MANIFOLDS

Watts Radiant offers a wide range of manifolds for RadiantPEX. Manifolds can be outfitted with CrimpRing or T-20 Compression fittings, with or without mini-ball valves. Additional accessories include unions, isolation valves, temperature gauges, vent/purge assemblies, actuators, and visual flow indicators. Other options can be found on the Watts Radiant RadiantPEX Submittal or in the Watts Radiant product catalog on our Web site.



Cast brass manifolds

CrimpAll[™] Tool

Tools for 3/8", 1/2", 5/8", 3/4", 1" connections.

Radiant**PEX****

NOMINAL I.D.

3/8"

1/2"

5/8"

3/4"

1"

3/8" RadiantPEX

1/2" RadiantPEX

5/8" RadiantPEX

3/4" RadiantPEX

1" RadiantPEX

CRIMPRING TOOL:





Stainless steel manifolds









FASTENING SYSTEMS:

Cross-Linked Polyethylene Tubing with EVOH Barrier

STANDARD COIL LENGTHS

600'

100'/300'/600'/1000'

600'/1200'

100'/600'/1200'

600'

FLUID CAPACITY PER 100'

0.50 Gal.

0.92 Gal.

1.4 Gal.

1.8 Gal.

3.0 Gal.





SnapClip™ and StrapDown™ installed in ClipRail





LockDow

Faster

RadiantPEX is a cross-linked polyethylene tubing manufactured with an EVOH oxygen barrier. All sizes meet ASTM F-876 standards and are manufactured to SDR 9 dimensions. It is shipped in 100' to 1200' length boxed coils in 3/8", 1/2", 5/8", 3/4", and 1" sizes.

BEND

RADIUS

4"

5"

6"

7"

10"

CODES, LISTINGS, AND STANDARDS

0.D.

1/2"

5/8"

3/4"

7/8"

1-1/8"

RadiantPEX is manufactured in accordance with American Standard Testing Methods F-876 and F-877, is Certified by NSF to Standards 14 and 61, and is listed by the International Conference of Building Officials (ICBO) Report #ER-6080 and the International Association of Plumbing and Mechanical Officials (IAPMO) carrying the Uniform Plumbing Code symbol. All RadiantPEX pipe sold in Canada is approved to CSA Standard B137.5.





A Watts Industries Company

In the United States: Watts Radiant

3131 W. Chestnut Expwy. Springfield, MO 65802 1-800-276-2419 toll-free 417-864-6108 phone 417-864-8161 fax www.wattsradiant.com

In Canada:

Watts Industries-Canada 5435 North Service Road Burlington, ON L7L 5H7 1-888-208-8927 toll-free phone 905-332-4090 phone 1-888-882-1979 toll-free fax 905-332-7068 fax www.wattscanada.ca











RECIE

This RadiantPEX Installation Manual represents the collective knowledge of thousands of our customers who have been kind enough to help us with ideas and techniques that have worked for them. We have selected the best of these ideas and rigorously refined them.

TM



This refining process is based on the collective wisdom that comes from having an engineering and technical staff with well over 100 years of combined experience with modern floor heating and snowmelting. Please take the time to carefully read this manual before installing your floor heating or snowmelting system.

PLEASE NOTE:

This manual only covers installation of Watts Radiant's RadiantPEX tubing, and should not be used for the installation of our Onix radiant hose.

This is not a design manual. For design assistance, we encourage you to contact us or our representatives for a design analysis using Watts Radiant's RadiantWorks[®] system design software.

Before designing or installing a radiant heating or snowmelting sytstem, you should always consult with local, experienced design and installation professionals to ensure compliance with local building practices, climate conditions, state and local building codes, and past customs.

Snowmelting Applications

Slab on Grade

Warm up a concrete slab to provide space heat.

Install a minimum of 2" of concrete above the top of the RadiantPEX for residential and 3" for commercial floor heat applications. You may need a greater thickness over the RadiantPEX, depending on structural loading.

Use an extruded polystyrene (Dow[®] Blue Board[®]) insulation board on the edge of, and optionally under the slab, depending on site conditions.

Slab over Existing Slab

Used when placing a new radiant slab directly over an existing slab. A great application when the slab will be subjected to heavy loads.

Where space permits, we recommend the use of extruded polystyrene (Dow[®] Blue Board[®]) insulation at the perimeter of the new slab. The use of poly-fiber material in the new concrete slab will add crack resistance.

In this application the RadiantPEX can be tied to rewire or poultry netting depending on the structural needs of the project. Sprayed-on insulation also works well in this application.

Typical Slab Snowmelt

This is the most popular application in snowmelting and it provides the best snowmelting performance.

Install RadiantPEX midway in the slab or at a depth that will provide a minimum of 3" of concrete over the top of the RadiantPEX; more may be required depending on structural loading.

The size and spacing of RadiantPEX varies widely in snowmelting projects and is based on many variables. Always refer to specific design information for the project.

Also, drainage is important in snowmelting. Make sure provisions are made to safely carry away the melt water.

Note that insulation is not required in this application.



Slab over Steel Deck



Fasten the RadiantPEX in place and then cover it with a minimum of 2" of portland concrete mix above the RadiantPEX; more may be required depending on structural loading.

Use a foil-faced insulation for this application, with the foil facing up, and a 2" minimum air space between the foil surface and the steel deck.

Brick Paver Snowmelt

This is a popular choice when



brick pavers are being installed in an entrance, courtyard, driveway or other outdoor area where snow and ice removal is needed. RadiantPEX is installed in a sand or crushed stone base, then secured with wire hooks every 2' along its length. A layer of sand is then placed over the RadiantPEX and compacted to provide a minimum of 1" coverage above the top of the RadiantPEX (more may be required

depending on structural loading). The brick pavers are then installed on the compacted base material.

The size and spacing of RadiantPEX varies widely in snowmelting projects and is based on many variables. Always refer to specific design information for the project. Also, drainage is important in snowmelting. Make sure provisions are made to safely carry away the melted water.

Note that insulation is not required in this application.



Section

Typical radiant zoning.

UnderFloor Applications

Introduction	6
Heat Transfer Basics	6
RadiantPEX Tubing	6
General RadiantPEX Installation Precautions	8
The Design Process	12
Step 1: Initial Design Considerations	12
Floor Coverings	12
Tile Floors	13
Hardwood Flooring	13
Controlling Moisture	14
Installation Cautions	15
Carpet and Pad Flooring	16
Step 2: Radiant Zoning	16
1. Zoned by Floor Coverings	16
2. Zoned by Occupancy	16
3. Zoned by Construction	16
4. Zoned by Mechanical Considerations	17
Step 3: Manifold Location	17
Step 4: Heat Loss Calculations	18
Using RadiantWorks [®] Reports	19
Zone List Report	19
Assumption Report	20
Heat Loss Report	20
Applications	20
Frame Floors	20
Design Parameters	21
RadiantPEX Spacing	21
Perimeter Banding	21
UnderFloor Applications	22
Installation Methods	22
Heat Transfer Plates	22
Suspended	22
Getting Started	23
Installation Steps	23
Step 1: Install Manifolds	24
Step 2: Zone Boundaries	24
Step 3: Tubing Requirements	24
Step 4: Drill Joists	24
Step 5: Install the Fasteners	25
Step 6: Install the RadiantPEX	27
Step 7: Repeat with Next Circuit	29
Step 8: Visual Inspection and Pressure Test	30
Insulation Details	30
TJI Joists	30
Open Web Trusses	31

Section

Page

Sandwich/SubRay Applications

Slab-on-Grade Applications

Sandwich/SubRay [®] Applications	
Installation Methods	
Heat Transfer Plates	
Clips	
SubRay	
Getting Started	
Tools and Materials Required	
Fasteners	
Installation Steps	
Step 1: Install Manifolds	
Step 2: Zone Boundaries	
Step 3: Tubing Requirements	
Step 4: Sleeper Placement and Sizing	
Step 5: Install the Fasteners	
Step 6: Install the RadiantPEX	
Step 7: Repeat With Next Circuit	
Step 8: Visual Inspection and Pressure Test37	
Insulation Details	
Walls and Ceilings	
Recessed Walls	
SubRay 862	
Cautions	
Slab-on-Grade Applications	
Site Preparation	
Insulation Details	
Type of Insulation	
Special Construction Considerations	
Control Joints	
Design Parameters	
RadiantPEX Spacing	
Perimeter Banding	
Tools Required	
Slab Profile and General Details	
Installation Steps	
Step 1: Pre-Pour Conditions	
Step 2: Install Manifolds45	
Step 3: Determine Zone Boundaries	
Step 4: Tubing Requirements	
Step 5: Install the RadiantPEX	
Step 6: Secure the RadiantPEX	
Step 7: Repeat With Next Circuit	
Step 8: Visual Inspection and Pressure Testing47	
Step 9: The Concrete Pour	

Thin-slab and Slab Cap Applications

Snowmelt Applications

Section

Thin-Slab and Slab-Cap Applications
Design Parameters
RadiantPEX Spacing
Perimeter Banding
Tools and Materials Required
Fasteners
Watts Radiant Staple Gun
Installation Steps
Step 1: Install Manifolds
Step 2: Determine Zone Boundaries
Step 3: Tubing Requirements
Step 4: Install the RadiantPEX
Walls and Built-ins
Step 5: Secure the RadiantPEX
Step 6: Repeat With Next Circuit
Step 7: Visual Inspection and Pressure Test52
Insulation Details
Thin Slab with Sleepers
Steel Deck
Precast Slabs
Snowmelt Applications 54
Introduction 54
Brick Paver 54
General Site Prenaration 55
Insulation Details 55
Control Joints 56
Design Parameters 56
RadiantPEX Spacing 56
Tools and Materials Required 56
Application Profiles and General Details 58
Installation Steps 58
Step 1: Pre-Pour Conditions
Step 2: Install Manifolds
Step 3: Determine Zone Boundaries
Step 4: Tubing Requirements
Step 5: Install the RadiantPEX
Step 6: Secure the RadiantPEX
Step 7: Repeat With Next Circuit
Step 8: Visual Inspection and Pressure Test60
Step 9: The Concrete Pour
Miscellaneous
Steps
Glycol

Section

Page

Supply Manifold

Piping

Appendix
Manifolds
Factory-Supplied Manifolds
Field-Constructed Manifolds63
Manifold Set-Up65
RadiantPEX Circuit Balancing Valves
RadiantPEX Fittings
Field Repairs
Pressure Test
Nomograph
Pressure Drop Charts
RadiantPEX No-Sweat Baseboard, Fan Coil,
and Manifold Connection74
Connection Details
Near Boiler Piping and Controls
Primary/Secondary75
Point of No Pressure Change
Circulator Sizing
Step 1: Determine Zone Flow Rate
Step 2: Determine Circuit Flow Rate
Step 3: Determine Zone Pressure Drop
Step 4: Determine Supply/Return
Pressure Drop
Step 5: Determine Complete Pump Spec
Expansion Tank Sizing76
Mixing Options
Mix Valves
Injection Pump Sizing
General Schematics

Introduction

Welcome to the exciting world of radiant floor heating and snowmelting. For some, this manual will be an introduction to installing floor heating and snowmelting projects. For others, these jobs are second nature. This manual is designed to help both the novice and expert, with information ranging from basic heat transfer to more complex system design and trouble-shooting.

With the ever-increasing sophistication of the radiant industry, Watts Radiant offers an expanded product offering through its worldwide network of companies. The best of what the United States and Europe have to offer can be found at Watts Radiant.

Watts Radiant also offers a wide range of support options, from local wholesalers and representatives to our toll-free number direct to the factory, for help answering those difficult questions.

When you select Watts Radiant, you select an entire support team.

Heat Transfer Basics

One of the goals of this manual is to enable installers to make better decisions on the job site. These decisions can range from modifying a layout to account for a room change to determining what effect added windows have on a room's heat loss.

To better address these types of concerns, you must understand how a radiant system works. All forms of heating work on three basic modes of heat transfer: Convection, Conduction and Radiant.

Convective Heat Transfer is the most familiar type of heat. All forced-air systems are convective heat transfer systems. This includes hydronic baseboards and fan coils.

Conductive Heat Transfer is energy moving through an object. Place a

metal pot on the stove and in a few minutes the handle is hot.

Radiant Heat Transfer is the least understood, but is the one that is most important in our daily lives. Radiant heat transfer is the exchange of energy from a hot source to a cold source. The sun is typically used to illustrate this mode of transfer.

Regardless of the type of heating system used, all follow one basic rule. Hot always moves to cold. Place your hand under a lamp and your hand begins to get warm. This is because the lamp is hotter than your hand and is trying to lose energy to its cooler surroundings.

In most cases all three forms of energy transfer are present in radiant floor heating systems.

In a RadiantPEX UnderFloor[™] application, Convection is present in the joist cavity, Conduction moves the energy from the cavity and tubing through the floor, and Radiant energy is broadcast from the floor to the cold objects in the room.

If these basic principles are understood, then any project will be a success. Just remember to think like heat; moving from hot to cold.

RadiantPEX Tubing

This manual is to be used with Watts Radiant's RadiantPEX tubing, a cross-linked polyethylene, or PEX for short. It should not be used to install Onix tubing.

Watts Radiant has long been a recognized leader in the manufacture and engineering of radiant floor heating and snow melt systems.

The cross-linked molecular structure of RadiantPEX offers toughness, flexibility and lasting durability. RadiantPEX is corrosion resistant and virtually maintenance free. This PEX tubing withstands temperatures ranging from below freezing to 180°F. RadiantPEX combines all of the traditional advantages of plastic PEX tubing, but with an EVOH oxygen barrier. This barrier provides added protection against corrosion for the various ferrous components of a heating system.

RadiantPEX is manufactured to meet the American Standard Testing Method for cross-linked Polyethylene Tubing (ASTM F-876) and all sizes are made to the Standard Dimension Ratio for PEX pipes, SDR-9.

Introduction

Illustration showing the layered construction of RadiantPEX tubing.

Typical bend radii for 1/2" diameter RadiantPEX. Larger diameter tubing will require larger bend radii.

Although RadiantPEX is used most in radiant floors, it can be used for other applications, such as supply and return lines for baseboard and fan coils.

Even though RadiantPEX is an exceptional choice for radiant applications, there are some installation features that need to be addressed.

PEX tubing will expand and contract with temperature changes (unless it is embedded in a cementious material). The amount of movement is directly proportional to the temperature increase. All PEX tubing options will expand 1.1" for every 10°F rise in temperature for every 100' of pipe. For example, a system uses 300' runs of 1/2" RadiantPEX and is filled using 60°F water. The system is heated to 160°F, which is a change of 100°F, or ten 10° increments. Each circuit in this system will expand:

$1.1''/10' \times 10' \times 3 = 33''$

In this example, the PEX circuits will move approximately 33" as the system heats up and cools down. In most cases this can lead to a potential noise issue, especially if the RadiantPEX is installed in a frame floor application.

If noise is a concern, certain precautions can be taken to minimize or eliminate noise, such as constant circulation, injection mixing, heat transfer plate or suspension attachments methods. Each of these options will be addressed in detail in this manual. Remember, PEX in slabs and thin slabs is not subject to movement.

Although various attachment methods and application conditions may allow for tighter than 6"–8" on center (OC) spacing of the RadiantPEX, it is advised not to go tighter. Closer spacings increase the risk of kinking the bends. Standard bend radius for any size PEX piping should not exceed 8 times the nominal outside diameter.

RadiantPEX Sizes

Watts Radiant offers a wide range of RadiantPEX sizes, from 3/8" to 1" nominal internal diameter (ID). It is a misconceived notion that a larger diameter tubing will offer greater heat output. A 3/8" circuit of RadiantPEX will generate the same amount of heat output as 1/2". The main difference is the flow capability. Larger diameter tubing allow for the same flow rates at lower head pressures, or friction loss. For most residential and light commercial heating, 200' lengths of 3/8" or 300' lengths of 1/2" RadiantPEX are used. For snowmelting and larger commercial applications, 1/2" to 1" RadiantPEX will be used.

Using WaterPEX for Radiant Applications

Throughout this manual, we refer to all Watts Radiant PEX as "RadiantPEX". However, there are applications where non-barrier WaterPEX can be used. If WaterPEX is selected for any heating or snowmelting application, we highly recommend protecting the ferrous system components from possible corrosion. This can be done by using non-ferrous components, separating ferrous components with the use of a heat exchanger, or installing a suitable water or glycol system treatment.

ID <u>Size</u>	Bend <u>Radius</u>	Fluid Volume <u>per 100'</u>	Typical Max Installed Length	Max Factory <u>Length*</u>
3/8"	4"	0.53 gal.	200'	600'
1/2"	5"	0.96 gal.	300'	1000'
5/8"	6"	1.40 gal.	400'	1,200'
3/4"	7"	1.90 gal.	500'	1,200'
1"	10"	3.10 gal.	600'	600'

*Lengths indicated are maximum available coil lengths. Smaller coil sizes are available. Call Watts Radiant for minimum quantities for special orders.

General RadiantPEX Installation Precautions

Do Not Use Incompatible (Non–SDR-9) Pipe and Fittings

There are a few incompatible types of pipe and fittings that look similar to SDR-9 materials, but are made to slightly different dimensions. All compatible PEX pipe will be labeled as meeting the ASTM 876/877 Standard.

Polybutylene Pipe and Fittings.

The same crimp tools used for SDR-9 RadiantPEX were also used on the older polybutylene pipe, but the fittings and CrimpRings are not compatible. Note that the SDR-9 RadiantPEX CrimpRings are colored black so that you can avoid crosscontaminating your parts bins with older polybutylene fittings.

European PEX Pipe and Fittings.

Most PEX pipe made in Europe, unless specifically stated otherwise, is not made to the SDR-9 standard. It may look the same, but do not use these materials with SDR-9 pipe and fittings. Some older PEX pipe made in North America was also made to this European dimensional standard. Be careful not to mix the two types.

Protect from Physical Damage

Although RadiantPEX pipe is, in many respects, a durable material, it must be stored, installed, and protected properly to ensure a quality job. Following are some key points to always keep in mind.

Do Not Exceed the Minimum Bend Radius.

The minimum bend radius for RadiantPEX pipe is 8 times the outside diameter of the pipe. Depending on the temperature of the pipe, whether it is being rolled with or against the curvature of the roll, and the speed at which the bend is made, this number may be somewhat more.

Minimum bend radius (left) for RadiantPEX, or 8 times the diameter of the pipe. (Right) RadiantPEX bent to radius less than minimum. Tubing is strained, becomes oval, and may kink or fail.

Use RadiantPEX bend supports to hold a bend at the correct radius and to hold the pipe in place. If you kink the pipe you may be able to reform it. See page 11 for how to reform RadiantPEX tubing if it is kinked.

Support the PEX Properly.

Although RadiantPEX is strong, it must be supported against undue

stress, strain, and thermal expansion and contraction.

Most codes require the use of approved fastening devices. It is very important that plastic fasteners are used for mounting to wood members studs, joists, or plywood. Use a special stand-off type fastener like the StrapDown[™] or SnapClip[™] to make

StrapDown PEX fastener (top) and the SnapClip fastener (bottom). These fasteners are used for making vertical or horizontal supply/return runs to manifolds or other distribution points.

