

Chapter 1: Glossary

It is important to become familiar with the terminology used in this manual to fully understand the design and installation of hydronic radiant floor, wall and ceiling heating systems. Some of the definitions found in this chapter are unique to hydronic radiant floor, wall and ceiling heating systems, and some may be applicable only to Uponor systems.

Active loop length — The length of piping within the total loop length that is physically installed within the room to be heated.

Below-grade edge insulation — The amount of insulation (expressed in R-value) placed against the vertical edge of a radiant slab that is more than 4 feet below grade.

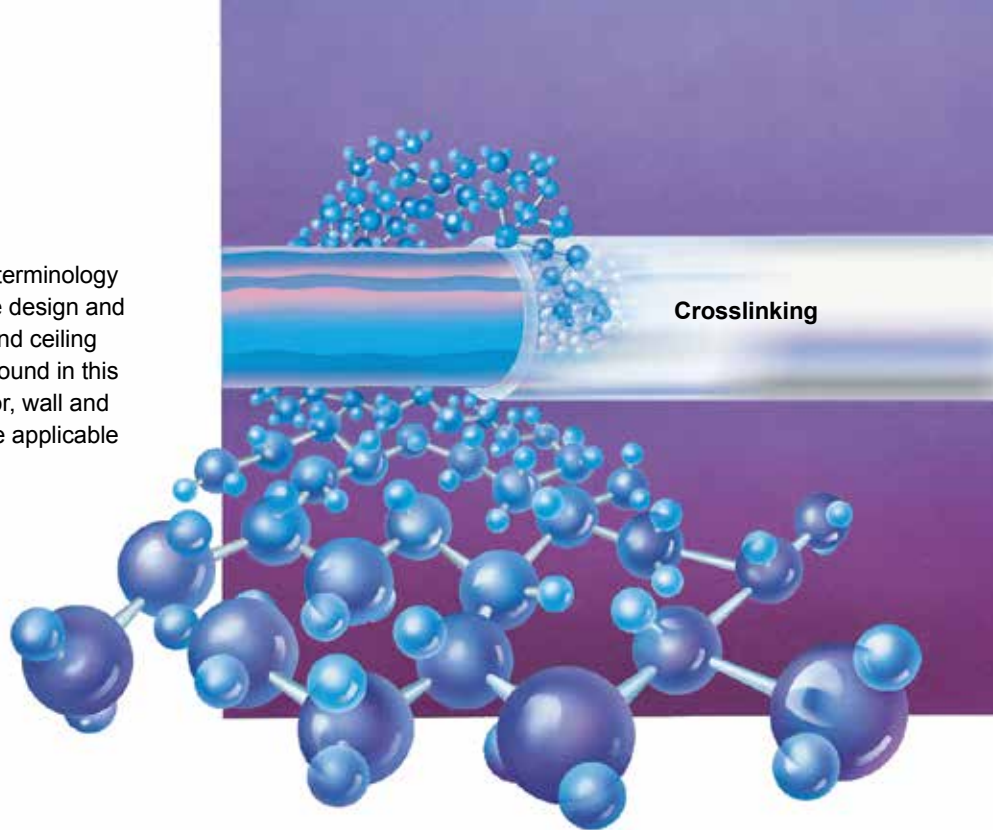
Below-grade perimeter insulation — The amount of insulation (expressed in R-value) placed horizontally under the first 4 feet from the perimeter of a radiant slab that is more than 4 feet below grade.

BTU (British Thermal Unit) — A unit of measure equal to the amount of energy necessary to raise the temperature of one pound of water one degree Fahrenheit.

- BTU/h — The amount of BTU expended per hour.
- BTU/h/ft² — The amount of BTU expended per hour per square foot of panel. BTU/h/ft² is derived by dividing the BTU/h by the amount of available square footage in the room to be heated.

Bypass loop — A piping arrangement that directs the flow of a heat-absorbing medium (water) around, rather than through, a piece of mechanical equipment.

Closed loop — Any piping arrangement in a circulating system that protects the circulating medium (water) against exposure to atmospheric pressure.



Closed system — Any closed-loop hydronic piping system that prevents atmospheric oxygen from entering the system to a degree which effectively protects components from excessive oxidative corrosion. (See **DIN 4726**.)

Conduction — A process of heat transfer whereby heat moves through a material or between two materials that are in direct contact with each other.

Convection — Transfer of heat by movement of a liquid or a gas.

- Natural convection is a result of movement caused by changes in density as temperature changes within a fluid medium such as a liquid or a gas.
- Forced convection is the result of mechanical force moving a fluid or gas.

