulation.
- Verify elevations for finished floor, slab thickness, and door thresholds.

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7. Insulation & Vapor Retarder

- **Field insulation:** Install rigid foam across the slab area per energy code and design. Use appropriate compressive strength (PSI) for load conditions.
- **Perimeter insulation:** Provide continuous vertical edge insulation at slab perimeter; extend above the insulation plane as detailed. In frost regions, follow FPSF designs if applicable.
- **Vapor retarder:** Place under the slab (above insulation unless detailed otherwise). Lap seams per manufacturer, tape seams, and seal all penetrations. Keep surface clean for reinforcement placement.

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8. Reinforcement (WWR/Rebar)

- Place reinforcement on chairs so steel sits at approximately mid-depth of the slab.
- Maintain designed clearances from edges and penetrations.
- Do not drag mesh or rebar over the vapor retarder without protection.

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9. Tubing Handling & Placement

- **Tube type:** Use oxygen-barrier PEX or PEX-AL-PEX suitable for hydronic heating.
- **Bend minimums:** Respect the manufacturer's minimum bend diameter (typical guidance: 1/2" ≈ 6" min; 5/8" ≈ 7"; 3/4" ≈ 8"—verify with your tubing spec).

- **Wall offsets & obstacles:** Keep 4–6" off framed walls. Avoid areas under permanent cabinets, floor registers, toilet flanges (keep ≥8"), and fastener zones.
- **Depth & cover:** Keep tubing at or below mid-depth with **≥1" concrete cover** above the tubing after finishing.
- **Fastening:** Tie tubing to reinforcement at intervals (about every 24–30" straight runs, closer at bends). Add stakes or anchors to prevent float during the pour.
- **Protection:** Use sleeves or conduit where tubing exits the slab and anywhere it is exposed to potential damage.

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10. Layout Patterns & Spacing

- **Common spacings:** 6", 9", or 12" on-center. Tighten spacing near high-loss perimeters and large glazing.
- **Patterns:**
    - *Counterflow spiral* for uniform surface temperatures.
    - *Serpentine* where simple routing or rectangular rooms favor it.
- **Loop balance:** Keep loops on the same manifold within ~10% total length of each other (including leaders) to simplify balancing.

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11. Loop Lengths & Hydraulics

- **Typical planning range (1/2" tubing):** ~250–330 ft per loop, then confirm by head-loss calculations for the selected pump and design ΔT.
- Record the measured length of each loop and label it at the manifold. Maintain a loop schedule in the as-built documents.

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12. Manifold Location & Mounting

- Locate manifolds to minimize leader lengths and ease service access. Consider visibility for gauges and air vents.
- **Temporary mounting for layout day:** Secure the manifold to a rigid backer or cabinet framing at the planned elevation. Protect and cap all ports.

- **Penetrations:** Use long-sweep elbows and sleeves at slab entries. Group and label leaders neatly.

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13. Joints: Control, Expansion, and Isolation

- **Control joints (saw-cuts):** Coordinate tube routing to avoid cuts. Where crossing is unavoidable, route the tubing at the **bottom of the slab** in a short protective sleeve centered on the joint. Typical saw-cut depth ≈ 1/4 slab thickness (verify with the finisher/engineer).
- **Expansion/isolation joints:** Use protective sleeves below slab level and place a thin poly "slip sheet" over the sleeve so the concrete doesn't bond to it. Keep tubing clear of dowels, waterstops, and load transfer devices.

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14. Pressure Testing

Follow your local code and the tubing manufacturer's instructions.

- **Preferred:** Hydrostatic pressure test (water). Common practice is **100 psi (690 kPa) minimum for ≥30 minutes** before concrete placement. Many specs also require maintaining a visible test pressure throughout placement and finishing.
- **Air testing:** Only where allowed by the authority having jurisdiction **and** tubing manufacturer. If permitted, use dry, regulated air with safety controls. **Never** use flammable gas.
- **Procedure (typical):**
    1. Cap all circuits at the manifold.
    2. Fill with water and purge air from each loop.
    3. Pressurize to test pressure and hold ≥30 minutes; inspect for leaks.
    4. Restore/maintain ~30–60 psi during the pour so damage is immediately obvious.

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15. Concrete Placement & Finishing

- Keep tubing **under pressure** during placement and saw-cutting.