Use the LockDown fastener to support the PEX in UnderFloor Sandwich applications.

vertical or horizontal supply/return runs to manifolds or other distribution points. Use these for mounting to steel framing members, as well. Use the LockDown[™] fastener for UnderFloor Sandwich floor-heating applications.

Vertical Runs. Vertical runs must be supported at least at every floor level. We recommend every 30".

Horizontal Runs. Where the pipe is fastened to the side of floor joists it should be supported every 30". If it is continuously supported the pipe can be strapped down every 6'.

Terminate RadiantPEX with Care.

Always leave enough excess tubing at the beginning and end of runs to make connections without putting strain on the tubing and/or connection. **Do not** bend RadiantPEX tubing on a radius smaller than 8 times the diameter of the pipe. If bending **against** the coil, the allowed bending radius is 24 times the diameter of the pipe. Damaged pipe must be cut out and replaced.

Trenching Precautions.

Where RadiantPEX is laid in a trench, snake the pipe in with sufficient "waves" in the pipe so that there is sufficient allowance for expansion and contraction with temperature changes in the pipe.

RadiantPEX can be damaged by abrasion and by contact with abrasive materials, such as fill material with sharp edges. It is essential that the soil in the trench provide stable, continuous support for the pipe. Play it safe by installing polyethylene pipe insulation around the tubing for protection.

Always ensure that the pipe is buried such that any external load, such as the weight of the soil, or vehicular traffic does not cause the vertical dimension of the pipe to flatten by more than 5%. Suggested procedure is to pressurize before backfilling to minimize flattening of the pipe. All installation should be in compliance with local codes. Additional information on trenching and pipe embedment practices can be obtained from ASTM D2774, Standard Recommended Practice for Underground Installation of Thermoplastic Pressure Piping, or the American Water Works Association (AWWA) report TR31, Underground Installation of Polyolefin Piping.

Protect RadiantPEX Tubing at Expansion Joints.

If RadiantPEX tubing is installed under expansion joints, the piping must be either sleeved with a protective layer of insulation, or the piping must dip under the slab into the underlying base material. See elsewhere in this manual for further details.

Avoid Excessive Pressure and Temperature.

RadiantPEX is rated up to 160 psi at 73°F, 100 psi at 180°F, or 80 psi at 200°F. Make sure you don't exceed these temperature and pressure ratings. Exceeding rated temperature or pressure will void the warranty.

Protect From Sharp or Abrasive Hangers.

RadiantPEX can be damaged by metal hangers with sharp or abrasive edges; don't use them. Don't use hangers, staples, or fasteners that crush or pinch RadiantPEX pipe. Be careful when using hangers or fasteners. Make sure they are not driven in too far and damage the pipe. Better yet, use approved Watts Radiant fasteners.

Protect from Excessive Heat

RadiantPEX must be protected against excessive heat. Following are some typical kinds of exposure to excessive heat that you must be careful about.

Soldering.

Never solder next to RadiantPEX. If you are soldering onto a RadiantPEX fitting, make the solder connection first and then make the connection to the RadiantPEX second.

Water Heaters and Boilers.

Use metal tubing to transition between water heaters and RadiantPEX. Maintain a minimum of 18" separation between the RadiantPEX and water heaters/gas boilers.

Recessed Light Fixtures.

Maintain at least 12" of separation between all recessed light fixtures and the RadiantPEX tubing.

Gas Appliance Vents.

Maintain at least 6" of separation between RadiantPEX and all gas appliance vents. Maintain at least 18" of separation between RadiantPEX and wood appliance vents.

Protect from Chemicals

Chlorine.

Except for short-term superchlorination of potable water lines when a potable water system is being cleaned, do not permit prolonged exposure of free chlorine concentrations in excess of 2 parts per million. Do not expose RadiantPEX to any chemicals internally or externally, other than water or water/glycol solutions, unless approved by Watts Radiant.

Leak-Testing Agents.

Certain kinds of chemicals found in liquid-based leak detectors, especially those containing soap, can cause longterm damage to PEX and other types of plastic pipes. The same chemicals used to "lift" dirt from soiled clothes can cause microfracturing of PEX pipe and lead to its eventual failure.

Adhesive Tape.

RadiantPEX can also be damaged by some of the adhesives found in adhesive tape. Unless an adhesive tape or label is supplied by a PEX manufacturer do not apply adhesive tape to any PEX.

Pipe Dope, Threading Compound, Mineral or Linseed Oil.

RadiantPEX is damaged by some of the materials found in pipe dope, mineral oil, putty, cutting oil, and similar compounds. Do not expose RadiantPEX to these materials.

Petroleum Products.

RadiantPEX is damaged by petroleum products such as gasoline, diesel fuel, cutting oil, brake and transmission fluids, and others. Do not expose RadiantPEX to these materials. Do not bury RadiantPEX in soil that is contaminated with these materials.

Do not use RadiantPEX to convey natural gas, propane, fuel oil, or any other hazardous or volatile fluids. Do not use RadiantPEX as an electrical ground.

Protect Against Freezing

While RadiantPEX is resistant to freeze damage, we recommend that all systems be protected from freezing in a manner typical of the area. RadiantPEX cannot prevent damage to materials if the system freezes. RadiantPEX fittings and field connections can be damaged if a system is allowed to freeze.

Handling and Care of RadiantPEX

Storage of Pipe.

Reasonable care and protection must be taken to protect RadiantPEX from damage, both before and during the construction process.

Temperature Range.

Caution should be exercised when installing RadiantPEX at temperatures below freezing. The pipe is more easily damaged and kinked when installed at these temperatures. Best results are observed when the pipe is installed at temperatures above 50°F. In very cold weather you may wish to warm the pipe up in a heated room or truck cab before installing it. RadiantPEX is most flexible when installed at temperatures above 50°F.

Reforming Kinked Pipe.

- **1.** Gently straighten the kinked RadiantPEX.
- 2. Using an electric heating gun, gently heat the kinked area using a sweeping motion of the heat gun that is parallel to the kink, and perpendicular to the pipe. Never use any type of open flame.
- 3. Maintain at least 1" of distance between the end of the gun and the surface of the pipe. Do not hold the nose of the heat gun against the pipe or allow the nose of the heat gun to come in contact with the pipe.
- 4. Do not overheat the kinked area in an attempt to speed up the process. The surface temperature should not exceed 265°F. The hot air from the gun should not exceed 350°F. If the gun you are using is rated at a higher temperature, hold it back further from the pipe.
- **5.** Within a minute of heating, the tubing should gradually begin to straighten and return to its original shape. Any small creases in the kink should begin to fade.

- **6.** As soon as the pipe returns to a generally round shape and the kink has smoothed out, stop heating it. The pipe should not be discolored.
- **7.** Do not disturb the pipe until it cools down to room temperature.
- **8.** Before burying the pipe it must be pressure tested.

Thawing Frozen Pipes.

RadiantPEX pipe is somewhat resistant to freeze damage, but can be damaged by excessive heat. For that reason please follow these precautions when thawing frozen pipes.

Do not attempt to send electrical currents through the pipe to melt the ice. Do not apply a torch to the pipe's exterior.

You can use hot air guns, as long as the temperature of the air does not exceed 300°F. Do not apply heat from hot air guns for more than 5 minutes at a time to one spot on the pipe. Do not heat the pipe to the point where it begins to change color.

Splicing Damaged Pipe.

If at all possible, don't make splices in inaccessible locations, such as under slab floors, or behind dry wall. If it is necessary to make buried splices, wrap the field coupling with insulation to protect the metal components against possible corrosion and mechanical stress. Pressure test splices before burying. Use only genuine RadiantPEX field repair kits when making these field splices. Never use any hose fittings/clamps or non-RadiantPEX fittings/clamps when making splices or connections.

Sunlight Exposure.

Do not expose RadiantPEX to more than 30 days of direct sunlight. It will damage the pipe and void the warranty.

The Design Process

A system design should be performed for all radiant projects. This design should include, at minimum, a radiant heat loss calculation, minimum tubing requirements and pump size calculations.

Watts Radiant's RadiantWorks® design software should be used to account for all building specifications and all system components. A copy of RadiantWorks can be obtained through your local Watts Radiant representative. A demo version of the program can be downloaded from our website: www.wattsradiant.com.

Keep in mind, conventional heat loss calculations will tend to over-estimate the actual heat loss that a radiant building experiences. In this manual, the design steps and the report examples shown are from Watts Radiant's RadiantWorks design software.

Should additional information about design, controls or other radiant applications be required, please call your local Watts Radiant representative or the Watts Radiant design department for assistance.

Step 1: Initial Design Considerations

There are three primary considerations in a radiant design.

- 1. Heat Loss how much energy do we have to impart to the system to keep the occupants warm or the surface snow and ice free?
- 2. Tubing how much and what type of tubing is required to deliver the needed heat?
- **3.** Control and Performance system operation will vary greatly depending on how the system is controlled and operated.

To answer these questions, some initial information is needed. This information primarily relates to the heat loss calculation. It is important to gather as much project information as possible. Even though this information is conveyed to the end user via the RadiantWorks Assumption Report, it saves time and effort to have the correct information at the beginning.

To perform an accurate heat loss and radiant design, the following information is required.

Heating:

- 1. Wall R-Values
- 2. Ceiling R-Values
- 3. Window R-Values and Sizes
- 4. Amount of exposed wall
- 5. Fireplaces or other high infiltration sources, such as overhead hoods and vents
- 6. Floor Cross Section: It is important to know how many separate layers make up the floor. Different floor coverings may have anywhere from one to four distinct layers
- 7. Finish Floor Covering Materials
- 8. General Site Information

Snowmelting:

- 1. Slab construction details
- 2. Amount of snowfall
- 3. Desired response time
- 4. General Site Information

Additional information concerning snowmelting systems is discussed in the Snowmelting section.

Carpet and pad generally requires the highest supply fluid temperature.

Floor Coverings

used over a radiant floor.

The main misconception regarding

whether or not carpet or wood can be

Virtually any floor covering can be

used if the insulative value (R-value)

for that covering is accounted for in

the radiant design and installation

process. In a radiant floor heating

source. The floor gives off heat

(energy) to the room because it is

has to be warmer than 70°F. The

warmer than the surroundings - hot

moves to cold. If we want to maintain

a room temperature of 70°F, the floor

warmer the floor, the more energy it

will emit into the space. So, the higher

the heating load, the warmer the floor

needs to be. The room does not care

construction details are as long as the

what the floor type is, or what the

system, the floor is the room's heat

floor coverings tend to center on

Hardwoods are the most popular floor covering to use over a radiant floor system.

Tile and other stone floor coverings generally require the lowest supply temperature. The more conductive the floor covering the lower the required supply water temperature.

required floor surface temperature is achieved.

There is a limit to how hot we can make the floor. In theory, we could heat any room with the use of a radiant floor heating system. The limiting factor is human comfort. The maximum temperature we can allow the floor surface to reach is 85°F. Temperatures above this point become too warm for our bodies and in turn make the floor uncomfortable to stand on. This 85°F floor limit in turn limits the maximum BTU output of the floor to around 45 BTU/sq.ft., based on room temperature.

With this in mind, let's return to the floor itself and look at the different floor coverings. All floor coverings have different conductivity values. Conductivity values relate a material's ability to transfer energy. The higher the conductivity, the better the material conducts, or transfers energy. For example, wood has a conductivity value of approximately 0.078 BTU/ hr/ft/°F while tile has a conductivity of 0.41 BTU/hr/ft/°F. In this example, tile will transfer energy faster. But does that make tile a better choice? Not really. Both the hardwood floor and the tile floor will perform exactly the same if we maintain the same surface temperature. To do this, we have to vary the supply water temperature depending on the floor covering and construction. A hardwood floor may require 120°F supply temperature while a tile floor may only require 100°F.

Even though the main goal is the same for all floor types, there are some special considerations that need to be maintained for each floor covering. The following should be used as a guide only. If more information is required, contact the flooring manufacturer for more specific information relative to the actual floor covering being used.

Typical tile/stone installation sequence over a frame floor.

Tile Floors

Tile, stone, and other masonry floors are unique in the sense they are bonded to the main floor construction. In addition, they are extremely hard and, to some degree, brittle. Hard surfaces require special care during the installation process, whether or not a radiant system is being installed.

Some items to be aware of are:

1. Floor stability. Tile will crack if the floor has a deflection greater than 1/360th of the span. To minimize this deflection, adequate joists, subfloor, and a stiffening layer such as a tile backer board or additional plywood, may be installed over the subfloor.

2. Crack/Isolation Membrane.

Floors move continuously over time as the environment changes. Tile installed over a slab or a frame floor is subject to crack propagation as the slab below develops minor cracks or as the subfloor shifts. A cleavage membrane or a crack/isolation layer is recommended to prevent cracks from moving upward through the tile.

3. Mortar and Adhesives.

There are a wide range of mortars and adhesives used with tile and stone. Most standard mortar and latex modified thin-sets are adequate for tile and stone applications over radiant.

As with any cement or mortar flooring, DO NOT apply heat to the system until the flooring materials have had time to cure. This usually takes anywhere from 14 to 28 days.

Hardwood Flooring

Watts Radiant customers have successfully installed parquet, laminated, and strip wood flooring over radiant tubing for decades. Most wood floor manufactures limit the floor surface temperature to 85°F. Since the radiant design uses the same surface temperature limit, hardwoods can be used in almost any room or application with a radiant floor.

This is not to say certain precautions should not be followed. These installation techniques are the same for a radiant floor heating system as they are for a conventional forced air system.

Wood Moisture Content

Wood is hydroscopic, meaning it acts like a sponge. If the wood is installed wet relative to its surroundings, it will give off the excess moisture and

Typical hardwood installation sequence over a frame floor.

shrink. If the wood is installed dry relative to its surroundings, it will absorb moisture and expand. We all have experienced this within our own homes. The back door seems to fit tighter in the summer than it does in the winter. This is because the humidity levels are higher in the summer. The wood absorbs this excess moisture and expands. A wood floor will do the same thing. This is the reason why a 1/2" to 3/4" gap is placed around the perimeter of the room.

On average, wood can expand or contract within 7% of its original size. For a single planking of wood, this can equate to as much as 1/8" in width. To help minimize this effect, a few guidelines have been developed to reduce the effects moisture can have on a wood floor.

1. The wood must be kiln dried. Kiln dried wood ensures the core of the wood is at the same moisture content as the outer surface

2. Hardwood Moisture Content. Wood is naturally stable between 7% and 10% moisture content.

3. Subfloor Moisture Content. Make sure the moisture content of the subfloor is no higher than 4% above the hardwood itself. If it is, then moisture can be driven from the subfloor to the hardwood, causing its internal moisture levels to change.

4. Concrete Moisture.

Make sure the concrete slab below the hardwood has a vapor barrier to prevent absorption from ground moisture. Make sure to test that the concrete has completely dried before installing hardwood floors.

Movement for 3" wood strip.

% Moisture Change	Approx. Width Change/Inch
1	1/128"
4	1/32"
8	1/16"
12	5/64"
16	7/64"
20	9/64"
24	11/64"

5. Room Moisture.

Try to keep the room's relative humidity between 35% and 50% moisture.

6. Use Strips, not Planks.

The narrower the board, the less movement it will create. The ideal maximum size is 3" to 3-1/2" in width.

7. Quarter Sawn vs. Plane Sawn. Quarter sawn wood will expand in height while plane sawn wood will expand in width. A quarter sawn board is more dimensionally stable than a plane sawn board. the concrete during the non-heating season. Verify with local code and building practices.

Before wood flooring is installed over any slab or elevated thin slab, the slab should be well aged. Preferably, the slab should have been heated for at least a week before the flooring is delivered. Pre-heating the slab before flooring installation will drive out residual moisture that might cause problems. This pre-heating must be done before a surface vapor barrier is installed.

Hardwood expansion.

Controlling Moisture

The most common cause of moisture problems in a new home is moisture trapped within the structure during construction. Problems sometimes arise from a continuing source of excess moisture, e.g., from the basement, crawl space, or slab.

For a slab on or below grade, a minimum 6 mil plastic vapor barrier should be used under the slab to prevent the absorption of ground moisture through There is a simple procedure for checking the presence of excessive moisture in the slab. Tape a 4' x 4' section of polyethylene plastic sheeting to the surface of the slab and turn on the heat. If moisture appears under the plastic, the slab should be heated for another day or so and then checked again for moisture. If a hardwood floor is to be laid over a wooden subfloor, similar precautions should be observed, as the plywood subfloor may also be saturated with moisture.

The recommended procedure is to first drive off the moisture in the slab, then heat the plywood subfloor for a few

With a vapor barrier, moisture is prevented from entering the slab.

days before unwrapping the finish flooring from its factory packaging.

Plywood or oriented strand board make good candidates for subfloor materials in radiant installations. *Do not use particle board as a subfloor.*

USDA Forest Service Recommendations

The following procedures are recommended by the USDA Forest Service's "Wood Handbook."

Cracks develop in flooring if (the wood) absorbs moisture either before or after it is laid, and then shrinks when the building is heated. Such cracks can be greatly reduced by observing the following practices:

- 1. Specify flooring manufactured according to association rules and sold by dealers that protect it properly during storage and delivery.
- 2. Do not allow the flooring to be delivered before the masonry and plastering are completed and fully dry, unless a dry storage space is available.
- 3. Have the heating plant installed before the flooring is delivered.
- 4. Break open the flooring bundles and expose all sides of the flooring to the atmosphere inside the structure.
- Close up the house at night and raise the temperature about 15°F above the outdoor temperature for 3 days before laying the floor.
- 6. If the house is not occupied immediately after the floor is laid, keep the house closed at night or during damp weather and supply some heat, if necessary, to keep the house at about 65°F.

Cautions for Hardwood Floor Installations:

If the radiant heating system cannot be installed prior to the hardwood installation, an alternative form of heat

The National Hardwood Council allows the hardwood to be installed directly on top of the radiant tubing. However, it is advised to first install a subfloor over the radiant system, or use C-Covers, to help protect the tubing from nails and other attachment devices.

needs to be provided while the floor is being installed. Temporary, unvented sources of heat (such as a propane fired "salamanders") are *not* appropriate as they can put excessive amounts of water vapor into the building.

Asphalt paper should never be used when installing a radiant floor heat-

ing system, as it may give off an unpleasant odor when it is heated. If in doubt as to the presence of old asphalt paper when doing a building renovation, a floor core sample needs to be taken. Watts Radiant does not recommend radiant installations under asphalt paper. As a rule of thumb, standard 3/4" hardwood floor coverings with a 3/4" subfloor do not pose a problem to normal heat transfer. The performance of a radiant floor begins to be affected when the total thickness of wood

covering is between 2"–3". This range is dependent on the heating intensity. Lower heating intensities allow for thicker wood coverings.

There is added caution for wood floors when installed in a Sandwich application. The National Hardwood Council allows the hardwood to be installed directly on top of the radiant tubing. However, it is advised to first install a 1/2" or 3/4" subfloor over the radiant system, or use C-Covers, to help protect the tubing from nails and other attachment devices.

It is important to note that the floor construction above the tubing needs to be continuous, i.e., no air gaps. Air gaps will increase the floor's overall R-value, thus reducing the floor's ability to transfer energy, which will in turn decrease performance.