Crosslinking — A chemical process that changes the molecular structure of a polymer material by linking otherwise independent hydrocarbon chains. Crosslinking creates a three-dimensional network of hydrocarbons. The end product is incapable of being melted and is insoluble.

Degree day — A unit of measurement used to describe potential heat load (Heating Degree Day or HDD). It is equal to one degree variation from a standard temperature to the average temperature of one day. For example, if the standard is 65°F and the average outside temperature is 50°F for one day, then the number of degree days equals 15 (65 - 50 = 15).

Differential temperature (Δt) — The difference in temperature between two opposing masses used to describe the potential that exists for heat transfer.

Diffusion — A penetration process that describes the tendency of gas or liquid molecules to spread out into the entire space that is available (including spaces that exist within solids). Diffusion is expressed as a function of the volume of space available. A related process, permeation, describes the movement of such substances through a solid membrane and is expressed in terms of the area of membrane penetrated.

DIN — DIN is an abbreviation for the German Institute of Standards (Deutsches Institut für Normung).



DIN 4726 — An internationally recognized standard that prescribes, among other things, the maximum rate of oxygen diffusion allowed for non-metallic pipes used in closed-loop hydronic heating systems.

Downward loss — The amount of heat energy in BTU/h/ft² transferring downward from a radiant heated floor.

Dry-bulb temperature — The temperature of air recorded by a thermometer that is freely exposed to the air, but does not take into account effects from moisture or radiation. The dry-bulb temperature is the temperature that is generally referred to as the air temperature.

Edge area — The exposed surface of a radiant heated slab equal to the thickness of the slab multiplied by the exposed linear perimeter length.

Edge insulation — The amount of insulation (expressed in R-value) placed vertically along the exposed perimeter of the slab.

Effective floor area (EFA) — The approximate square footage of a radiant floor that effectively radiates heat to satisfy the heat load of a zone. EFA is the result of multiplying the net floor area by the effective floor factor.

Effective floor factor (EFF) — An approximation (expressed in percentage) used to describe the amount of net floor area that will effectively radiate heat. This factor is used by the designer to take into consideration intangibles (such as abnormally large furniture that covers a large percentage of floor space) that might interfere with heat transfer from the floor.

Efficiency rating (ER) — A ratio of energy output to energy input expressed as a percentage. It is used to describe the amount of energy available for the intended purpose of the appliance and is independent of cost.

Engel method — A peroxide-based method of manufacturing crosslinked polyethylene (PEX) piping. Engel-method PEX is crosslinked during the extrusion process while the raw polyethylene is above its crystal melting temperature, creating an even, consistent, three-dimensional network of joined hydrocarbons.

Exposed perimeter insulation — The amount of insulation (expressed in R-value) placed either horizontally or vertically to a distance or depth of 4 feet along an exposed perimeter of a radiant slab less than 4 feet below grade.

Exposed perimeter length — Equal to the linear feet of perimeter less than 4 feet below grade along an outside wall.

Floating action — Output used to modulate the position of an actuator motor and mixing valve. Power is applied to drive the valve further open or closed. If no power is supplied, the valve will remain at its present position.

Floor insulation — The amount of insulation (expressed in R-value) placed directly below a radiant floor to reduce downward heat loss.

Gross floor area — The entire floor surface area of a room or zone whether heated or not.

HDPE — Abbreviation for high-density polyethylene.

Head pressure loss — The pressure available at the outlet side of a pump or inlet side of a flow conducting system. It is expressed in feet of head. Feet of head is the height of a column of water that is supported by a pump against standard atmospheric pressure.

Heat loss — The transfer of heat from a contained space to the atmosphere surrounding it. Heat loss is the result of heat transfer through walls, windows, roofs and other building-envelope components, as well as infiltration losses due to the exchange of heated inside air with unheated outside air.

Heating load — The amount of energy (in BTU/h) required for space heating.

Infiltration — The exchange of warm air inside a building with the cold air outside. Natural infiltration takes place as a result of air leakage through minute openings in walls, windows, doors and ceilings. Controlled infiltration occurs due to the forced exchange of a mechanical system. Infiltration is expressed in air changes per hour or fractions thereof. For natural infiltration in newly constructed homes, Uponor recommends calculation at a rate of 0.35 air changes per hour for new construction. Compensate accordingly for older homes.

Infiltration losses — The loss of heat energy due to infiltration, which is expressed in BTU/h. Infiltration losses are calculated from the air changes per hour, differential indoor/outdoor temperature and the heat-carrying capability of the lost air.