- Use placing methods that prevent tubing displacement. Do not hook or snag tubing with tools or rebar.
- Vibrate and finish per concrete best practices; avoid aggressive bull-floating directly over shallow tubing.
- Maintain cover—do not pull tubing upward.

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16. Saw-Cutting & Joint Treatment

- Cut control joints on the finisher's schedule to preempt random cracking. Do **not** saw where tubing is present.
- Where a crossing was planned, confirm tubing is at the bottom of slab in a sleeve centered on the joint. Maintain pressure during cutting.

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17. Curing, Initial Heat-Up, and Flooring

- Cure the slab per specification. Do not operate the system to accelerate cure unless directed by the engineer/finish spec.
- **Initial heat-up:** After the slab reaches required strength and moisture condition, start warm and increase supply temperature gradually (e.g., steps of ≤10 °F per 24 hours) up to design supply temperature.
- **Flooring:** Follow the flooring manufacturer's moisture and temperature limits. Many comfort standards cap occupied floor surface temperatures around 85 °F (29 °C). Use low-R finishes (tile, engineered products rated for radiant) where response is critical.

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18. Controls, Balancing, and Commissioning

- **Controls:** Outdoor-reset or mixing controls are recommended to modulate supply temperature based on outdoor conditions and load. Limit max supply temperature to protect finishes.
- **Balancing:** Set initial flows at the manifold based on design; verify loop ΔT at steady state; fine-tune to achieve uniform surface temperatures.

- **Air removal:** Bleed at manifolds and high points; confirm operation of automatic air vents.
- **Documentation:** Record final flow settings, supply/return temperatures, and control setpoints. Keep a copy with the owner's documents.

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19. Operation & Maintenance (O&M)

- Inspect annually: check system pressure, vents, valves, and any actuators/thermostats.
- Keep a clean strainer (if used) and service the pump per manufacturer instructions.
- If remodeling, **locate tubing** before coring/fastening (use the as-built drawing and a thermal camera/locator).

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20. Troubleshooting (Quick Guide)

- **Uneven floor temps:** Re-balance flows; verify air removal; confirm loop lengths and spacing; check supply temperature.
- **Slow response:** Confirm insulation coverage; verify control strategy (outdoor reset); consider perimeter boost zones (within comfort limits).
- **No heat in a loop:** Check actuator/valve position, flow meter reading, and purge air.
- **Unexpected pressure drop:** Inspect for leaks at manifolds/fittings; isolate loops as needed.

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21. As-Built Documentation (Deliverables)

- Final loop layout drawing with circuit IDs and measured lengths
- Manifold location(s) and zoning diagram
- Insulation and vapor retarder details (photos recommended)
- Pressure-test records (date, pressure, duration, witness if required)
- Commissioning log: final flows, ΔT, supply temperature limits, control programming

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22. Quick Checklists

A. Pre-Pour Checklist

- Sub-base compacted and level
- Insulation complete (field + perimeter) and protected
- Vapor retarder installed, seams taped, penetrations sealed
- Reinforcement placed on chairs (mid-depth)
- Tubing placed: spacing correct, offsets respected, tied/staked, minimum bends respected
- Sleeves installed at all slab entries and joint crossings; slip sheets set where required
- Manifold mounted; loops labeled with measured lengths
- Hydrostatic pressure test completed and documented (maintain pressure for pour)

B. Pour Day Checklist

- Pressure maintained on all circuits; gauge visible
- Tubing protected at high-traffic and tool staging areas
- Placement and vibration controlled to prevent tubing displacement
- Finish per spec; confirm saw-cut window and depths

C. Post-Pour & Commissioning Checklist

- Joint cuts completed without contacting tubing
- Gradual system heat-up after cure requirements are met
- Loops balanced to design flows; ΔT verified
- Controls programmed (limits and schedules set)
- Owner receives as-built documentation and O&M notes

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23. Notes & Best Practices

- Keep loops serving the same area within ~10% length for easier balancing.

- Group leaders neatly and protect them with sleeves or conduit where exposed.
- Avoid running tubing through door thresholds unless necessary; protect with sleeves if you must.
- Photograph tubing near penetrations and along joint lines before the pour for future reference.
- Where frost design applies, coordinate slab edges and insulation with local FPSF details.

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24. Support

Installation must follow this manual, applicable codes, and component manufacturer instructions. Improper installation can void warranties. For technical support or design assistance (layouts, sizing guidance, control selection), contact:

FloorHeat LLC — Technical Support
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