Carpet and Pad Flooring

Carpet floor coverings help prevent floors from feeling cold because they have a higher R-value, or resistance to heat transfer, than any other floor covering. Carpet pads reduce energy transfer while providing some support and cushion to those standing.

With respect to a radiant floor heating system, a carpet and pad floor covering is the most difficult to heat through. In general, the ideal floor covering would have an R-value of 2 or less. In most cases, since we are using a floor heating system, a thinner pad should be used. Try to keep the pad thickness below 1/2".

Typical carpet and pad installation sequence over a frame floor.

Carpet Type	Thickness (in)	R-Value
Level Loop	0.26	0.64
Berber	0.41	0.83
High/Low Loop	0.42	0.86
Berber	0.42	0.96
Berber		1.00
Frise		1.10
Saxony	0.41	1.10
Saxony		1.15
Saxony	0.50	1.25
Saxony	0.55	1.32
Cushion	Thickness (in)	R-Value
Slab Rubber	0.23	0.62
Waffled Sponge Rubber	0.43	0.78
Prime Urethane	0.40	1.61
Hair and Jute Coated		1.71
Bonded Urethane	0.50	2.09
Carpet and Pad Com	bined Thickness (in) T	otal R-Value
Level Loop and		
Textured Rubber	0.36	1.04
Level Loop and Froth	0.25	1.23
Berber and Textured Rubber	0.36	1.36
Berber and Froth	0.25	4.54
Saxony and Textured Rubber	0.36	1.62
Level Loop and		
Bonded Urethane	0.32	1.67
Level Loop and		
Synthetic Fiber	0.33	1.67
Saxony and Froth	0.25	1.83
Level Loop and		
Grafted Prime	0.36	1.88
Berber and Synthetic Fiber	0.33	1.98
Berber and Bonded Urethane .	0.32	2.01

Step 2: Radiant Zoning

Zoning is a way of controlling how heat is delivered to a given area. The more zones there are, the higher the control level. There is no "rule" to the amount of zones needed for a project. There can be as many zones as there are rooms and as few zones as there are floor levels (minimum one zone per floor level). There are several ways to zone a project.

1. Zoned by Floor Coverings:

Different floor coverings transfer energy at different rates, resulting in varying supply water temperatures. A kitchen with a tile floor may only need 100°F supply water, while the family room right next to it with a carpet may require 140°F supply water. If these two rooms were placed on the same zone, there may be control and comfort problems.

2. Zoned by Occupancy:

Different areas of a home or business will be used during different times of the day or for different activities. Bedroom or warehouse areas tend to be kept at a lower thermostat setting while the rest of a building will tend to be kept warmer.

3. Zoned by Construction:

There are various construction details present in almost every project. For example, it is difficult to place a room with a slab floor on the same zone as a room with a frame floor. Likewise, it is a good idea not to zone multiple levels of a project on a single zone. Tubing is not easily installed from one level to the next and heat losses/gains can be dramatically different from floor to floor. Other construction concerns

Typical radiant zoning.

might be varying joist directions or expansion joint locations.

4. Zoned by Mechanical **Considerations:**

Mechanical issues tend to relate to the required supply water temperature or heat load required in a given area.

Typically, rooms can be grouped in the same zone if the supply water temperature does not cause the floor surface temperature in any of the rooms to exceed 85°F.

Supply/Return Piping

Supply	Max. Flow
Pipe Size	Rate (typical)
3/4"	4 GPM
1"	12 GPM
1-1/4"	20 GPM
1-1/2"	32 GPM
2"	60 GPM

Rooms with similar heating intensities (BTU/sq.ft.) can be zoned together, as well. If a room has a load of 50 BTU/sq.ft., like a sunroom, it should not be zoned with a room that only requires 10 BTU/sq.ft.

The above illustration uses the occupancy technique for zoning, dividing the "waking" areas from the "sleeping" areas.

Subzones are areas within a zone with dedicated runs of tubing. In the house illustration, the master bathroom is a subzone of the master bedroom. In this case, there are five circuits for this zone. Three circuits are dedicated to just the master bedroom while two circuits are dedicated to just the master bathroom. If the master bathroom were not designated a subzone, all circuits would be installed in both areas.

Subzones can be used to help balance the heat delivered within a zone. By

designating certain circuits to specific areas, heat delivery can be controlled by flow (circuit balancing valves or telestats).

Step 3: **Manifold Location**

Each zone has one manifold pair: a supply and a return. Watts Radiant offers a wide range of manifolds ranging from custom brass and cast brass to stainless steel manifolds. More information on manifold options can be found in the Watts Radiant product catalog or on the Web site.

With respect to any design, the manifold location has a direct impact not only on the aesthetics of a room, but also on the amount of tubing being installed.

- 1. Manifolds should be placed in a location that allow them to remain accessible, but also out of sight. In cabinets, behind doors, and in closets are good locations. These locations allow for the use of a cover plate or manifold box over the manifold to keep the assembly hidden from everyday view.
- 2. Manifold placement determines the minimum tubing circuit length. Minimum circuit equates to the distance from the manifold to the farthest point, taking right angles, and back. For most residential projects, 200' circuits are adequate. For most commercial projects, 300'-400' circuits are used.

Zoning

- 3. Locate the manifold within the given zone. If a manifold is located outside the zone boundary, then twice the distance (supply and return) to the manifold needs to be added to each circuit length. For example, if a zone calls for 180'. circuits, and the manifold is moved to a location 10' away, then 20' is added to the circuit. The circuit lengths required for this zone will be 200'.
- 4. Manifolds should be mounted horizontally if a vent/purge assembly is installed. This allows for easier circuit connection to the manifold, and allows the vents to work properly without leaking.
- 5. Manifold sizes are based on the zone flow rates (GPM). The smallest trunk size provided by Watts Radiant is 1". For commercial and snowmelt applications larger manifolds, 1-1/4" to 6" ID, are available.

Manifold Trunk Sizing

Manifold Flow	Manifold
Max. GPM	Trunk Size
12	1"
20	1-1/4"
32	1-1/2"
60	2"

Step 4: Heat Loss Calculation

Conventional heat loss calculations can be used to size radiant heating equipment; however they tend to overstate the actual heat loss that a radiantly heated building experiences. In addition, the use of these unadjusted calculations will tend to oversize boilers, circulators, and piping, as well as the amount of radiant piping required. There are four major factors that reduce heat loads as compared to conventional heating systems.

1. Lower indoor air temperatures can be maintained for greater human comfort. When the floor is

Applications

radiantly warmed, the human body does not need as warm an air temperature to stay comfortable. With radiant heat, the indoor thermostat can be set $2^{\circ}-3^{\circ}$ lower.

- 2. Indoor air movement and temperature gradient is greatly reduced. This reduces heat loss through the ceiling.
- 3. Because of factors one and two, infiltration losses are also less. This means buildings with higher air infiltration rates will save more energy if fitted with a radiant floor delivery system, compared to a forced air (convective) heating system.
- 4. Due to heat storage in the radiant floor and surrounding walls, peak heating loads are reduced. This effect is greater in more massive construction.

Due to these factors, a typical radiantly heated building often requires 10-30% less energy to heat than a conventional convective system. RadiantWorks automatically accounts for these factors to properly and accurately size any radiant project.

Using RadiantWorks[®] **Reports as a Design Tool**

For most projects, the radiant design will be performed using Watts Radiant's RadiantWorks design software. This is an easy, efficient way to apply the design steps discussed earlier. A variety of reports are available through RadiantWorks, including a Zone List, an Assumption report and a Heat Loss report. These reports help transfer information about a project quickly without guess work.

Zone List Report

Each Zone List contains information on what is required to properly heat a given area. It is important to verify that the Radiant Capacity for each room within a zone is greater than the

RadiantWorks Zone List Report

ZONE 1 - MAIN LEVEL (Under-Floor)

Room Specifications									
Room Name Primary Primary Banded Banded Heating Required Radia									
	Spacing	Area	Spacing	Area	Intensity	Heat	Capacity		
	[in]	[ft]	[in]	[ft]	[Btu/h ft]	[Btu/h]	[Btu/h]		
Foyer	8	118			15.7	1,853	2,421		
Powder Room	8	42			27.2	1,144	1,147		
Breakfast / Kitchen	8	520			17.2	12,012	13,832		
/ Family / Pantry									
Hall	8	135			16.0	2,154	2,484		
Zono Chosifications									

			Eono opoonio	allonio				
Supply	Delta T	GPM	Head	Radiant	Product	Tube	No. of	
Fluid [°F]	[°F]		[ft]	Panel	Туре	Length [ft]	Circuits	
				Load				
				[Btu/h]				
112	20	2.4	2.1	24,038	1/2" PEX	300	8	
Pump Spe	cs & Radiant I	Panel Load are	e calculated or	the smaller o	f			
Required H	leat or Radiar	nt Capacity (+ I	back and edge	losses)				

RadiantWorks Assumption Report

Outside	Elevation	Wind	Glycol	Job Type	System
Temp [°F]	[ft]	Speed			Chemicals
		[mph]			
0	1268	10	None	Residential	No

ZONE 1 - MAIN LEVEL (Under-Floor) [3/8" RadiantPEX]

Project Assumptions

Min Tube Length:	20 ft	Max Tube Length:	300 ft	Circuit Rounding:	5 ft
Supply Water	112.3°F	Delta T:	20°F	Manifold Distance:	0 ft
Temp:					
Joist Spacing:	16 in	Joint Thickness:	kness: 1.5 in Joist Conductivity:		0.078 Btu/h- ft-F
Subfloor Thickness:	0.75 in	Subfloor	0.085 BTU/h-		
		Conductivity:	ft-F		
		Foyer			
		Room Size Para	ameters:		
Area:	118 ft	Perimeter:	44 ft	Total Area:	118 ft
Heated Floor Area:	118 ft	Unheated Floor	0 ft		
		Area:			
		-			
		Room Construction F	arameters:		
Space Below:	Crawl			Crawl Space	Yes
	Space			Insulation:	
Foil Faced	3.5 in	Tube Spacing:	8		
Insulation					
Thickness:					
		Room Heat Loss P	arameters:		-
Indoor Design	68°F	Max Eff. Surface:	85°F	Heating Intensity:	15.70 Btu/h
Temp:					ft
Floor Covering:	Tile Floor &	R Value:	0.16	Unheated Floor R	19
	Mudset			Value:	
ACH:	0.5	CFM:	7.867	Number of Stories:	1

RadiantWorks Heat Loss Report

118 ft

Exp'd Ceiling Area:

ZONE 1 - MAIN LEVEL (Under-Floor)

9 ft

Ave. Ceiling

Height:

Calculated Heat Loss for Foyer @ 68°F Indoor										
Description	Units	R-Value	Heat Loss	Infil. Loss	Total Loss					
			[BTU/hr]	[BTU/hr]	[BTU/hr]					
Exposed Walls	59 ft	13	303	0	303					
Doors	21 ft	2	635	0	635					
Exposed Ceiling Area	118 ft	30	265	0	265					
Infiltration	0.5 ACH			650	650					
Totals			1203	650	1853					

30

Ceiling R Value:

Frame Floor Applications

Required Heat. If this is not the case, then the room will require auxiliary heat.

Assumption Report

The Assumption Report conveys information about the heating system to those working on the project. It shows all of the assumed values and conditions taken from a plan or blueprint when calculating the heating load for a project.

Many projects change during the construction process. Windows get added to the living room, a fireplace is added to the family room, etc. Hardwood replaces carpet or a skylight goes into the master bathroom. Sometimes, these changes happen after the initial radiant design is done. Although these changes seem small and inconsequential, they can have a drastic impact on how a radiant floor heats a space.

If the window size for the family room goes from 30 sq. ft. to 50 sq. ft., the heat loss through that section of wall just increased over 60%! This seemingly simple change might require modifications to the radiant heating system, such as additional banding (tighter tube spacing along an exposed wall, where applicable) or higher water temperatures and possibly a larger heat source.

Heat Loss Report

The Heat Loss Report is a room-byroom breakdown of exactly where energy is lost. This information is used to identify those items that are causing an unusually high heating load. For example, assume the load for a room was 10,000 BTU and the assumed windows were single pane and had a total heat loss of 6700 BTU. The Heat Loss Report would reflect this unusually high heat loss area and a decision to install double pane windows might be made to help make this room more energy efficient.

Applications

It is impossible to try to fit all possible construction scenarios into this manual. Because of this, only the most common applications are discussed. Each section contains examples and techniques for the most popular variations.

Should a project call for a construction detail not mentioned in this manual, please feel free to contact Watts Radiant or a Watts Radiant representative for design assistance.

Frame Floors

Introduction

Even though some installation details vary from application to application, basic design considerations remain the same. The most important goal is to make sure the RadiantPEX is installed in accordance with the design parameters. If not, the system may not function as desired. The second most important detail for an UnderFloor application is to properly install foil-faced batt insulation below the tubing. If a non-foil-faced insulation is used, *the system may operate with a 25% loss of maximum heat output and some (smaller) loss of efficiency.* Other insulation can be used instead of a fiberglass batt, however, certain cautions need to be observed.

- 1. Tight seal. One of the largest areas of heat loss with any underfloor application is convective loss through the band joists and other perimeter areas. The tighter the joist cavity, the better the system will perform. This joist cavity must be sealed with insulation along the joists and at the perimeter. Also, any electrical, plumbing, or other penetrations into the heated joist bay must be sealed with insulation or caulk.
- 2. Foil Face. The foil on the insulation will ensure most of the heat coming from the tubing is reflected up to the subfloor where it is distributed. This foil also spreads the heat out over the subfloor, reducing temperature variations.

Frame Floor Applications

- **3.** Air Gap. A 2"-4" air gap is necessary between the tubing and the insulation. This air gap helps increase the effective R-value of the insulation while fully optimizing the ability of the foil insulation. If contact is made, energy is no longer reflected upwards, but rather, is conducted downward. This can reduce the effective heating of the floor by 10–20%, depending on the load conditions and thickness of insulation.
- **4. R-Value.** As a rule of thumb, an R-Value of at least 4 times higher than the floor is desired. For most indoor conditions, an R-13, or a 3-1/2" batt should be used. When installing over an unheated area, exposed area or crawlspace, a minimum R-19 or 6" batt should be used.

Design Parameters

With any new or renovation project, it is important to know the layers used in the floor construction. As these layers increase or change, variances in the heating system will result.

RadiantPEX Spacing

RadiantPEX is generally installed 8" on center, to the underside of the subfloor for an UnderFloor application. Closer spacing may be used in areas of high heat loss, such as an exposed wall with a high percentage of glass. Tighter tubing spacings, up to 4" OC, may also be used in areas that have a low thermal conductivity, such as areas with thicker than normal subfloor or dense carpet and pad. Note: Tighter than 8" OC tube spacing is only possible if 3/8" PEX is used. If 1/2" PEX or larger is used on the project, the design should maintain a constant 8" OC spacing.

It is important to note that simply doubling the amount of tubing does not double the floor's heating output. The floor's ability to deliver heat to a room is based on the temperature difference between the floor and the room. The amount of radiant tubing and the fluid temperature control the floor surface temperature. RadiantWorks design software generates a specific Nomograph for each room. Nomographs are charts that detail key factors associated with a room, such as tube spacing, floor surface temperature, floor heating intensity, mean (average) water temperature and back and edge losses. Nomographs are essential to any radiant design. More information on how to read and use a Nomograph can be found in the Appendix.

Banding Areas. RadiantPEX is sometimes installed at closer spacings at the perimeter of exterior rooms to improve comfort.

UnderFloor Application

Installation Methods

When considering a RadiantPEX UnderFloor application it is important to first determine the type of UnderFloor system to use. There are two primary methods of installing an UnderFloor system — with heat transfer plates and suspended.

Why the two methods?

These two techniques for installing PEX tubing in underfloor applications have emerged due to the movement of PEX as it heats and cools. This movement can lead to noise, as well as reduced heat transfer. As mentioned before, PEX will expand and contract in length based on the change in temperature. Given the correct conditions, this can be as much as 33" per circuit.

PEX used to be installed in a similar manner as Watts Radiant's Onix tubing, that being stapled directly to the underside of the subfloor. Unfortunately these systems proved to be noisy. As the PEX expanded and con-

Aluminum PEX Plates.

Plastic LockDown fasteners.

tracted, it would move across the surface of the subfloor, creating a "ticking" or "popping" noise which proved to be annoying and could possibly lead to pipe damage at the staples.

In response to this, methods were developed to minimize the noise while continuing to deliver the required heat load to the space.

Heat Transfer Plates

Heat transfer plates are aluminum plates that are either roller or extruded. Watts Radiant offers an aluminum plate designed to be used with 1/2" Watts Radiant RadiantPEX.

Do not use these plates for any PEX sizes other than 1/2".

The heat transfer plate is attached to the subfloor and the RadiantPEX is then inserted into the plate. This allows the PEX to be separated from the subfloor, eliminating the noise issue before mentioned.

However, this separation raises concerns relative to the conductive transfer of energy needed to deliver the required heat to a space. The aluminum transfer plates offer this contact, allowing for conduction to continue from the RadiantPEX to the subfloor.

In most cases a PEX system installed with heat transfer plates will still deliver the required BTU load to a space. The maximum BTU delivered will typically be around 45 BTU/sq.ft.

It is important to install the aluminum plates in accordance with the specified installation details. Failure to do so may result in noise associated with the aluminum plates moving during the heating process. Refer to the section Installing Heat Transfer Plates on page 25 for more information.

Suspended

The next popular method of installing PEX UnderFloor is to suspend the tubing in the joist bay. Although this

method addresses several items raised by the plate method, it too has some limitations.

A suspended installation does just that; it suspends the PEX in the joist cavity every 24"–32" with the use of a plastic clip or fastener. Watts Radiant LockDown fasteners eliminate noise from an underfloor application by allowing the PEX to quietly move while the PEX expands and contracts.

However, the cost of having a quiet system is a reduction in heat transfer. Since the tubing is not in contact with the subfloor, either directly or indirectly through heat transfer plates, the overall BTU capacity of the system is reduced. For most suspended systems the maximum BTU capacity of the floor is reduced to a maximum of 25 BTU/sq.ft.

Getting Started

Tools and Materials Required

Make sure all materials are present and in good working order before beginning a radiant installation. The following is a list of the most common items needed for a typical RadiantPEX UnderFloor radiant installation.

1. RadiantWorks reports.

These reports help ensure the proper amount of tubing is installed in each area, along with the correct manifold.

2. RadiantPEX tubing and corresponding number of fittings.

There are two types of connections that can be used with RadiantPEX: CrimpRing (installed with the CrimpAll Tool), and Compression (installed with a standard crescent wrench). Each fitting type is designed for ease of installation, durability, and longevity. Fittings are typically chosen based on installer preference, unless otherwise specified.

3. Manifolds.

Use only Watts Radiant manifolds or Watts Radiant manifold components for field-constructed manifolds.

4. Unwinder.

A required component for easily unrolling each RadiantPEX coil without kinks and twists.

- **5. Field repair kit.** Each kit contains two barb-by-barb splices and four RadiantPEX fittings.
- 6. Manifold mounting bracket. Brackets are used to temporarily or permanently mount each manifold pair to the floor or wall.
- 7. Watts Radiant heat transfer plates and/or LockDowns and screws or nails.