Injection mixing — A method of resetting radiant system water by injecting hot boiler water into a lower-temperature distribution loop in order to maintain proper radiant system supply water temperature. In addition, injection mixing can allow for changes in radiant system supply water temperatures based on changes in outside weather conditions. Injection mixing can be controlled through either an on/off valve or variable-speed injection pumping using a simple wet rotor type circulator. Refer to the variable-speed injection essay in **Appendix I** for more information.

Leader loop length — The horizontal and vertical distance from the heated room to the manifold in which the loop originated. This distance is multiplied by two (supply and return) and added to the active loop length to obtain the total loop length.

Lightweight concrete — Thinly poured concrete (typically 1½ inches) with small aggregate that can be used in some poured-floor applications. The concrete is poured over the piping that is directly fastened to a plywood subfloor. The lightweight concrete needs to be leveled and is prone to cracking due to structural movement if reinforcing material is not used in the concrete. Do not confuse with gypsum-based concrete underlayment. (See definition for **poured-floor underlayment**.)

Linear expansion (thermal) — Refers to the physical material characteristic of a body which causes it to expand in the presence of heat. It is known as heat expansion. Linear expansion creates a force within the product which, if held back by huge compressive strengths such as concrete, will transmit itself as an internal stress. Unlike other piping products, PEX is highly resistant to stresses caused by linear expansion.

Mean radiant temperature (MRT) — The area-weighted average temperature of all the surfaces in a room.

Net floor area (NFA) — The gross floor area minus the unheated floor area. This is the area of the radiant floor, measured in square feet, that has PEX piping installed.

Olefins — Unsaturated hydrocarbon substances (double bond). The most important building blocks (monomers) of the olefins are ethylene, propylene and butylene.

Open system — A circulating hydronic system exposed to atmospheric conditions. Open systems require components resistant to oxidative corrosion. Open systems are the result of continual introduction of fresh water, open vessels or oxygen diffusion through non-metallic components.

Operative temperature — The uniform temperature where an occupant would exchange the same amount of heat via radiation and convection as the surrounding controlled environment. Simply, the operative temperature combines the effects of radiation and convection. The operative temperature equals the sum of the air temperature and mean radiant temperature, divided by two. Operative temperature may also be referred to as the equivalent temperature or operative temperature.

Outdoor design temperature — A standard design temperature somewhat warmer than the seasonal lowest temperature for the area. In the 2017 ASHRAE Handbook, Chapter 14 Climatic Design Information, Appendix: Design Conditions for Selected Locations recommends selecting a residential design temperature at 99% of the seasonal lowest temperature. Adjustments may be made to reflect local climates which differ from the tabulated temperatures due to altitude differences or local weather experiences. Outdoor design temperature is used to calculate anticipated load under the most common low-temperature conditions expected to occur without over-sizing the heat appliance.

Partially exposed basement slab — A concrete slab in which a portion of the slab is more than 4 feet below grade and a portion is less than 4 feet below grade. This is commonly featured in homes with walk-out lower levels.

PE — Abbreviation for polyethylene.

Perimeter area — The first 4 horizontal feet in from the exposed perimeter of the slab (applicable to under-slab insulation).

Perimeter insulation — The amount of insulation (expressed in R-value) placed horizontally for the first 4 feet along the exposed perimeter of the slab.

Perimeter length — The linear length of the slab perimeter for a room exposed to outside conditions (used to calculate edge area).

PEX — Abbreviation for crosslinked polyethylene.

PEX-a — PEX-a is produced using the peroxide (Engel) method of extrusion. The peroxide method is a result of the crosslinking taking place above the crystal-melting point during extrusion. This method is also called hot crosslinking. Hot crosslinking produces crosslinking all the way through the piping wall. PEX-a piping is approximately 85% crosslinked, making it the most uniformly crosslinked type of PEX.

PEX-b — PEX-b is made via two separate processes. Crosslinking is performed in a secondary, post-extrusion process that produces about 65% to 70% crosslinking. As crosslinking occurs below the crystal-melting point, there is not uniform crosslinking throughout the piping wall.

PEX-c — PEX-c is produced by using an electron beam to change the molecular structure of the piping, which generates crosslinking after the extrusion process. Multiple passes of the beam are required to create crosslinking of 70% to 75%. This process may discolor the piping as well as result in a slightly stiffer product.

Polymer extrusion — A method used for the continuous formation of piping from polymer materials.