8. Pressure test kit.

Each manifold pair must be pressure tested. This helps ensure each RadiantPEX connection has been installed correctly and to make sure no damage has been done to the tubing during installation.

9. Chalk line

- 10. Angle drill with 1-3/4" holesaw bit.
- 11. T-Square and marker.

Installation Steps:

Installation procedures will change from job to job and are affected by how the structure is built. Joist spacing, bracing and zoning details are just a few items that can affect how an

Typical RadiantPEX banding at exterior walls.

UnderFloor application is installed. The following guidelines and examples cover the most common installation conditions. If unexpected circumstances arise, please contact Watts Radiant or a Watts Radiant Representative for assistance.

The most common installation pattern in an UnderFloor application is a single serpentine layout.

Step 1: Install Manifolds

With the use of Watts Radiant Manifold Brackets or Manifold Box, secure the manifolds to the joist or wall enclosure. If the manifolds are located in the wall above the radiant floor, drill holes to transfer RadiantPEX through the subfloor and into the joist cavity below. If the manifolds are located in the joist bay, simply attach the manifold enclosure horizontally to the joist. Follow local code guidelines when penetrating any framing members.

Always keep the manifolds easily accessible.

Wall Stud

Step 2: Determine Zone Boundaries

Before RadiantPEX is installed, visually inspect the area to determine the zone boundaries. This helps determine where the first circuit is to be placed, while identifying any obstacles that may be in the way.

Step 3: Confirm Tubing Requirements

Measure the distance from the manifolds to the farthest point in the zone. Make sure the RadiantPEX circuits are more than twice this distance. If not, the RadiantPEX will not be long enough to reach the farthest point and still have enough length to return to the manifold.

Step 4: Drill Joist

For this step, gather the following tools: Chalk line

Marker T-square 1-3/4" bit Angle drill Safety glasses Ladder

Measure 8" from the outside wall and mark the bottom of the joist. Locate the last joist in the run and mark it 8"

Metal Manifold Enclosure located in wall.

ication. BOCA 2305.3.2 Guideline for joist penetration.

Watts Radiant: RadiantPEX Installation Manual

from the outside wall. Snap the chalk line to mark the joists in between. With the use of the T-Square measure a drilling point in the <u>middle</u> of the joist. <u>Any</u> hole drilled into a joist must be located between the mid-line and upper 1/3 of the joist. Mark the hole location on each subsequent joist. This will help keep the holes in a straight line and make pulling the RadiantPEX much easier.

Step 5: Install the Fasteners

Heat Transfer Plate Method Heat transfer plates are 24" long and 5" wide. The size of the plates and the 1/2" PEX limit the RadiantPEX spacing to 8" OC, or two runs per joist bay.

At each end of the joist bay make a mark on the bottom of the subfloor 3/4" from the joist (see figure (a) on the next page). Snap a chalk line parallel to the joists between these two points. Repeat for the other joist. These lines will be used to line up the edge of the plate.

Secure the plate to the subfloor along one side of the plate as shown. The other side is to remain free to allow PEX to be installed and to minimize expansion noise associated with movement of the plates.

Position the plates approximately 12" away from the band joists or other blocking to allow enough room for the PEX to bend. A maximum 6" space should be left between plates. This will help when inserting the PEX into the plate later on.

In most cases it will not be possible to install plates evenly across the length of the joist bay. To figure out how many plates will fit into the joist bay take the length of the bay and subtract 2' from this length to account for the space needed at either end. Take the new length and divide this by 2.5 (the length of one plate and the maximum 6" space between plates). Round down

It may be necessary to loop the PEX before running through the joist to help absorb movement due to thermal expansion. Plates should be installed no farther than 6" apart. Space the plates so full plates are used. Do not attempt to cut the heat transfer plates to make them shorter as a rough edge may be created that may damage the PEX tubing.

this number to the nearest whole number. This will give the number of plates needed to fill the space in one joist bay.

For example, in a room that measures 20' long:

$$20' - 2' = 18'$$

18'/2.5' = 7.2 plates
7 × 2 = 14 plates

14 plates are required for this bay.

The number of plates was doubled to account for both runs of tubing installed in this bay. The spacing of the last few plates may need to be adjusted slightly to allow the last plate to remain 12" off of the band joist or blocking.

Note: Do not cut the plates to make them shorter. This will potentially create a sharp or ragged edge that may cause damage to the RadiantPEX. A bead of silicone should be added to the plate channel to help minimize noise that may sometimes be generated as the PEX tries to expand and contract.

Install enough plates to accommodate the first circuit. *Do not install plates across the entire floor at one time* as it may become necessary to adjust plate locations as new circuits of PEX are installed. The next circuit of PEX will begin 6"–8" off of the first circuit and the next 6"–8" off of that one. It is sometimes difficult to visualize where each circuit will end and the next begin. Correspondingly, it will be difficult to know where the next series of plates need to begin.

Suspension Method

Suspension systems are best installed with Watts Radiant LockDowns. The same installation procedures should be followed if other Watts Radiant attachment clips are used. Although using LockDowns allow for tighter than 8" OC spacing of the RadiantPEX, it is still advised not to go much tighter. Closer spacing increases the risk of kinking the bends. Standard bend radius for any size PEX piping should not exceed 8 times the nominal outside diameter.

LockDowns must be installed no farther apart than 32" and should support the PEX on both sides of a bend. Ideal spacing is 24" OC.

At each end of the joist bay make a mark on the bottom of the subfloor 3" away from the joist. Snap a chalk line parallel to the joists between these two points. Repeat for the other joists. These lines will be used to line up the screws of the LockDown. Secure the LockDown every 24"–32" OC.

Position the first LockDowns approximately 12" away from the band joists or other blocking to allow enough room for the PEX to bend.

LockDowns should be spaced no farther apart than 32". Where possible, LockDowns should be positioned around bends and turns to help support the tubing. Additional LockDowns may be used as necessary.

Install enough LockDowns to accommodate the first circuit. *Do not install LockDowns across the entire floor at one time*. The next circuit of PEX will begin 6"–8" off of the first circuit and the next 6"–8" off of that one. It is difficult to visualize where each circuit will end and the next begin. Correspondingly, it will be difficult to know where the next series of LockDowns will need to begin.

Step 6: Install the RadiantPEX

Place the unwinder underneath the manifold with a coil of RadiantPEX placed over the center post. Place the support bracing down over the RadiantPEX and cut the binding tape on the coil. Pull one end of the RadiantPEX off the unwinder and feed it through the guide eye on the unwinder. This will help prevent any kinking from taking place.

Before any PEX is pulled from the unwinder, first determine how many joist bays the first circuit will cover.

Take the required circuit length (found on the RadiantWork's Zone List Report), subtract twice the distance from the manifold to the far joist bay and divide by twice the joist length.

First Circuit

For example, let's assume we have a project with 20' joist bays, is $30' \times 20'$ in size and the design calls for 200' circuits. In this example the number of joist bays filled by the first circuit would be calculated as follows:

$$200' - (2 \times 30') = 140'$$

$$140'/(2 \times 20') = 3.5$$
 bays

Drill two series of holes in the joists to the far bay. The first one should be 6"-8" from the band joist or joist support. The second should be 4"-8" away from the first.

Begin by pulling the PEX tubing down the second series of holes

Second Circuit

The second circuit will need to pick up the remaining section of the last joist bay left by the first circuit.

To determine the number of complete bays the second circuit will cover, use the same formula discussed earlier when installing the first circuit. Subtract from this value the amount of free joist bay left by the first circuit.

Remember in our example the distance to the farthest point is four joist bays less than the first circuit.

Our second circuit equation is figured as shown:

 $200' - [2 \times (30' - 5.3')] = 150.60'$

 $150.60'/(2 \times 20') = 3.76$ bays

3.76 bays - 0.5 bays = 3.26 bays

The next circuit will cover approximately 3.26 "new" bays. The value of 5.3' is the equivalent of the first four joist bays the first circuit covered. Also, the 0.5 is the portion of joist bay that remained from the first circuit.

All new tubing should be pulled from the unwinder first and then fed through the bays, keeping the hanging loops 4'-6' in length.

For the next bay any extra PEX that may be needed to finish the joist bay will come from the loop of PEX hanging in the previous bay. It may be necessary to extend this loop before pulling the second bay.

Continue this process until all three bays are filled. Cut the PEX from the unwinder and attach to the manifold.

Step 7: Repeat With Next Circuit

Repeat the same procedure for this and all subsequent circuits. Manifold connection details can be found in the

Typical UnderFloor application.

Appendix of this manual. Be sure to follow all appropriate steps and use all approved fitting components and tools.

In some cases it may prove easier to leave the ends of the circuits unattached to the manifolds until all circuits for the given zone are installed. In these cases, it is important to make sure both ends of a single circuit are selected at one time when making the final connections to the manifold. One method to prevent cross circuiting the loops is to tape the corresponding ends together with electrical tape when each circuit is installed.

Note: Do not use duct tape on RadiantPEX.

If the ends have not been taped, or if the tape did not hold, it is important to verify corresponding ends of the same circuit are selected. To do this, chose two circuit ends and blow through one, with a thumb placed over the other end. Air should be felt on the other side, confirming both ends of the same circuit have been selected. If air is not felt, select another circuit end until air is detected.

Most coils of PEX will provide multiple circuits, depending on the design. In some cases scrap material may

remain at the end of the coil. Scrap material is any length of tubing not long enough to be a complete circuit.

Make sure to use as much of each circuit as possible. If the last circuit is longer than needed, try not to cut it shorter. Shorter circuits have a lower pressure drop and will tend to cause an imbalance in the fluid flow. Some tubing may be removed from this last circuit as long as the remaining length remains within 10% of the existing circuits. For example, if 200' lengths were installed, the last circuit can be cut to a length of 180' and still maintain a balanced system. If more than 10% is in excess, run the remaining tubing along an exposed wall or in other areas of the zone.

In the event excess tubing cannot be utilized, balancing control will need to be installed on the manifolds.

Step 8: Visual Inspection and Pressure Testing

After all the circuits are installed, take a few minutes to walk each circuit and visually inspect the tubing for possible damage caused during installation. If damage is found, repair it using an approved Watts Radiant method. In the event of extensive damage, a Watts Radiant Repair Kit may be required. More information on the repair kits and repair methods can be found in the Appendix.

For detailed information on the proper steps to conducting a pressure test, refer to the Appendix of the installation manual.

Insulation Details

Insulation is one of the most important factors that can affect how a system operates and performs. Different conditions call for different insulation requirements. Insulation should be a minimum of 3-1/2", or R-13, foilfaced fiberglass batt when the radiant floor is installed over a heated space, such as a basement. 5-1/2", or R-19, foil-faced batts (or thicker, depending on the climate) should be used when the area below the radiant floor is unheated or exposed to the elements.

Caution: The exterior band joists must be insulated with the same type of foil-faced insulation to prevent any excess heat loss directly to the outside.

The design calculations used in RadiantWorks are based on foil-faced insulation. If a non-foil-faced insulation is used, the performance of the radiant system will be reduced by as much as 25%.

Foil-faced batt insulation is preferred because it completely seals the joist cavity, but a foil-faced, high temperature board insulation, such as a polyisocyanurate or extruded polystyrene, may be used. Make sure a proper thickness board is selected to provide the required R-Value for the project. To ensure proper performance from a board insulation, make sure the board creates a completely airtight cavity. Use foam sealants as needed to seal all air gaps.

The use of foil only or the use of a foil-faced bubble pack insulation is not recommended by Watts Radiant.

These products should only be used in conjunction with another type of insulation, such as a non-foil-faced batt or a blown-in insulation. Use of these methods should only be considered by professional installers who have had prior successful experience with these types of products and/or applications.

Special Joist Construction

More and more projects are using TJI joists and open web trusses. These specially engineered building joists allow for greater loads and broader spans. Although they may solve some of the construction issues, they do raise some challenges for a proper radiant floor installation.

TJI Joists

TJI (Truss Joist International) flooring systems are installed in a similar manner as conventional joists. The design of a TJI joist system is slightly different, consisting of a laminated core material that resembles an I-beam. Due to this design, the allowable space between the two center supports is slightly wider than what would be seen in a conventional 16" OC joist system. A wider batt insulation is required to fill this space, typically a

19"-wide batt is required. The remaining installation details described earlier should be followed.

Note: Heat is often lost from a joist bay through holes drilled for plumbing and electrical lines. To prevent this, install "foam spray" insulation in these holes.

Open Web Trusses

Cross bracing is applied to two main header beams to form a "W" style profile. This design allows for easy installation of radiant tubing and other components such as electrical and plumbing. However, since a tight joist cavity is desirable, some previously discussed guidelines need to be adjusted.

Air movement in a joist bay can be a problem with radiant heat installations. Reduced radiant floor output is associated with air movement from joist bay to joist bay or from joist bay to the outside. In a conventional joist system, air movement is isolated to a single bay. This is not the case with an open web system.

To help seal the joist cavity, the insulation needs to be placed up against the header plate of the truss. This will prevent air from moving from bay to bay and from moving downward to the environment below. By doing this, a 2" air gap is no longer a possibility. If the insulation is placed so it just extends into the header space, a 1/2"-3/4" air space should be easily maintained. It still remains critical that the insulation does not touch the radiant tubing.

Typical TJI (Truss Joist International) cross-section.

Typical Web Joist cross section.

Open Web Trusses offer several advantages on large construction projects. Web Truss floors can carry heavier loads and can span greater distances.

Sandwich/SubRay Applications

Sandwich Application

Sandwich and SubRay[®] applications mimic UnderFloor in almost every way except one. In a Sandwich application, the RadiantPEX tubing is placed on top of the subfloor instead of beneath. Four- to six-inch-wide sleepers, 3/4" to 1-1/2" thick, are installed every 8" OC. Sleeper requirements will vary depending on the attachment method used. These sleepers mimic the function of the joist in the main floor, aiding support for the upper subfloor that will be added prior to the finished floor.

Sleepers should be installed perpendicular to the joists wherever possible.

In some cases, a sandwich application may be installed over an existing slab. In these cases, the installation requirements are the same as they are for Sandwich applications over a frame floor. Variations occur in how the systems are insulated. Sandwich over slab applications must be insulated between the sleeper runs to isolate the heat loss into the slab. This will require a thicker sleeper, typically a 2×4 will be used, giving a sleeper height of 1.5".

Many contractors have discovered the benefits of Watts Radiant's SubRay[®] flooring system. SubRay is a prefabricated sleeper and header system, providing an easy, low profile installation. Further information on the SubRay installation techniques and requirements can be found in the Watts Radiant SubRay Installation Manual.

Sandwich Installation Methods

Heat Transfer Plates

Watts Radiant offers an aluminum plate designed to be used with 1/2" Watts Radiant RadiantPEX.

The heat transfer plate is attached to the sleeper and the RadiantPEX is then inserted into the plate. This allows the PEX to be separated from the subfloor, eliminating any potential noise issue.

However, this separation raises concerns relative to the conductive transfer of energy needed to deliver the required heat to a space. The aluminum transfer plates offer this contact, allowing conduction to continue from the RadiantPEX to the upper subfloor.

In most cases a PEX system installed with heat transfer plates will still

Heat Transfer plates can be used to secure the PEX tubing to the sleepers. This method helps to increase the system's response time and helps to reduce tubing movement.

deliver the required BTU load to a space. The maximum BTU delivered will typically be around 45 BTU/sq.ft.

It is important to install the aluminum plates in accordance to the specified installation details. Failure to do so may result in noise associated with the aluminum plates wanting to move during the heating process. Refer to the section Installing Heat Transfer Plates for more information.

Sandwich/SubRay application over frame floor.

Sandwich/SubRay Applications

Watts Radiant's LockDown fasteners can be used to secure the PEX tubing to the existing slab or subfloor. Insulation methods must be considered prior to the PEX installation.

Cross sections of the SubRay subfloor radiant system, over slab (left) and over frame floor (right).

Clips

Another method of installing PEX in a sandwich application is to use a clip, such as Watts Radiant's LockDown[™]. Although this method is easier to install than heat transfer plates, there are some design cautions that need to be followed.

LockDown installations keep the PEX from coming in contact with the upper subfloor. **This may cause a significant reduction in heat output from** the system, depending on the load, floor covering, etc. Secure the PEX on either side of a bend or corner. On long straight runs, the PEX should be fastened every 24"–32". It is important to secure the PEX often enough so it does not rise above the sleeper.

However, the cost of having a completely quiet system is a reduction of heat transfer. Since the tubing is no longer in direct contact with the subfloor, either directly or indirectly

through heat transfer plates, the overall BTU capacity of the system is reduced.

SubRay

The fastest and easiest method for installing RadiantPEX above the floor is Watts Radiant's SubRay system. SubRay is a premanufactured sandwich system, complete with headers, sleepers and fasteners. It's a complete, ready-to-install system. For more information on SubRay please refer to the SubRay installation manual, a 24-page booklet packed with installation guidelines and tips, or visit the Watts Radiant Web site, www.wattsradiant.com.

Getting Started

Tools and Materials Required

Make sure all materials are present and in good working order. Following are the most common items needed:

1. RadiantWorks Reports. These reports help ensure the proper amount of tubing is installed in each area, along with the correct manifold size.

2. RadiantPEX tubing and corresponding number of PEX fittings. There are two types of connections that can be used with RadiantPEX: CrimpRing (installed with the CrimpAll Tool), and Compression (installed with a standard crescent wrench). Each fitting type is designed for ease of installation, durability and longevity. Fittings are typically chosen based on installer preference, unless otherwise specified.

Watts Radiant's SubRay system is a fast and easy way to install PEX tubing above the floor. Refer to the SubRay installation manual for more details.

Sandwich/SubRay Applications

3. Manifolds

Only use Watts Radiant manifolds or Watts Radiant manifold components for field-constructed manifolds.

4. Unwinder.

A required component for easily unrolling each RadiantPEX coil without kinks and twists.

5. Field Repair Kit.

Each kit contains two barb-by-barb splices and four RadiantPEX corresponding fittings.

6. Manifold Mounting Bracket.

Brackets are used to temporarily or permanently mount each manifold pair to the floor or wall.

7. Watts Radiant heat transfer plates and/or LockDowns and corresponding screws or nails.

8. Pressure test kit.

Each manifold pair must be pressure tested. This helps ensure each RadiantPEX connection has been performed correctly and to make sure no additional damage has been done to the tubing during installation.

9. Chalk line

Fasteners

It is important to chose a fastener type in conjunction with the floor construction requirements. Different projects may have height limits imposed on the system. This limit may make a difference in the fastener type chosen.

Caution: Make sure sleepers are correctly chosen in accordance with the Watts Radiant fastener used. If the sleepers are too shallow, the fastener will become a high point, which may cause complications while installing the upper subfloor or finished floor covering.

INCORRECT PEX CLIP INSTALLATION: Sleeper selection is too shallow for the clip height. To correct this, a taller sleeper must be used, or a more shallow clip.

CORRECT PEX CLIP INSTALLATION: It is recommended to size the sleepers so that a slight gap results between the top of the clip and the new subfloor or finished floor covering. Watts Radiant's LockDown or SnapClip fasteners work great if you are using 2" x 4" sleepers.

Installation Steps

Installation procedures change from job to job and are affected by how the structure is built. Sleeper spacing, thickness and zoning details are just a few items that can affect how a Sandwich application is installed. The following guidelines and examples cover the most common installation conditions. If unexpected circumstances arise, please contact Watts Radiant or a Watts Radiant Representative.

Step 1: Install Manifolds

With the use of Watts Radiant's manifold brackets or manifold mounting enclosure, secure the manifolds to the joist or wall enclosure. If the manifolds are located in a joist space, make allowances for the PEX to transfer through the wall base plate and into the sleeper system. Follow local code guidelines when penetrating framing base (bottom) plates.

Step 2: Determine Zone Boundaries

Before RadiantPEX is installed, visually inspect the area to determine the zone boundaries. This helps determine where the first circuit is to be placed, while identifying any obstacles that may be in the way.

Step 3: Confirm Tubing Requirements

Measure the distance from the manifolds to the farthest point in the zone. The minimum RadiantPEX circuit must be at least twice this distance. If not, the RadiantPEX will not be long enough to reach the farthest point and be able to return to the manifold.
Sandwich/SubRay Applications



Step 4: Sleeper Placement and Sizing

For this step, gather the following tools: chalk line, marker, circular saw, and sleepers. There are two main variations to a Sandwich installation; each is dependent on how the system will be insulated. If the system is to be insulated in the joist cavity, a Watts Radiant SubRay sleeper system should be used. If the system is to be insulated on top of the subfloor, between the sleepers, then the sleeper height needs to be chosen based on the insulation height to still allow a 3/4"-1" vertical space for the RadiantPEX and corresponding fastener. Most systems insulated on top of the subfloor need a 2" x 4" sleeper, or greater, with a 1/2"-3/4" insulation board.

PEX Size	Fastener Type	Min. Sleeper Thickness
3/8"	Plates LockDown	N/A 1-1/8"
1/2"	Plates LockDown	3/4" 1-1/2"

Place a position sleeper around the zone and all interior walls. This position sleeper will help keep the RadiantPEX away from exterior and interior wall construction. This is important to help prevent damage to the tubing that may be caused by wall finishing or floor covering installation, such as carpet strips or other anchor points. If insulating between the sleepers, sleepers are typically spaced 8" OC. This spacing is based on a standard 3/4" subfloor being applied on top.

Whenever possible, run the sleepers perpendicular to the joist direction. This will help add stability and stiffness to the floor.

Step 5: Install the Fasteners Heat Transfer Plates

Heat transfer plates are 24" long and 5" wide. The size of the plates limit the RadiantPEX spacing to 8" OC.

Note: If using SubRay, heat transfer plates are neither necessary nor recommended. See the SubRay Installation Manual or video for more details.

Install the sleepers across the room, maintaining a 1"-2" spacing between them. This will result in a 1-1/2" section of the plate to be attached to the sleeper.

In some cases it may be necessary to install a wider sleeper along the walls that run parallel with the sleepers, since 8" is not always evenly divided into a room's width. In most cases it will not be possible to install all the plates evenly across the subfloor, keeping the 6" spacing between plates. To figure out how many plates will fit along the sleepers, take the length of the sleeper and subtract 2' from this length to account for the space needed at either end. Take this new length and divide this by 2.5 (the length of one plate and ideal 6" space between plates). Truncate this number to the nearest whole number. This will give the number of plates needed to fill the distance.

For example, a room is 20' long.

Seven plates are required for this sleeper run.

The spacing of the last few plates will need to be adjusted slightly to allow the last plate to remain 12" away from the edge of the room.

Note: Do not cut the plates to make them shorter. This will potentially create a sharp or ragged edge that may cause damage to the PEX.



Secure heat transfer plates along one side to allow for thermal expansion. Do not over secure the plate as unwanted noise may occur.

Sandwich/SubRay Applications



Add a bead of silicone to the plate to help minimize noise that may sometimes be generated as the PEX tries to expand and contract, as well as improve heat transfer.

Install enough plates to accommodate the first circuit. Do not install plates across the entire floor at one time. The next circuit of PEX will begin 6"-8" off of the first circuit, and the next 6"-8" off of that one. It is difficult to visualize where each circuit will end and the next begin. Correspondingly, it will be difficult to know where the next series of plates need to begin.

LockDown Fasteners

Sandwich systems can be installed using a variety of attachment options. We recommend Watts Radiant's LockDown fasteners, which fit the PEX loosely thereby allowing the PEX to expand or contract.

Although using LockDowns allow for tighter than 8" OC spacing of the RadiantPEX, it is still advised not to go much tighter. Closer spacings increase the risk of kinking and may

unnecessarily complicate the layout. Standard bend radius for any size PEX piping should not exceed 8 times the outside diameter.

LockDowns must be installed no farther apart than 32", and should support the PEX on both sides of a bend. Ideal spacing is 24" OC.

At each end of the sleeper bay make a mark 3" off of the sleeper. Snap a

lines will be used to line up the screw of the LockDown. Secure the LockDowns every 24"-32" OC.

Position the first LockDown fastener approximately 12" away from the edge of the wall to allow enough room for the PEX to bend.

Step 6: Install the RadiantPEX

Place the unwinder beside the manifold with a coil of RadiantPEX placed over the center post. Place the support bracing down over the RadiantPEX and cut the binding tape on the coil. Pull one end of the RadiantPEX off the unwinder and feed it through the guide eye on the unwinder. This will help prevent any kinking from taking place.

Pull the free end of RadiantPEX from the unwinder and begin placing it along the position sleeper to the far end of the room/zone, snapping the RadiantPEX into the LockDowns. Stop when the desired tubing length has been reached. If possible, try to install full runs of tubing to minimize the need to cut into a sleeper in mid-run. Secure the RadiantPEX back to the manifold and make the corresponding connection onto the second manifold.



Sleeper height needs to selected to allow for a slight gap between the clip used and the new floor covering. LockDowns are 1-3/8" tall and therefore work great with 2" x 4" sleepers.

Sandwich/SubRay Applications

It is generally easier to install full sleeper lengths and then cut transition points in a sleeper run with a circular saw.

In most sandwich applications, clip spacing of 24" OC will be more than adequate. However, depending on the sleeper depth, closer clip spacing may be required. It is important to prevent the RadiantPEX from rising above the sleeper to prevent damage during the installation of the upper subfloor or finished floor covering.

Note: If using SubRay, LockDown fasteners are neither necessary nor recommended. See the SubRay Installation Manual or video for more details.

Additional fasteners may be required around bends and corners to minimize stress on the bend, and to prevent the tubing from "curling" upward.

Step 7: Repeat With Next Circuit

Repeat steps 4 through 6, keeping the new series of sleepers spaced according to the required tube spacing. If a partial sleeper bay needs to be filled, cut in a new transition point 8" from the previous point for the new circuit.

Try to keep all circuits the same length. If the last circuit is too long, try not to cut it. Shorter circuits have a lower pressure drop and will tend to cause an imbalance in the fluid flow. Some tubing may be removed from this last circuit, or any previous circuit, as long as the remaining length is within 10% of the existing circuits. For example, if 200' lengths were installed, the last circuit can be cut to a length of 180' and still maintain a balanced system. If more than 10% is in excess, run the remaining tubing along an exposed wall or in other areas of the zone.

In the event excess tubing can not be utilized, balancing control will need to be installed on the manifolds.

Step 8: Visual Inspection

After all the circuits are installed, take a few minutes to walk each circuit and visually inspect the tubing for possible damage caused during installation. If damage is found, repair it using an approved Watts Radiant method. In the event of extensive damage, a Watts Radiant Repair Kit may be required. More information on the repair kits and repair methods can be found in the Appendix.



For detailed information on the proper steps to conducting a pressure test, refer to the Appendix of the installation manual.

Insulation Details

Foil-faced batt insulation is primarily used when an air gap can be maintained between the tubing and the insulation. In the case of a Sandwich application, the air gap is to either side of the tubing, not below the tubing. If the insulation is installed in the joist cavity, a standard Kraft faced insulation can be used. Make sure to install the insulation tight against the subfloor to minimize any convective losses that may be generated. **Note: This is a change from previous manuals.**

The actual R-value of the insulation should be the same as an UnderFloor application. The insulation should be a minimum of 3-1/2", or R-13, foilfaced fiberglass batt when the radiant floor is installed over a heated space, such as a basement. 5-1/2", or R-19, foil-faced batts (or thicker, depending on the climate) should be used when the area below the radiant floor is unheated or exposed to the elements.

If insulating above the subfloor, then insulation between the sleepers should be a foil-faced insulation board. We recommend a high-temperature polyisocyanurate board, such as Celotex[®] Thermax[®]. Even though there is no air gap below the tubing, the foil will help even out the heat transfer across the sleeper spacing and the upper subfloor.

If using SubRay, an aluminized tape can be used between the sleepers.

In the case of a Sandwich-over-Slab application, especially a basement remodel, an extruded polystyrene insulation board, such as Dow[®] Blue Board[®], is recommended. This is due to the tendency for moisture to collect in basement areas, either because of condensation or high seasonal water table levels. An extruded polystyrene board will withstand moisture conditions better than a polyiscocyanurate.

Wall and Ceiling Applications

Walls and Ceilings

Radiant floors have a limited amount of energy they can produce, usually around 45–50 BTU/sq.ft. This limit is set by the maximum human comfort limit of 85°F. Most of the time this limit will be seen in areas such as sunrooms or vestibules. In cases like these where auxiliary heat is sometimes required, supplemental heat may be added in the form of baseboard or fan coils.

Or, supplemental heat may be added by simply increasing the radiant surface area.

Tubing can be installed in an interior wall or ceiling to increase the radiant surface area for a given room.

Walls and ceiling panels may also be used in cases where construction details prohibit a radiant floor installation.

Installation requirements are the same for both ceiling and walls as seen in other frame applications.

If Watts Radiant's SubRay product is to be used for the ceilings or walls, consult the SubRay Installation Manual or video for further details.



Side View.



Top view of a wall application, or a side view of a ceiling application.

Wall and Ceiling Applications





For most wall applications, it is advised not to extend the system beyond 4' above the floor. This is due to various penetrations associated with items such as pictures and shelving. To minimize damage to the tubing, keep the installation below the level required for normal decorating practices.

Recessed Wall

One method for installing a wall or ceiling is to first install a drop panel. This drop panel will usually consist of a 1" insulation board, but may also be 1/4" or 1/2" plywood. Both will be supported by runners attached to the sides of the studs or rafters.

If a plywood drop board is used, insulation needs to be installed behind the plywood. Use LockDown fasteners, attached to the plywood, to hold the PEX in place.

If 1" or 2" insulation board is used, fasten ScrewClips to the insulation board at 2' OC. Then attach the PEX to the ScrewClips.

SubRay 862

In some cases, the wall or ceiling cavity may not be deep enough to allow for the RadiantPEX, insulation, and support material. In these cases, Watts Radiant SubRay 862 can be used. This will go on top of the wall studs or ceiling joists.

A 2×4 support plate will need to be added to either end of the wall to help secure the Header Stick. Make sure to select the 15-mm SubRay product to accommodate the 3/8" RadiantPEX tubing, and 18-mm SubRay product for 1/2" RadiantPEX tubing.

SubRay Sleepers are installed across the studs or joists with Grippers installed every stud (16" OC) to keep the RadiantPEX in place.

Caution should be used when securing the ceiling material, taking extra care to only nail into the studs or joists.

Wall and Ceiling Applications

Refer to the SubRay 862 Installation Manual for more product and installation information.

Cautions

One limitation to walls and ceilings is the maximum allowable temperature the dry-wall can maintain. According to the National Gypsum Company, the maximum operating temperature for wallboard and ceiling board is 125°F. Due to this limitation do not allow supply fluid temperatures to exceed 120°F. From a design perspective, do not allow the surface temperature to exceed 90°F.

If a different wall material is to be used, consult that product's manufacturer for specific temperature limits.

Gripper

Header Stick



0

٥

ο

Slab-on-Grade Applications

Introduction

Slab applications are one of the most common applications used by commercial, as well as residential, radiant heating systems. The added thermal mass provided by a slab increases the overall thermal efficiency of the system, while providing more even heat distribution throughout the structure.

However, since the slab is in direct contact with the ground, energy can be lost to the surroundings. To help reduce these back and edge losses, certain conditions must be met prior to the radiant installation to help ensure proper system operation.

Site Preparation

A radiant slab should be placed on well drained base rock material. Subsurface water will rob heat from a radiant slab faster than a boiler can produce it. Basements and slabs



installed in hillsides should have good drainage to carry any subsurface groundwater away from the site. The slab should be placed above an ample amount of crushed rock or gravel.

Radiant slabs placed on low-lying, poorly drained soil or sand should have at least 1" of extruded poly-



Insulated Slab on Grade.

styrene (Dow® Blue Board®) insulation under the entire slab — even in southern climates.

<u>A radiant slab should never be placed</u> <u>directly on top of clay or organic sub-</u> <u>soil</u>, as these materials can conduct heat away from the radiant slab, and the soils may shrink in volume when directly exposed to the heat of the slab. An intervening layer of four or more inches of crushed rock or river gravel should be installed above these soil materials.

Caution: A radiant slab should never be placed directly on top of solid bedrock, as this material can rapidly conduct heat from the slab into the earth. Crushed rock and/or insulation must be installed between the slab and rock.

Sometimes 1"–2" of sand is placed on top of the coarser base rock material. This gives a smooth, level surface to lay down rigid insulation, and helps prevent possible breakup of the rigid insulation in high traffic areas prior to concrete placement. The sand layer also allows for more precise leveling to minimize any variation in the slab thickness.

Insulation Details

Unlike a frame application where the insulation is installed after the radiant tubing, a slab application requires the insulation to be installed first, making the insulation part of the structure.

In a slab on grade application there are two main areas to insulate: vertically around the perimeter of the slab and horizontally underneath the slab. Both will aid in the slab's response and efficiency. Of these two, the vertical edge insulation is the most important because it prevents heat loss directly to the outside environment. Horizontal insulation helps decrease the slabs required start up time by isolating the heating mass from the ground mass below. Typically, the system will see a reduction of about 3-10% in overall operational efficiency if a horizontal insulation is not used, and as much as 15-20% if vertical edge insulation is not used.

Type of Insulation

Extruded polystyrene insulation board is recommended mainly because the insulation board will be in direct contact with the soil. Extruded polystyrene insulation will not degrade over time due to excess moisture or soil acidity. "Beaded" insulation boards should not be used because they are not strong enough and will break down over time. This, in turn, will cause structural instability.

In most applications, 1" insulation board is recommended. A thicker board may be used if the slab is to be installed in a cold, aggressive climate and/or if heavier traffic loads dictate stronger (i.e., thicker) insulation. Always consult with an architect or structural engineer to specify the appropriate insulation for the particular application.

Foil-faced insulation is not required or recommended when insulating a radiant slab. Foil-faced insulation is used when an air gap is able to be maintained. In the case of a slab application the tubing is completely encapsulated in the concrete, eliminating any air gap.

Watts Radiant does not recommend Bubble-type insulation under a slab application until more research has been done and performance has been verified.



Special Construction Considerations

Slab applications are generally the easiest to install. However, it is important to remember what type of construction steps remain after the concrete slab has been poured. In most projects, the concrete is the first phase of the project. Interior walls and other supports structures still have to be installed with most being mounted or secured directly to the slab. With this in mind, it is important to take some preliminary steps to help protect the tubing during construction.

Control Joints

Concrete slabs will expand and contract due to thermal changes. To prevent damage to the slab, expansion joints are used to control this movement. In some cases cut joints are used to control where cracking is to occur. Make sure the tubing is protected according to the requirements of the control joint.

Design Parameters

For proper radiant design it is important to know the type of layers used in the floor construction. As these layers increase or change, variances in the heating system are required. Concrete is a very conductive material, allowing for a wider spread in heat transfer throughout the mass. However, certain limitations should be present to ensure certain comfort levels are maintained.

RadiantPEX Spacing

Most residential slabs use 12" tube spacing with some perimeter banding. In a few cases, where control over supply fluid temperature is needed, an entire room may be installed at 6" OC. This may be the case in a high heat loss sunroom or pool area. For certain industrial or commercial projects the spacing may be greater.

RadiantPEX is generally installed on either rewire/rebar for concrete slab



RadiantPEX sleeved at expansion joint with foam insulation or PVC conduit.



RadiantPEX routed below expansion joint into subgrade.

applications, or to the subfloor for thin slab applications. Closer spacing may be used in areas of high heat loss, such as an exposed wall with a high percentage of glass. 9" OC spacing is sometimes preferred in bathrooms, kitchens and entries. Closer tube spacing, up to 6" OC, may also be used in areas that have a low thermal conductivity, such as areas with thicker than normal concrete or dense floor covering such as a carpet and pad.

It is important to note that simply doubling the amount of tubing does not double the floor's heating output. The floor's ability to deliver heat to a room is based on the floor's surface temperature. The amount of radiant tubing and fluid temperature controls this surface temperature. More tubing, or

tighter spacing may allow for the same surface temperature to be reached at a slightly lower supply fluid temperature.

Watts Radiant's RadiantWorks design software generates a specific nomograph for each room in the design. Nomographs convey several key factors associated with a room, such as tube spacing, floor surface temperature, floor heating intensity, mean (average) supply water temperature and back and edge loss values. Nomographs are essential to any radiant design. More information on how to read and use a Nomograph can be found in the Appendix.

Perimeter Banding

Six- and nine-inch RadiantPEX spacing is sometimes used along outside exposed perimeter walls in residential applications. These high-density spacing areas are called perimeter bands and tubing is generally spaced at half the primary spacing. Banded areas range in width from 2' to 8', with the wider bands generally used in front of taller exposed walls with a high percentage of glass. A good rule of thumb is to use a perimeter band width of 50% to 75% of the height of the wall.

Tools and Materials Required

It is a good idea to have all materials present and in good working order before beginning an installation. The following is a list of the most common items needed for a typical slab installation.

1. RadiantWorks Reports.

These reports help ensure the proper amount of tubing is installed in each area, along with the correct manifold size.

2. RadiantPEX tubing and corresponding number of RadiantPEX fittings.

There are two types of connections that can be used with RadiantPEX: CrimpRing (installed with the CrimpAll Tool), and Compression (installed with a standard crescent wrench). Each fitting type is designed for ease of installation, durability and longevity. Fittings are typically chosen based on installer preference, unless otherwise specified.

3. Manifold

Only use Watts Radiant manifolds or manifold components for fieldconstructed manifolds.



Typical slab tubing layout.

4. Unwinder.

A required component for easily unrolling each precut RadiantPEX coil without kinks and twist.

5. Field Repair Kit.

Each kit will contain two barb-bybarb splices and four corresponding RadiantPEX fittings.

6. Manifold Mounting Bracket.

Each bracket can be used to temporarily or permanently mount each manifold pair to the floor or wall. Use either Watts Radiant brackets or SnapClips to hold manifolds.

7. Watts Radiant Fasteners.

8. Pressure Test Kit.

Each manifold pair must be pressure tested. This helps ensure each RadiantPEX connection has been installed correctly and to make sure no additional damage has been done to the tubing during installation.

9. Installation Accessories

- a. Spray Paint for marking out zones and subzones, as well as areas not to be heated.
- b. Electrical Tape for temporarily mounting the manifolds or taping ends of tubing together.
- c. Cable Ties, ClipTies, ScrewClips, or other approved fasteners.