Polyolefin — A general term for a polymer built from olefins (e.g., polypropylene, polybutylene and polyethylene).

Poured-floor underlayment — A thin (typically 1½ inches) underlayment of gypsum-based concrete. The material is poured over the piping that is directly fastened to a plywood subfloor. The material is self-leveling and requires minimal finishing by the installer. The poured underlayment must be sealed for moisture after the concrete has cured. Do not confuse with lightweight concrete.

Pressure loss — The loss of fluid pressure between any two points in a flow-conducting system, expressed in pounds per square inch (psi). The loss of pressure is caused by friction against the piping walls and is further influenced by the piping size, length and texture of the inside wall of the piping, fittings, valves and other components. Pressure loss is also influenced by the temperature and viscosity of the fluid.

Primary/secondary pumping — The boiler loop with its own circulator is referred to as the primary loop. Secondary loop is any feed from the primary (boiler loop) that is the same

or lower temperature with its own circulator for flow control. Often in radiant floor systems, the secondary flow is first tempered to a lower temperature before entering the secondary loop.

R-value — A measure of a material's ability to resist the flow of heat. R-value is expressed in BTU/h/ft² ($1/U = R$).

Radiant emission — A measure of the propensity of a surface to radiate heat energy to its surroundings in the form of long-wave radiation.

Radiation — The process in which energy in the form of rays of light or heat is transferred from body to body without heating the intermediate air acting as the transfer medium.

Reactive tempering valve — A three-way, nonelectric valve that, when used in radiant heating applications, maintains a constant supply water temperature despite variations in boiler supply water temperatures. A reactive tempering valve mixes hot boiler water with cooler radiant system return water to produce a specific supply water temperature (setpoint).

Room setpoint temperature — The desired thermostat setting for the room, typically 65°F to 68°F for radiant floor heating. Radiant ceiling systems are designed with a 70°F setpoint

temperature. Radiant ceiling systems use a higher setpoint due to the lack of conductive transfer from the system.

Slab below grade — A concrete slab with the entire slab at a minimum of 4 feet below grade.

Slab depth — The thickness of the slab at the perimeter.

Slab on grade — A concrete slab with a perimeter that is less than 4 feet below the surface.

Supplemental heat — Additional heat provided by some distribution means other than the primary radiant floor or ceiling system to satisfy the heat-loss requirement.

Surface temperature — The required temperature at the floor surface required to transfer the calculated amount of BTU/h into a room for a given setpoint temperature to satisfy the current load. Radiant floor surface temperatures should not exceed 87.5°F for constant habitation. The surface temperatures should not exceed 80°F for hardwood floors. Radiant ceiling surface temperature should not exceed 100°F for 8-foot ceilings and 110°F for 9-foot to 12-foot ceilings.

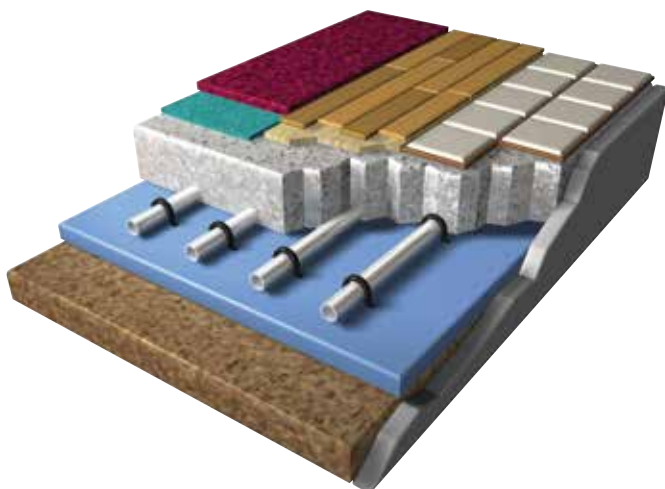


Figure 1-1: Slab-on or below-grade with underslab and edge insulation

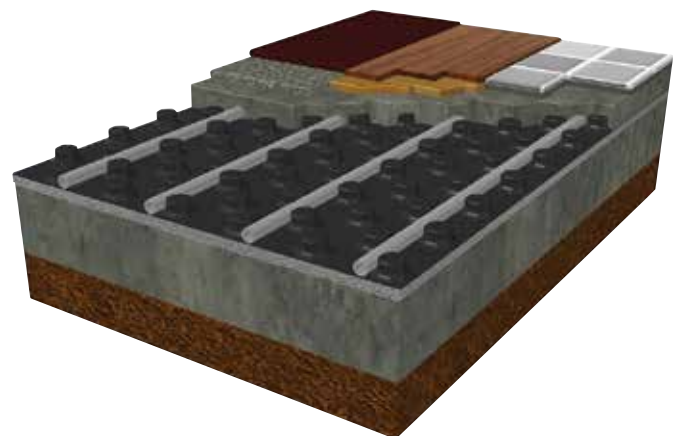


Figure 1-2: Poured-floor underlayment with Uponor Fast Trak™ 1.3i on finished floors

Suspended floors — Any floor which does not rest directly on the surface of the earth. Suspended floors may be constructed of any material and may be installed over heated or unheated spaces.