Since rewire/rebar is commonly used in concrete slabs for structural integrity, it is common practice to attach RadiantPEX to the rewire/rebar. This is commonly done with the use of nylon cable ties or Watts Radiant ClipTies and Clipper tool. Each secures the RadiantPEX to the rewire/rebar to prevent movement of the tubing during the concrete pour.

In applications where rewire/rebar is not used and an insulation board is placed underneath the slab, Watts Radiant's Foam Staples or Foam Clips can be used to secure the RadiantPEX tubing directly to the insulation board. Standard RadiantPEX staples can be used if a thin slab is installed over a wood subfloor.

For any attachment method, it is important to secure the tubing at least every 12"-18" OC. This will prevent the RadiantPEX from shifting during the concrete pour. (See Watts Radiant catalog or binder for more information on fasteners and tools.)



FoamBoard Stapler[™]



ClipTwister[™] Tool

Slab Profile and General Details

In slab-on-grade applications, it is important to maintain at least 2"-3" of concrete covering above the tubing. More coverage may be necessary depending on the structural requirements of the slab. The 2"-3" coverage is to ensure structural stability within the slab, allow for cut joints or frame walls to be applied and to allow enough space to float the aggregate. *Consult with the project manager or concrete installer to make sure this depth is appropriate.*

Complete encapsulation of the tubing is required to prevent stress points from forming on the slab, which may accelerate cracking over time.

Installation Steps

Manifold locations, final concrete thickness and zoning details are just a few items that are required for a successful radiant slab installation. The following guidelines and exam-

ples cover the most common installation conditions. If your situation is not covered here or if unexpected circumstances arise, please contact Watts Radiant or a Watts Radiant Representative.

The most common installation pattern for PEX slab applications is a single serpentine layout, although in some cases a double serpentine or a spiral pattern may be used.

Step 1: Pre-Pour Conditions

Verify all subgrade conditions are properly prepared, all insulation is installed according to design conditions and rewire or rebar is in place. With orange spray paint, locate all interior walls and other obstacles that may need to be avoided, such as toilet areas, sewer drains, and any structural supports that may penetrate the slab.

Step 2: Install Manifolds

Locate where the manifolds are to be installed. Drive two pieces of rebar vertically into the ground at this location. With the use of cable ties or electrical tape, temporarily secure the manifolds to the rebar. Remember to keep the manifolds high enough to allow for the thickness of the concrete, the interior wall base plate and other structural items that may need to be installed after the pour.

After the concrete is poured and just before the interior walls are installed, the rebar may be cut to free the manifolds. The manifolds can then be moved if necessary, to fit the actual wall construction. Make sure to leave plenty of slack in all RadiantPEX circuits (2'–5' is recommended). A Watts Radiant manifold box can be used to secure the manifolds within the new wall. Watts Radiant LockDowns and StrapDowns can be used to organize RadiantPEX coming from the floor and into the wall.



Typical slab installation. RadiantPEX is installed using a single serpentine pattern.



Step 3: Determine Zone Boundaries

Before RadiantPEX is installed, visually inspect the area to determine the zone boundaries. This helps determine where the first circuit is to be placed, while identifying any obstacles that may be in the way.

Step 4: Confirm Tubing Requirements

Measure the distance from the manifolds to the farthest point in the zone by right angles. Make sure the minimum circuit length is at least twice this distance. If not, the RadiantPEX will not be long enough to reach the farthest point of the zone and return.

Step 5: Install the RadiantPEX

Place the unwinder underneath the manifold with a coil of RadiantPEX placed over the center post. Place the support bracing down over the RadiantPEX and cut the binding tape on the coil. Pull one end of the RadiantPEX off the unwinder and feed it through the guide eye on the unwinder. This will help prevent any unwanted kinking from taking place.

Pull the free end of RadiantPEX from the unwinder and lay it along the perimeter walls to the farthest point in the zone, keeping the RadiantPEX 6"-8" from the edge of the slab. This will help protect the tubing from possible penetrations later on when the interior and exterior walls are installed. RadiantPEX can be run underneath interior walls as long as the RadiantPEX is deep enough in the slab to prevent nails in wall plates from damaging the circuits.

It is helpful to have a second person secure the PEX to the rewire/rebar as the coil is being pulled. Stop when the desired tubing length has been reached. Secure the RadiantPEX back to the manifold and make the corresponding connection onto the second manifold.

Transition sleeves should be used to protect the PEX from concrete trowels and other construction actions as it transitions from the slab to the wall. Unless the zone has only one loop or has a very short exterior perimeter, do not heat more than half of the perimeter with one circuit.

Step 6: Secure the RadiantPEX

Slab applications usually require some form of fastener, depending on the construction details. Most slab applications use rewire or rebar to add strength or crack resistance to the slab. In this application, the RadiantPEX attaches directly to the rewire/rebar by the use of cable ties or ClipTie clips every 12"–18". If the slab is poured without the rewire/rebar, other fasteners can be used that will secure the RadiantPEX directly to the foam insulation beneath the slab.

Make sure all bends and corners are securely fastened to prevent the PEX from curling, creating an unwanted



Typical slab application. RadiantPEX tubing installed 12" OC in a single serpentine pattern.



Various tube fasteners for slab applications.

high point in the circuit. Leave 2'–5' slack on each circuit in case the manifold position needs to be adjusted from its temporary location.

If cable ties are used, make sure all "tails" of the cable ties are either cut off or turned downward to prevent any unwanted surface protrusions.

Caution: Metal wire ties may increase the risk of damage to the PEX and are not an approved Watts Radiant fastener type.

Step 7: Repeat With Next Circuit

Repeat steps 4 through 6, keeping the next circuit spaced according to the design.

Try to keep all circuits the same length. If the last circuit is too long, try not to cut it. Shorter circuits have a lower pressure drop and will tend to cause an imbalance in the fluid flow. Some tubing may be removed from this last circuit, or any previous circuit, as long as the remaining length is within 10% of the existing circuits. For example, if 200' lengths were installed, the last circuit can be cut to a length of 180' and still maintain a balanced system. If more than 10% is in excess, run the remaining tubing along an exposed wall or in other areas of the zone.

In the event excess tubing can not be utilized, balancing control will need to be installed on the manifolds.

Step 8: Visual Inspection And Pressure Testing

After all the circuits are installed, take a few minutes to walk each circuit and visually inspect the tubing for possible damage caused during installation. If damage is found, repair it using an approved Watts Radiant method. In the event of extensive damage, a Watts Radiant Repair Kit may be required. More information on the repair kits and repair methods can be found in the Appendix.



For detailed information on the proper steps to conducting a pressure test, refer to the Appendix of the installation manual.

Step 9: The Concrete Pour

To help detect possible damage caused during the concrete pour, keep the system under pressure. If damage is done, locate the area in question and remove the section of tubing from the concrete. Clean off the damaged area and install a Watts Radiant splice fitting. Wrap the fitting with electrical tape to protect it from the concrete. Bring the circuit back up to pressure to ensure a proper fit on the splice.

Note: Do not use duct tape on RadiantPEX.

Some minor pressure changes will occur due to the increased internal temperatures of the concrete as it begins the curing process. Fluctuations in air temperature may also cause a slight change in the test pressure. In most cases, a 10–15-lb. drop in pressure over a 24-hour period is not uncommon. For more information on pressure testing, see the Appendix.

Thin-Slab and Slab-Cap Applications



Some construction details call for a thin slab, or a lightweight concrete, to be applied above the subfloor. These applications offer increased sound quality to a room and an increased thermal mass to the radiant heating system. In some cases, thin slabs are used to act as a fire-stop from floor to floor.

Most thin-slab applications are installed during the initial construction of a building, due to the increased structural requirements to carry the added weight.

Most lightweight concrete products will increase the floor height by 1-1/2" and the floor load anywhere between 12 to 18 lbs./sq.ft. This increase in load usually means a modification to the joist system and/or other support modifications. It is important to verify a floor's ability to withstand these loads prior to installing a lightweight concrete product.

Design Parameters

For proper radiant design it is important to know the type of layers used in the floor construction. As these layers increase or change, variances in the heating system result. Portland and gypsum-based concrete are very conductive materials, allowing for a wider spread in heat transfer throughout the mass. However, certain limitations should be present to ensure certain comfort levels are maintained.

RadiantPEX Spacing

Most thin slabs will use 12" tube spacing with some perimeter banding. In a few cases, where control over supply fluid temperature is needed, an entire room may be installed 9" or 6" OC. This may be the case in a high heat loss sunroom or pool area.

In a thin slab over frame floor application, RadiantPEX is generally installed directly to the subfloor with the use of staples and/or NailTites. If the thin slab is to be installed over an existing slab, LockDowns, SnapClips, or Railways may be used to secure the RadiantPEX.

Closer spacing may be used in areas of high heat loss, such as an exposed wall with a high percentage of glass; 9"-OC spacing is sometimes preferred in bathrooms, kitchens and entries. Closer tube spacing, up to 6" OC, may also be used in areas that have a low thermal conductivity, such as areas with dense floor coverings such as a carpet and pad. It is important to note that simply doubling the amount of tubing does not double the floor's heating output. The floor's ability to deliver heat to a room is based on its surface temperature. The radiant tubing controls this surface temperature. More tubing, or tighter spacing, allows for the same surface temperature to be reached at a slightly lower supply fluid temperature.

Watts Radiant's RadiantWorks design software generates a specific nomograph for each room in the design. Nomographs convey several key factors associated with a room, such as tube spacing, floor surface temperature, floor heating intensity, mean (average) supply water temperature and back and edge loss values. Nomographs are essential to any radiant design. More information on how to read and use a Nomograph can be found in the Appendix.





Perimeter Banding

Six- or nine-inch RadiantPEX spacing is frequently used along outside exposed perimeter walls. These highdensity spacing areas are called perimeter bands and tubing is generally spaced half the main spacing. Banded areas range in width from two to eight feet, with the wider bands generally used in front of taller exposed walls with a high percentage of glass. A good rule of thumb is to use a perimeter band width of 50% to 75% of the height of the wall, or half a standard wall height.

Tools and Materials Required

It is a good idea to make sure all materials are present and in good working order before beginning a radiant installation. The following is a list of the most common items needed for a typical Thin Slab installation.

1. RadiantWorks Reports.

These reports will ensure the proper amount of tubing is installed in each area, along with the correct manifold size.

2. RadiantPEX tubing and corresponding number of RadiantPEX fittings.

There are two types of connections that can be used with RadiantPEX: CrimpRing (installed with the CrimpAll Tool), and Compression (installed with a standard crescent wrench). Each fitting type is designed for ease of installation, durability and longevity. Fittings are typically chosen based on installer preference, unless otherwise specified.

3. Manifolds.

Only use manifolds provided by Watts Radiant or Watts Radiant manifold components for field constructed manifolds.



4. Unwinder.

A required component for easily unrolling each precut RadiantPEX coil without kinks and twist.

5. Field Repair Kit.

Each kit will contain two barb-bybarb splices and four corresponding RadiantPEX fittings.

6. Manifold Mounting Bracket. Each bracket can be used to temporarily or permanently mount each manifold pair to the floor or wall. Use Watts Radiant Manifold brackets or SnapClips to hold manifolds.

7. Watts Radiant Fasteners.

8. Pressure Test Kit.

Each manifold pair must be pressure tested. This helps ensure each RadiantPEX connection has been performed correctly and to make sure no additional damage has been done to the tubing during installation.

9. Installation Accessories.

- a. Spray Paint for marking out zones and subzones, as well as areas not to be heated.
- Electrical Tape for temporarily mounting the manifolds or taping ends of tubing together.
- c. LockDowns, SnapClips, Railways, staples, or other approved fasteners.

Fasteners

Although the Watts Radiant staple gun is the most useful attachment tool, other fasteners are available for areas where the staple gun can not reach. Watts Radiant's NailTites are used to secure RadiantPEX at turns and bends and in areas inaccessible to the staple gun. Both staples and NailTites need to be installed every 12"–18" along each run of PEX.

In a few cases, where it is impractical to insulate in the joist cavity, an extruded polystyrene insulation board may be installed on top of the subfloor, or over an existing slab prior to

the new thin slab pour. In these cases, fasteners such as Watts Radiant's Foam ScrewClips and Foam Staples may be used to secure the tubing directly to the insulation board. The proper insulation board must be specified by an architect or other structural professional.

To speed the installation of the RadiantPEX in a thin slab application, staple guns can be fitted with an extension arm. This arm allows the installer to move quickly through the attachment process. If Foam ScrewClips are used, a Watts Radiant ClipTwister tool will speed the installation. The ClipTwister is a 3'-long drill bit that attaches to a 3/8" standard cordless drill. Put a ScrewClip in the end of the ClipTwister, push the clip into the foam and screw it in place.



FoamBoard Staple









Watts Radiant Staple Gun

For details on the proper use of the Watts Radiant pneumatic staple gun, see the corresponding section under the Staple Up Application.

Installation Steps

Installation procedures change from job to job and are affected by how the structure is built. Manifold locations, final thin slab thickness and zoning details are just a few items that can affect how a Thin Slab application is installed. The following guidelines and examples cover the most common installation conditions. If a situation is not covered here or if unexpected circumstances arise, please contact Watts Radiant or a Watts Radiant Representative.

The most common installation pattern to use in a Thin Slab application is a single serpentine layout, although in some cases a double serpentine may be used.



Step 1: Install Manifolds

Locate where the manifolds are to be placed. With the use of Watts Radiant's manifold brackets or manifold mounting enclosure, secure the manifolds to the wall. Allowances may need to be made to allow the RadiantPEX to transfer through the wall base plate and into the thin slab. Follow local code guidelines when penetrating framing base plates.

Step 2: Determine Zone Boundaries

Before RadiantPEX is installed, visually inspect the area to determine the zone boundaries. This helps determine where the first circuit is to be placed, while identifying any obstacles that may be in the way.

Step 3: Confirm Tubing Requirements

Measure the distance from the manifolds to the farthest point in the zone. Make sure the minimum circuit length is at least twice this distance. If not, the RadiantPEX will not be long enough to reach the farthest point and still have enough length to return to the manifold.

Step 4: Install the RadiantPEX

Place the unwinder underneath the manifold with a coil of RadiantPEX placed over the center post. Place the support bracing down over the RadiantPEX and cut the binding tape on the coil. Pull one end of the RadiantPEX off the unwinder and feed it through the guide eye on the unwinder. This will help prevent any kinking from taking place.

Pull the free end of RadiantPEX from the unwinder and lay it along the perimeter walls to the farthest point in the zone, keeping the RadiantPEX 6"-8" from the edge of the slab. This

will help protect the tubing from possible penetrations later on when the final floor covering is installed.

It is helpful to have a second person secure the PEX to the subfloor as the coil is being pulled. Run the PEX back and forth in a serpentine pattern. Stop when the desired tubing length has been reached. Secure the RadiantPEX back to the manifold and make the corresponding connection onto the second manifold.

Transition sleeves may be used to protect the PEX from concrete trowels and other construction actions as it transitions from the slab to the wall. Unless the zone has only one loop or has a very short exterior perimeter, do not heat more than half of the perimeter with one circuit.

In most applications, a single serpentine layout will be used. In a few cases, a double serpentine layout may be used. The performance of the system is nearly identical with either layout option; however, installation issues and construction details may make one method easier to install.

Walls and Built-Ins

In most thin slab applications, built-ins such as cabinets, showers and walls are already in place before the thin slab is poured. This also means these



items are in place before the radiant tubing is installed.

Walls and other structural members can often create unique situations with tubing layouts. Most structural code requirements restrict the amount of material that can be removed from a wall member. Because of this, it is advised to try to run the RadiantPEX tubing through doorways when ever possible.



RadiantPEX secured using Watts Radiant Railway fastener. Railways accommodate 3/8", 1/2", or 5/8" Radiant PEX (1/2" RadiantPEX shown).



RadiantPEX secured using standard Watts Radiant staples.

Step 5: Secure the RadiantPEX

Most thin-slab applications require some form of fastener, depending on the construction details. When a thin slab is being installed over a subfloor, standard staples are used. To help reduce installation time, the staple guns may be fitted with an extension arm. Make sure the staple gun is set to 100 psi and does not come in contact with the RadiantPEX.

Other applications may use a foam installation board below the thin slab. In these applications, FoamBoard Staples or ScrewClips can be used. For slab-cap applications, use Railways. Railways can be glued or impact-nailed to the existing slab. In each case, secure the RadiantPEX to the floor every 18".

Step 6: Repeat With Next Circuit

Repeat steps 4 through 6, keeping the next circuit spaced according to the design. Most thin slabs use circuit spacing of 6", 9", or 12" OC. Don't

space the tubing wider than 12" OC as possible thermal striping may occur. Likewise, spacings tighter than 6" OC is not advised due to possible structural conflicts with the thin slab material. If tighter spacing is required, contact Watts Radiant for further advice.

Try to keep all circuits the same length. If the last circuit is too long, try not to cut it. Shorter circuits have a lower pressure drop and will tend to cause an imbalance in the fluid flow. Some tubing may be removed from this last circuit, or any previous circuit, as long as the remaining length is within 10% of the existing circuits. For example, if 200' lengths were installed, the last circuit can be cut to a length of 180' and still maintain a balanced system. If more than 10% is in excess, run the remaining tubing along an exposed wall or in other areas of the zone.

In the event excess tubing can not be utilized, balancing control will need to be installed on the manifolds.

Step 7: Visual Inspection and Pressure Test

After all the circuits are installed, take a few minutes to walk each circuit and visually inspect the tubing



for possible damage caused during installation. If damage is found, repair it using an approved Watts Radiant method. In the event of extensive damage, a Watts Radiant Repair Kit may be required. More information on the repair kits and repair methods can be found in the Appendix.

For detailed information on the proper steps to conducting a pressure test, refer to the Appendix of the installation manual.

Insulation Details

Foil-faced insulation is primarily used when an air gap can be maintained between the tubing and the insulating member. In the case of a thin-slab application, the tubing is completely encapsulated in the lightweight concrete, eliminating any need for an air gap. At this point, the main goal is to prevent heat migration downward. If the system is insulated in the joist cavity, a standard paper-faced insulation can be used. Make sure to install the insulation tight against the subfloor to minimize any convective losses that may be generated. The actual R-value of the insulation should be the same as what was illustrated for a Staple-Up application. The insulation should be a minimum of 3-1/2", or R-13, fiberglass batt when the radiant floor is installed over a heated space, such as a basement. 5-1/2", or R-19, batt (or thicker, depending on the climate) should be used when the area below the radiant floor is unheated or exposed to the elements.

For a thin-slab application over an existing concrete slab, 1" extruded polystyrene insulation board is recommended to isolate the new pour from the existing. If a 1" board is unavailable or if space does not allow for a 1" board, a thinner board can be used. It is not recommended to go below a 1/2" insulation board. The proper insulation board must be specified by an architect or other structural professional.



RadiantPEX tubing stapled down to the subfloor with paper-faced batt insulation located below in the joist cavity. Since no foil facing is used, the insulation has to be installed against the subfloor.



Board insulation is used to isolate the thin slab from the subfloor below. ScrewClips or FoamBoard staples are used to secure the PEX to the foam insulation board. Additional insulation may be added below, in the joist cavity, for an increased R-Value.



RadiantPEX tubing stapled down to the subfloor with paper-faced batt insulation located below in the joist cavity. Since no foil facing is used, the insulation has to be installed against the subfloor. A lightweight concrete filler is used between the sleepers for added sound quality and increased thermal mass.

Thin Slab with Sleepers

Sleepers are sometimes installed within a thin-slab application to allow for points of attachment for future floor coverings. The most common application is with a hardwood floor.

Caution: The thin-slab surface must contact the upper wood floor or subfloor. Thin slabs can shrink during curing, creating an air gap which will restrict heat transfer and the floor's overall output capacity.

Steel Deck Applications

Commercial applications require special design considerations and flexibility. This is especially true when designing and installing a radiant floor over a steel deck or precast concrete floor.

Steel Deck

Steel decks are usually seen in commercial buildings and other areas that will experience light to moderate loads. There are several different types of steel decks, ranging from 2" angle channels to 6" square channels. These channels will play a part in determining the RadiantPEX spacing.

When possible, install RadiantPEX perpendicular to the ribbing on the steel deck. If using Railways, fasten them parallel to the ribbing.

There is only one way a steel deck application can be insulated, that being under the steel deck. In this configuration, it is almost impossible to insulate under a steel deck system with batt insulation, since the support members tend to be farther apart than the typical 16" OC. A board insulation is typically used.

In most slabs, rewire or rebar will be used, giving the installer a way to secure the RadiantPEX. In some applications fiberglass mesh will be used instead of rewire/rebar. In this case Railways can be used.

Precast Slabs

Precast slabs are similar to a steel deck application with the exception of the main support layer. The precast slab is designed, in most cases, to be the floor support of the level above and the finished ceiling for the level below. Because of this, it is difficult to insulate a precast slab system. Insulation options need to be discussed with the project engineer or architect.

Likewise, rewire/rebar may or may not be used in the cap pour. Fastener types are chosen based on the approved construction requirements.



Various tube fasteners for steel deck slab applications.







Typical Slab over Precast application. Insulation location and fasteners are variables depending on the structural requirements of the total mass. Consult with the structural engineer before choosing an insulation or fastening method.

Caution: Maintain a minimum 2" concrete thickness above tubing unless otherwise specified by a structural profesional.

Snowmelt Applications

Introduction

Radiant snowmelt and ice-removal systems for concrete, sand, and brick pavers are installed in the same manner as shown for a standard concrete slab. The main differences tend to be the tubing size. Due to the increased pumping requirements for the higher loads, a larger diameter tubing is needed to keep an acceptably low pressure drop.

Although there are several similarities between a slab snowmelt project and a brick paver project, there are some important distinctions.

Brick Paver

RadiantPEX can be installed under brick pavers for the purpose of snow melting. However, it is important to observe several cautions. While Watts Radiant does not hold itself as expert in the art of brick paving, there are several precautions to observe. The thickness of the paving bricks must be selected according to the manufacturer's printed cautions and load limitations. Bricks not thick enough to support the design load will crack and/or shift in service.

There are three installation methods described below. Once a determination is made as to which method is preferred, RadiantWorks should be used to take into account the insulation value of the concrete (or alternate base material), sand, and bricks over the heating circuits. Base, sand, and brick materials retard the passage of heat, and must be compensated in the design of the snowmelting system..

There are three general types of installations for RadiantPEX installed under brick pavers:

1. Concrete.

The easiest and most predictable substrate is concrete, where RadiantPEX is typically embedded in the slab, and the bricks are adhered to the top of the slab. Consult with experts in the field to ensure that the correct adhesives are used to secure the bricks to the concrete, and the slab will meet the load requirements of the expected traffic.

2. In the First Course of Base Material.

The RadiantPEX may be imbedded in the first course of base material. A local engineer should determine the type of base material chosen, the thickness of the base, and the degree of compaction. The depth at which the RadiantPEX is buried should be determined in consultation with the local engineering firm. The first course of base material is typically compacted base rock, mixed with fines to present a relatively impervious surface.

3. In the Second Course of Base Material.

To improve system response, the RadiantPEX may be placed on top of the first course of base material. The RadiantPEX is then covered with approximately two or more inches of smaller base material. The depth at which the RadiantPEX is buried should be determined in consultation with the local engineering firm.



After the secondary base course is installed, a 1/2" to 1" layer of sand base is placed and leveled. Bricks are placed on this secondary base course and often vibrated, so sand fills all the joints between the bricks. Sometimes additional sand must be swept into the brick joints, again depending on the local engineer and contractor recommendations. The stability of the brick pavers is very dependent on these brick joints being properly filled with sand, and upon the perimeter of the brick surface being firmly held in place. If the perimeter of the bricks is not secured, the bricks will tend to drift apart.

If sand is not present in the joints when the bricks are installed over base material, unwanted movement of the bricks may be experienced, resulting in an uneven finished surface. Refilling the brick joints with sand is a task that may have to be repeated several times, or until all the joints are completely filled. Contact the local brick supplier and local contractor for professional advice in this matter.

General Site Preparation

Snowmelt slabs should be placed on well compacted material, consisting of rock or sand. Load issues need to be discussed with a structural engineer or the project supervisor.

The snowmelt area needs to be designed with drainage in mind. Water will run off of the snowmelt area in the same manner as rain. External areas, such as water drain ways, outside the snowmelt zone may be blocked by snow, ice or slush. Drain locations and runoff profiles need to be designed with winter conditions in mind. In some cases, extra RadiantPEX tubing may need to be installed around drain lines to prevent water from freezing.

A radiant slab should never be placed directly on top of solid bedrock, as this material can rapidly conduct heat from the slab into the earth. Crushed rock and/or insulation must be installed between the slab and rock. Sometimes 1" to 2" of sand is placed on top of the coarser base rock material. This gives a smooth, level surface to lay down rigid insulation (if necessary), and helps prevent possible breakup of the rigid insulation in high traffic areas prior to concrete placement. The sand layer also allows for more precise leveling to minimize any variation in the slab thickness.

Insulation Details

Unlike interior slab applications where the insulation is recommended, snowmelt systems often do not require insulation. This is due to:

1. Loading.

Snowmelt areas will experience higher weight loads than standard interior heating applications. Heavy vehicular traffic, such tractortrailers, may cause the insulation to compress. This compression increases the risk of cracking in a slab.



RadiantPEX installed in a slab-on-grade snowmelt application.

2. Heat Transfer.

Heat moves to cold. The coldest point of a snowmelt system is the surface. Heat will naturally move more towards the surface than to the ground below.

This is not to say insulation cannot or should not be used on a snowmelt system. Areas that need a faster response or are more hazardous will benefit from insulation. Stairs, handicap access ramps, and sidewalks are a few areas which may benefit from insulation.

If insulation is used, a non-foil-faced, high-density, extruded polystyrene (such as Dow® Blue Board®) is recommended.

The use of foil-faced insulation is not required nor recommended when insulating a snowmelt slab. Foil-faced insulation is used when an air gap is maintained between the tubing and the insulating member. In the case of a snowmelt slab or brick paver application the tubing is completely encapsulated in the bedding material, eliminating any air gap. In addition, concrete will tend to degrade exposed foil over time.

Caution: Watts Radiant does not recommend the use of bubble-type insulation under a slab application until more research has been done and performance has been verified. If needed or specified by a structural professional, use only extruded polystyrene, such as Dow® Blue Board® or equivalent. Density and thickness should be specified by a professional.

Control Joints

Concrete slabs will expand and contract due to thermal changes. To prevent damage to the slab, expansion joints are used to control this movement. In some cases cut joints are used to control and direct cracking. Make sure the tubing is protected according to the requirements of the control joint.



RadiantPEX sleeved at expansion joint with foam insulation or PVC conduit.



RadiantPEX routed below expansion joint into subgrade.

Design Parameters

For proper snowmelt design, it is important know the type and thickness of each layer used. As these layers increase or change, variances in the snowmelting load may result. Concrete is a very conductive material, allowing for a wider spread in heat transfer throughout the mass. Brick pavers do not have the same conduction rate and will require specific design considerations. It is important all layers of a snowmelt system are modeled correctly with the use of Watts Radiant's RadiantWorks design software.

RadiantPEX Spacing

Most snowmelt systems will use 9"–12" tube spacing with some areas, such as steps or in front of door openings, installed 6" OC.

Tools and Materials Required

It is a good idea to have all materials present and in good working order before beginning an installation. The following is a list of the most common items needed for a typical snowmelt installation.

1. RadiantWorks Reports.

These reports help ensure the proper amount of tubing is installed in each area, along with the correct manifold size.

2. RadiantPEX tubing and corresponding number of RadiantPEX fittings.

There are two types of connections that can be used with RadiantPEX: CrimpRing (installed with the CrimpAll Tool), and Compression (installed with a standard crescent wrench). Each fitting type is designed for ease of installation, durability and longevity. Fittings are typically chosen based on installer preference, unless otherwise specified.

3. Manifolds.

Only use Watts Radiant manifolds or manifold components for fieldconstructed manifolds.

4. Unwinder.

A required component for easily unrolling each precut RadiantPEX coil without kinks and twist.

5. Field Repair Kit.

Each kit will contain two barb-bybarb splices and four corresponding RadiantPEX fittings.

6. Manifold Mounting Bracket.

Each bracket can be used to temporarily or permanently mount each manifold pair to the floor or wall. Use either Watts Radiant brackets or SnapClips to hold manifolds.

7. Watts Radiant Fasteners.

8. Pressure Test Kit.

Each manifold pair must be pressure tested. This helps ensure each RadiantPEX connection has been performed correctly and to make sure no damage has been done to the tubing during installation.





Typical Snowmelt Slab on Grade with Railways.



Typical Snowmelt Brick Paver with Cable Ties.

9. Installation Accessories

- a. Electrical Tape for temporarily mounting the manifolds or taping ends of tubing together.
- b. Cable Ties, ClipTies, Screw Clips or other approved fasteners.

Since rewire/rebar is commonly used in concrete slabs for structural integrity, it is common practice to attach RadiantPEX to the rewire/rebar. This is commonly done with the use of nylon cable ties or Watts Radiant ClipTies and Clipper tool. Each will secure the RadiantPEX to the rewire/rebar in such a way to prevent movement of the tubing during the concrete pour.

In applications where rewire/rebar is not used or an insulation board is



placed underneath the slab, some additional attachment devices can be used to secure the RadiantPEX. Railways can be attached to subgrade with the use of ground stakes or talons. Watts Radiant's Foam Staples or Foam Clips can be used to secure the RadiantPEX tubing directly to the insulation board.

For any attachment method, it is important to secure the tubing every 12" to 18" OC. This will prevent the RadiantPEX from shifting during the concrete pour. (See Watts Radiant's Product Catalog or Web site for more information on fasteners and tools.)

Application Profiles and General Details

In slab-on-grade snowmelt applications, it is important to maintain at least 2"-3" of concrete covering above the tubing. More coverage may be necessary depending on the structural requirements of the slab. The 2"-3" coverage is to ensure structural stability within the slab, allow for cut joints, and to allow enough space to float the aggregate. Complete encapsulation of the tubing is important to prevent stress points from forming on the slab, which may accelerate cracking over time. In brick paver applications it is important to maintain a minimum 1"-2" layer of sand or stone dust between the top of the tubing and the bottom of the paver, depending on the recommendation of the engineering firm responsible for the installation.

Installation Steps

Manifold locations, final concrete or sand thickness and zoning details are just a few items that can affect how a snowmelt application is installed. The following guidelines and examples cover the most common installation conditions. If a given situation is not covered here or if unexpected circumstances arise, please contact Watts Radiant or a Watts Radiant Representative.

The most common installation pattern for snowmelt applications is a single

serpentine layout, although in some cases a double serpentine may be used.

Step 1: Pre-Pour Conditions

Verify all subgrade conditions are properly prepared, all insulation (if necessary) is installed according to design conditions and rewire or rebar is in place. With orange spray paint, locate any obstacles that may need to be avoided. These may include trench drains or other structural supports that penetrate the slab, such as hand rails.

Step 2: Install Manifolds

Locate where the manifolds are to be installed. In most snowmelt systems, the manifolds will be located in an environmentally resistant box, such as an irrigation system box, and placed in the ground. Some applications may allow the manifolds to be mounted in a structural wall, such as in the exterior wall of a garage. With either method, it is important to support the manifolds in such a way so they are not damaged during the concrete or paver installation.

Drive two pieces of rebar vertically into the ground at the manifold location. With the use of cable ties or electrical tape, temporarily secure the manifolds to the rebar. This will help protect from jobsite activity. Manifolds placed on the ground can be subject to unwanted damage.



After the concrete is poured, the rebar may be cut to free the manifolds. The manifolds can then be moved if necessary, to fit the final enclosure area. Make sure to leave plenty of slack in all RadiantPEX circuits (2'–5' is recommended). A Watts Radiant manifold box can be used to secure the manifolds within a structural wall. Watts Radiant SnapClips, StrapDowns, and ClipRails can be used to organize RadiantPEX coming from the floor and into the protective enclosure.

Step 3: Determine Zone Boundaries

Before RadiantPEX is installed, visually inspect the area to determine the zone boundaries. This helps determine where the first circuit is to be placed, while identifying any obstacles that may be in the way.

Step 4: Confirm Tubing Requirements

Measure the distance from the manifolds to the farthest point in the zone by right angles. Make the minimum circuit length is at least twice this distance. If not, the RadiantPEX will not be long enough to reach the farthest point and still have enough length to return to the manifold.

Step 5: Install the RadiantPEX

Place the unwinder beside the manifold with a coil of RadiantPEX placed over the center post. Place the support bracing down over the RadiantPEX and cut the binding tape on the coil. Pull one end of the RadiantPEX off the unwinder and feed it through the guide eye on the unwinder. This will help prevent any kinking from taking place.

Pull the free end of RadiantPEX from the unwinder and lay it along the perimeter to the farthest point in the zone, keeping the RadiantPEX 6"-8" from the edge of the slab.





It is helpful to have a second person secure the PEX to the rewire/rebar as the coil is being pulled. Stop when the desired tubing length has been reached. Secure the RadiantPEX back to the manifold and make the corresponding connection onto the second manifold.

Transition sleeves should be used to protect the PEX as it transitions out of the slab.

In most applications, a single serpentine layout will be used. In a few cases, a double serpentine layout may be used. The performance of the system is nearly identical with either layout option; however, installation issues and construction details may make one method easier to install.

Step 6: Secure the RadiantPEX

Slab applications usually require some form of fastener, depending on the construction details. Most slab applications use rewire or rebar to add strength or crack resistance to the slab. In this application, the RadiantPEX attaches directly to the rewire/rebar by the use of cable ties or ClipTie clips every 12"–18".

Make sure all bends and corners are securely fastened to prevent the PEX from curling, creating an unwanted high point in the circuit. Leave 2'–5' slack on each circuit in case the manifold position needs to be adjusted from its temporary location.

If cable ties are used, make sure all "tails" of the cable ties are either cut off or turned downward to prevent any unwanted surface protrusions.

Caution: Metal wire ties may increase the risk of damage to the PEX and are not an approved Watts Radiant fastener type.

Step 7: Repeat With Next Circuit

Repeat steps 4 through 6, keeping the next circuit spaced according to the design.

Try to keep all circuits the same length. If the last circuit is too long, try not to cut it. Shorter circuits have a lower pressure drop and will tend to cause an imbalance in the fluid flow. Some tubing may be removed from this last circuit, or any previous circuit, as long as the remaining length is within 10% of the existing circuits. For example, if 200' lengths were installed, the last circuit can be cut to a length of 180' and still maintain a balanced system. If more than 10% is in excess, run the remaining tubing along an exposed wall or in other areas of the zone.

In the event excess tubing can not be utilized, balancing control will need to be installed on the manifolds.

Step 8: Visual Inspection and Pressure Test

After all the circuits are installed, take a few minutes to walk each circuit and visually inspect the tubing for possible damage caused during installation. If damage is found, repair it using an approved Watts Radiant method. In the event of extensive damage, a Watts Radiant Repair Kit may be required. More information on the repair kits and repair methods can be found in the Appendix.

For detailed information on the proper steps to conducting a pressure test, refer to the Appendix of the installation manual.

Step 9: The Concrete Pour

To help detect possible damage caused during the concrete pour, keep the system under pressure. If damage is done, locate the area in question and remove the section of tubing from the concrete. Clean off the damaged area and install a Watts Radiant splice fitting. Wrap the fitting with electrical tape and/or pipe insulation to protect it from the concrete. Bring the circuit back up to pressure to ensure a proper fit on the splice.

Some minor pressure changes will occur due to the increased internal temperatures of the concrete as it begins the curing process. Fluctuations in air temperature may also cause a slight change in the test pressure. In most cases, a 10–15-lb. drop in pressure over a twenty four hour period is not uncommon. For more information on pressure testing, see the Appendix.



Miscellaneous

Although a snowmelt installation is very similar to a standard slab installation, there are a few additional areas that need to be discussed. These being steps and glycol.

Steps

Steps are generally viewed as difficult areas for a radiant installation. There are two important areas to keep in mind when installing steps in a snowmelt application: tread area, and riser area. Tread area is where ice and snow will have the greatest build up. The edge of the tread is where the least amount of melting will take place since it will be the farthest from the tubing. It is also the area that can cause the most hazards. When selecting an installation technique, keep these factors in mind.

The finished covering may also influence which installation method is used; for example a standard slab versus a stone cap over the slab. In addition, the riser height will be a factor in determining how much tubing can be installed.



Preferred Method: RadiantPEX installed running parallel with the steps. An additional run of RadiantPEX may be installed in the riser of the step to help increase melting along the outer edge.



RadiantPEX installed running perpendicular with the steps. This method of installing RadiantPEX under steps should be done with a certain level of caution because the point where the riser and tread meet may not receive proper melting due to its distance from the RadiantPEX. Although this method is not preferred over the parallel method shown above, it may be necessary due to construction or design constraints.

RadiantPEX can be installed either parallel or perpendicular to the step treads. Each method offers advantages and disadvantages.

RadiantPEX installed perpendicular to the treads will tend to limit the amount of heat delivered to the riser. This application may be used if the riser height is shallow or if the snow load is minimal.

Parallel installations may be somewhat more complicated to install, but they offer the most melting potential. This approach will more easily melt snow and ice that may build up along the outer step edge. However, it may require additional rebar to support the tubing around bends as it moves from step to step. As with all applications, it is important not to exceed the minimum tube bend radius (8 times the OD of the pipe) for the PEX when transitioning from step to step.

In both applications it is important to keep the RadiantPEX 2"–3" away from the surface of the concrete.

In some cases it may be ideal to install a designated manifold for the steps. This allows for a dedicated vent/purge assembly to be used for purging the tubing located in the steps.

Glycol

Any hydronic system that is exposed to near or below freezing conditions must have propylene or ethylene glycol installed as the working fluid. Glycol can prevent the system fluid from freezing. The level of frost protection will depend on the glycol concentration used.

Glycol Basics

Glycol is naturally corrosive. Buffers and inhibitors are added to offset this corrosive effect. In addition, glycol acts like an "oxygen grabber," absorbing any free oxygen molecules in the system. The more oxygen the glycol "grabs," the more acidic it will become.