Temperature below — The temperature of the soil or air below the center of the radiant slab or suspended floor. For slab-on-grade or slab-below-grade floors not exposed to very high water tables, Uponor recommends using a temperature below or equal to the room setpoint temperature. This temperature is likely to occur for the longest portion of the heating season and under design conditions.

Thermal conductivity — Thermal conductivity is a metric for the ability of a material to conduct heat. For a given material, the thermal conductivity is the rate of heat transfer through a unit thickness per unit area per degree of temperature difference. In English units, thermal conductivity is measured in BTU/hr/ft²/°F.

The thermal conductivity of PEX-a piping is 0.202 BTU/hr/ft²/°F.

Thermal mass — Any material used to store heat energy or the affinity for heat energy.

Total heat transfer coefficient — Describes the transfer of heat from a bordering surface expressed in BTU/h/ft²/°F. Thermal transfer coefficient is comprised of radiation, convection and conduction properties, as well as the orientation of the radiant surface (floor, ceiling or wall).

- Radiant floor thermal transfer coefficient = 2.0 BTU/h/ft²/°F
- Radiant wall thermal transfer coefficient = 1.4 BTU/h/ft²/°F
- Radiant ceiling thermal transfer coefficient = 1.1 BTU/h/ft²/°F

Total loop length — The active loop length added to the leader loop length equals the total loop length.

U-value — The capability of a substance to transfer heat. Used to describe the conductance of a material or composite of materials,

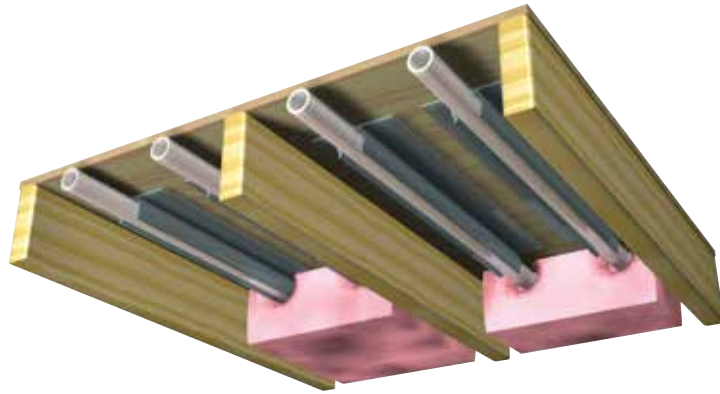


Figure 1-3: Suspended floors heating with Uponor Joist Trak™ heat emission plates

in construction. U-value is expressed in BTU/h/ft² and is the inverse function of R-value ($1/R = U$)

Under-slab area — The interior portion of the slab to include all but the first 4 feet around the perimeter.

Under-slab insulation — The amount of insulation (expressed in R-value) under the interior area of the slab, excluding the perimeter area.

Unheated floor area — The amount of floor included in the gross floor area that does not have piping installed.

Upward load — The amount of heat energy expressed in BTU/h/ft² required to overcome the envelope losses of the room.

Velocity — The speed of fluid at a specific flow expressed in feet per second (fps).

Volumetric flow rate — The volume of a fluid that passes through a given cross-sectional area per unit of time. Volumetric flow rate is commonly expressed in terms of cubic feet per minute (cfm) or gallons per minute (gpm).

Water table temperature — Equal to the estimated temperature of the water table for the area and is used when the presence of a water table will affect the performance of the radiant panel heating system. Typically, insulation should be added below a radiant slab if there is a water table within 6 feet of the slab.

Weather-responsive reset —

A method of fine-tuning a radiant system by changing the system supply water temperature based on changing weather conditions. As the outside temperature decreases, the supply water increases. Likewise, as the outside temperature increases, the supply water temperature decreases.

Zone — An area of a radiant panel served by one or more loops, and individually controlled through a thermostat.