Systems should not be operated at levels below 30% glycol. Glycol levels below 25% do not contain enough corrosion inhibitors and may cause the glycol to act as food, allowing microbes to grow. The microbes feed, grow, and die, allowing a black sludge material to form in the system. In concentrations above 25%, propylene glycol prevents microbe growth. Try not to exceed a mixture level greater than 70% as the fluid may become too viscous (thick) to circulate.

As glycol in the system ages, the inhibitors and buffers added to the system begin to break down. This process slowly returns the system to the natural pH level of the glycol. If not properly maintained, glycol in the system can cause corrosion. Check a glycol system at least once a year to ensure the glycol is still within its operating parameters.

Caution: Do not install automotive antifreeze in hydronic heating or snowmelting applications. Also, do not install non-inhibited propylene glycol. Either of these will harm the mechanical components of the system.

Glycol Maintenance

A glycol system should be checked for two things: system pH and freeze protection. The quickest way to check a glycol system's pH is with litmus paper. If the pH drops below 7, then more buffers must be added to a system or the system needs to be flushed and refilled. There are only a limited number of times buffers can be added to a system before it must be flushed and replaced. Check with the glycol manufacturer for further details. Some glycol manufacturers will require a higher minimum pH to be maintained.

Freeze Protection

The second item that must be checked in a glycol system is the actual level of freeze protection provided. Watts Radiant recommends a 50% glycol solution. However, this does not always equate to a 50% glycol solution and 50% water. Different glycol providers supply different concentrations of glycol and/or may mix a certain amount of distilled water with the inhibitors. For example, a glycol that is already pre-mixed to a 50% level and then is diluted by the installer with 50/50 water have a true 25% glycol concentration.

The only way to accurately measure glycol in a system is to use a refractometer. A refractometer uses a simple property of a liquid to determine its freeze point. Liquid will refract, or bend light at a known angle. This angle is a direct correlation to its freeze point. A refractometer is a device that measures this deflection. A basic refractometer is a device that looks like a kaleidoscope. The user places a drop of fluid on a lens on one end and then looks through the other end. What is seen is a chart that shows the freeze point.

This should be checked before and after the glycol is installed. Check a sample mixture, one cup glycol and one cup water. Test this solution with the refractometer to see what the system freeze protection will be. Do this each time the system is refilled with new glycol. Also, check the freeze protection when the system pH is checked just to make sure the system is operating within the desired parameters.

Caution: The refractometer used must be calibrated for propylene glycol. A refractometer calibrated for automotive (ethylene) glycol will not yield accurate results.



Typical Refractometer image as seen through the view finder. The terminus line between the shaded area and the light area represents the freeze level of the fluid in question. In this case, the fluid being tested is freeze protected to $-15^{\circ}F$.

Manifolds

Copper and Brass Manifolds

Manifolds are used to transition from supply/return piping to RadiantPEX. Manifolds are usually copper or brass bodies, with brass branches attached to the sides.

Factory-Supplied Manifolds

A variety of pre-manufactured manifold options are available from Watts Radiant, each specifically designed to meet or exceed any job specification.

Among the various options are: <u>Stainless Steel</u> (extruded stainless steel)

> Stainless steel manifolds are constructed of tubular stainless steel and range from 2 to 12 circuits. Each pair comes with flow meters, circuit balancing valves and mounted brackets.

Standard Tubular (copper and brass) Standard manifolds are custom fabricated to each project's specifications with any number of circuits in diameters from 1" to 6".

<u>CazzBrass</u> (cast brass) CazzBrass manifolds are constructed of cast brass and come in either 3 or 4 circuits and couple directly to each other to form larger manifold sets. CazzBrass manifolds come with the following options: blank, flow meters or balancing valves.

<u>CustomCut</u> (copper tube) CustomCut manifolds are premade manifolds that come with 12 or 16 barbs. CustomCut manifolds are then cut in the field to the specific circuit number needed for each zone.

<u>Swedged</u> (copper tube)
<u>Swedged</u> manifolds are pre-made manifolds with 3, 4, or 5 circuits.
One end of a Swedged manifold is flared so it can directly couple to another Swedged manifold.
For example, a 3- and a 4-branch



Typical Copper or Tubular Brass Manifold Pair.

Swedged manifold can be field coupled to form a single 7-branch manifold assembly.

For more information on the various manifold options see the Watts Radiant Product Catalog, or visit our Web site at www.wattsradiant.com.

Field-Constructed Manifolds

Some installers prefer to build their own manifolds on the jobsite. Copper manifolds can be made of any size copper water pipe tubing. Manifolds from Watts Radiant are made of type L copper for standard use, and if requested, type K copper for underground external applications.

Caution: Use only Watts Radiant Parts.

Do not use fittings that are not supplied by Watts Radiant. Connections made with barbs or fittings supplied by other companies are specifically excluded from any Watts Radiant warranty coverage. Watts Radiant has found many fasteners supplied by other companies can cause long-term damage to the cover of the tubing, possibly leading to leaking and/or premature RadiantPEX failure.

Refer to Watts Radiant's warranty for more information.

There are three main ways to field-construct a manifold.

1. CustomCut Manifolds:

Manifold "sticks" from the factory are designed to be used with any RadiantPEX barb. Installers can purchase prefabricated CustomCuts or base branch manifolds and field-solder various combinations of barbs and mini ball valves as the job demands.



2. Swedged Manifolds: Pre-assembled manifold sections that sweat together as needed.



3. 1" x 1" x 1/2" reduced T-fittings can be soldered together forming a complete manifold. RadiantPEX barbs are then soldered into the 1/2" fittings.



For each of the assembly options, the smallest trunk size used must be at least 1".

Other methods exist to construct manifolds, such as T-Drill machines or even a standard drill press.

Manifold Trunk Sizing

Manifold Trunk Size
1" 1-1/4"
1-1/2"

Maximum flow rate for a manifold is determined by the velocity of the fluid. Maximum design velocity for manifolds should be between 4–6 ft/sec.



Direct Piping Option. This option will require some balancing once the manifolds have been installed.



Reverse Return Option A.

This option shows the supply and return piping installed in the same direction.



This option shows the supply and return piping installed in the opposite directions.

Manifold Set-Up

There are two ways fluid can flow through a manifold pair: Direct, and Reverse Return. Both are dictated by how the RadiantPEX is attached to the manifolds.

Direct is the easiest to install, and in most cases, the easiest to follow. The down side to this method is balancing. A Direct set up will tend to require more post-fill balancing. This is due to the simple fact that the last circuit on the manifold will see a potentially higher pressure drop than the first circuit. This higher pressure drop will equate to less flow and less heat delivery from that circuit. To fix this problem, it is important to have mini ball valves installed on one or both manifolds.

Reverse Return is the preferred approach. It eliminates almost all need for post-fill balancing. For this set up, the first circuit on the supply manifold will be the last circuit off the return manifold. Each circuit "sees" the same



manifold length, creating an even pressure drop across each circuit.

Both set ups depend on the simple fact that each circuit is the same length, give or take 10%.

If a "Long Manifold" is installed, it is imperative to set the manifold up in a Reverse Return fashion. This is essential when the manifold spans the length of the zone.

Supply and return manifolds are installed along the length of the zone,

perpendicular to the floor joists. To make RadiantPEX connections simpler, we recommend running a third copper line so the supply manifold is being supplied hot water at one end of the manifold array. The return manifold should then be discharging cooler water at the opposite end of the manifold array, as illustrated.

If each joist space is relatively long, it may prove beneficial to run only one circuit for each joist space. A more common installation is to use one circuit to supply the heat to several joist



Long manifolds are installed perpendicular to the floor joists. To ensure balanced flow through each circuit, a reverse return method is recommended. A reverse return manifold requires a third copper line to be installed. This extra line allows each circuit to "see" the same total manifold length, thus creating a balanced system. Remember, "first in, last out."



bays — drilling holes through the joists as necessary. However, never use both approaches in the same zone unless circuit balancing valves are installed to balance the flow.

In the long manifold approach, manifolds may be installed in the joist spaces by drilling a sequence of three holes in each joist. An alternative method is to attach the manifolds to the bottom of the joists. In either case, always install the manifolds so that all RadiantPEX connections are easily accessible for future balancing, air purging, or maintenance.

RadiantPEX Circuit Balancing Valves

Individual circuits can be isolated or balanced with the use of circuit valves.

Circuit balancing valves are used to isolate and/or balance the flow of fluid through an individual circuit. They may be installed on any or all of the circuits on a manifold. If used for balancing purposes only, they are usually installed on the return manifold. If used for isolation purposes, the circuit valves need to be on both the supply and return manifold.



RadiantPEX Fittings

RadiantPEX requires special mechanical fittings, designed for higher temperature and burst pressure ratings. Watts Radiant provides two fitting options:

1. CrimpRing: CrimpRing fittings are composed of a ribbed barb that fits into the PEX tubing and a ductile copper ring that is placed over the barb and PEX. The CrimpRing is compressed over the PEX, against the barb, with the use of a special crimp tool.



2. T-20 Compression: Compression fittings are composed of three main components: the barb, the compression ring, and the compression collar. The barb fits into the PEX while the compression collar is used to draw the compression ring down around the PEX and barb assembly. Three O-rings located on the barb ensure proper fit against the PEX and manifold.



The Crimp fitting is a permanent connection. The Compression fitting is a removable fitting that should not be over tightened. Maximum torque allowance for the Compression fitting is 20 in-lbs.

Cautions

- a. Do not solder near, or overheat, any RadiantPEX connections. Extreme temperatures associated with soldering may seriously damage the RadiantPEX and will void warranty.
- b. All RadiantPEX and brass fitting surfaces must be clean and dry before making the connection.
- c. Whenever possible, avoid making connections or splices in inaccessible locations.
- d. Repairing RadiantPEX that has been in service requires special attention, particularly when glycol has been used. Any residual amounts of glycol or any other coating inside the RadiantPEX tube must be removed. Use water and a swab or pad to remove the residue(s), then allow the tube to dry prior to connection.

Field Repairs Heat Gun

Most jobsite damage will consist of over bending, or kinking, the RadiantPEX tubing. To repair a kinked circuit, use a heat gun set on low temperature. Hold the heat gun approximately 6"–8" from the damaged area. Continuously move the heat gun and/or roll the PEX under the heated air to prevent a hot spot from forming. The PEX should turn a milky white color as it heats up. During this process the PEX will begin to return to its original shape. Allow the PEX to cool for 15 minutes before returning it to service.

If the heat gun is held too close, or held on one spot for too long, the PEX can be damaged. Damage usually occurs as a hole in the PEX pipe and the damaged area will need to be repaired using a splice.

Splice

Jobsite damage does occur from time to time. To prevent the need to replace a complete circuit of RadiantPEX, Watts Radiant provides a repair kit. Each kit contains two barb-by-barb splices and four corresponding RadiantPEX CrimpRings or Compression fasteners.

WARNING:

Use Field Repair Kits only for the repair of RadiantPEX damaged in the field. Read complete instructions before beginning repairs. Do not splice together multiple lengths of RadiantPEX to make a single length longer than design. Refer to previous chapters in this manual for recommended circuit lengths.

Caution:

Use of materials not supplied by Watts Radiant to make a splice or manifold connection may eventually result in leaks. Watts Radiant's RadiantPEX and fittings are engineered to work together. Watts Radiant extends no warranty — expressed or implied — to



CrimpRing Splice



T-20 Compression Splice

any failure or damage of any kind resulting from use of materials not supplied by Watts Radiant (see RadiantPEX warranty for specifics).

1. Cut the RadiantPEX.

Make a straight cut-off on both pieces of RadiantPEX to be spliced together.

2. Select the Correct Brass Splice.

Use only Watts Radiant brass splices and corresponding fittings to repair RadiantPEX.

3. Choose the Correct Fitting.

Make sure to use correctly sized CrimpRing or Compression Fitting for making RadiantPEX connections.

4. Make the Connection.

CrimpRing

Slide a CrimpRing onto each end of the PEX, about 2" down. Slide the crimp barb into each end of the PEX and slide the CrimpRing back over both the PEX and the barb. Make sure the CrimpRing is positioned in the middle of the barb with about 1/8" PEX showing. Center the CrimpAll crimping tool over the CrimpRing and squeeze. The tool will bottom out when the fitting is complete. Do not crimp the ring at an angle as damage to the PEX may occur.

Use a Go/No-Go gauge to determine if the fitting is acceptable. If not, remove the crimp with the use of a heat gun, cut off 3"-4" of PEX and reapply.



CrimpRing Fitting

T-20 Compression

Slide the compression collar over the PEX with the threads facing the end of the tubing. Next, slide the compression ring over the pipe, followed by the insertion of the barb. It is important to make sure the end of the PEX is cut square in order for a proper seal to be created between the PEX and the O-ring insert at the base of the barb.

Note: The compression ring is unidirectional and should be placed on the PEX with the directional line positioned towards the end of the PEX.

Seat the barb against the male thread adapter (this should already be sweat onto the manifold) and pull the compression collar down and thread the collar onto the male adapter. The compression ring will automatically slide onto the PEX and will compress as the collar is tightened.

Tighten the collar with a crescent wrench or torque wrench to 20 in-lbs. of torque, or until tight and then 1/4 turn further.

Do not overtighten the fitting as damage to the PEX or compression ring may occur.



When making a buried slab repair, protect the final splice assembly with a double wrap of PVC electrician's tape or plastic shrink wrap.

Note: Do not use duct tape on RadiantPEX.

Do not use compression fittings as repair joints inside a slab pour.

Pressure Test

After the RadiantPEX and manifolds have been installed, it is time to pressure test each zone. Individual test kits may be field constructed or a factory supplied kit may be used. The following directions are specially directed to the use of Watts Radiant test kits, although the general principles remain the same for field-built units.

Attach the pressure test kit to the manifolds. Watts Radiant manifolds and test kits with optional unions, can easily be hand tightened to hold up to 100 psi. Make certain the rubber O-ring is properly seated before threading the unions together.

One half of the Watts Radiant test kit has a Schraeder valve (air valve) on side A. The other half, side B, has a pressure gauge. Fill the system (air or water, but not both) through side A. When filling with water, leave the drain on side B open (side with the pressure gauge) until water comes out. Close the valve and fill until the zone is pressurized to between 50 psi and 100 psi. Do not test over 100 psi, as this will ruin the gauge on the test kit.

If the temperature is below freezing, use air to pressure test. If a fluid must be used, use a 50/50 water/glycol solution. Failure to use glycol may result in frozen circuits.



Nomograph for Breakfast/Kitchen Area: Slab Application, 3/8" RadiantPEX. © Watts Radiant.



The cool night air will usually cause less than a 10-psi drop in pressure as the water or air contracts from the cold. If there is more of a pressure drop, or if there are other reasons to believe there is a leak, spray a soapy solution on all connections and inspect for leaks. If there are still concerns about leaks, increase the test pressure

Typical Nomograph

to 100 psi and inspect each of the

circuits. A leak should be visible.

Nomographs are generated by RadiantWorks as design aids for contractors and engineers for optimizing radiant floor heating designs. Each nomograph is customized for a specific room or zone within a project. The following is a brief explanation of how to interpret a nomograph. Note: The accompanying slab nomograph is customized and should not be generalized to frame floors, other floor coverings, other RadiantPEX sizes or differing indoor air temperatures.

On the upper left hand corner of the nomograph you will see the system design parameters. In this case, the nomograph is for a slab with 1/4" tile where the desired indoor temperature is 70°F, the outdoor temperature is 0°, the project is at an altitude of 2000' and 3/8" RadiantPEX is being installed.

The left vertical axis displays the radiant floor heat output intensity, as expressed in BTU/hr/sq.ft. of radiant floor surface.

The right vertical axis displays the average floor surface temperature. The actual floor surface temperature will vary $\pm 1^{\circ}$ F relative to the measurement location; that being taken over a circuit or between two circuits. In general a system will need to be designed so the average floor surface temperature is 85°F or below. Higher surface temperatures can be used if allowed by ASHRAE guidelines and the floor covering manufacturer.

The top axis on the nomograph reflects the total heat loss through the edges and underneath the radiant floor. As the radiant floor heat loss increases, the mean water temperature in the floor also increases. This heat loss is expressed as BTU/hr/sq.ft. of radiant floor. It is calculated for each project by RadiantWorks based upon the actual design parameters which include floor insulation, floor covering and overall system design.

The bottom horizontal axis shows the average, or mean, water temperature flowing through the radiant circuits. This is not the entering water temperature. For example, if the entering water temperature is 108°F and the exiting temperature is 88°F then the mean temperature is 98°F, the average of the two.

The diagonal lines illustrate the design possibilities if the spacing of the RadiantPEX tubing is adjusted.

Each diagonal line shows the heat output of a different RadiantPEX spacing, under the same design parameters. Changes in the RadiantPEX spacing, supply water temperature, or the R-value of the floor covering will make a difference in the heat output of the radiant slab.

This nomograph shows five possible RadiantPEX spacings, ranging from 6" to 18" OC. Spacings greater than 12" are usually limited to certain commercial and industrial applications where floor temperature variations between circuits is not a design consideration.

Read the Nomograph from left to right. A possible solution exists wherever the horizontal line associated with the heating intensity intersects the diagonal line associated with a particular RadiantPEX spacing, as long as the required floor temperature is below the maximum floor temperature. If this is not the case, and the required floor temperature is higher than the maximum 85°F floor surface temperature, auxiliary heat will be required.

Next, find the required mean water temperature necessary to heat the given conditions. Mark the point on the nomograph where the horizontal heat intensity line intercepts with a hose spacing. From that point, move directly down to the bottom axis. This is the required mean temperature.

For our example, the kitchen slab needs to radiate 17 BTU/hr/sq.ft. and we chose a RadiantPEX spacing of 12" OC. The mean water temperature where these two lines intersect is about 92°F, or 102°F supply temperature (based on a 20° temperature drop). If a 6"-OC tube spacing is used, a mean water temperature of 87°F is required, or 97°F supply temperature.

This tool should be used with care, as the RadiantPEX spacing necessary to meet the load still may not satisfy the customer. For example, an 18"-OC radiant circuit spacing in a home or office would likely generate customer complaints about uneven floor surface temperatures. Also, care must also be taken not to exceed the warranty temperature limits of Watts Radiant products and the installed flooring products. Generally speaking, mean water temperatures of 140°F and below should be used for slab heating and mean water temperatures of 150°F and below should be used for frame heating applications.

Pressure Drop Charts

Watts Radiant's pressure drop charts are available for all sizes of RadiantPEX, for plain water, ethylene and propylene glycol. Information regarding the heat required by the circuit (Q_s), pressure drop in the hose (fthd/ft), flow rate (GPM), and water velocity (ft/sec) can all be calculated from these charts. The charts are cataloged by average water temperatures required to heat a radiant zone, ranging from 100°–180°F. The following pressure drop charts are for an average water temperature of 120°F.

Example

The following example will demonstrate the use of these charts.

Assume the total heat required for a radiant zone is 16,000 BTU/hr. Four, 200' circuits of 3/8" RadiantPEX are used with an average water temperature of 120°F.

The pressure drop for a circuit in the zone is calculated by following these steps.

- 1. Determine the heat required for each circuit in the zone. (16,000/4 = 4,000 BTU/hr/circuit)
- 2. Find this number on the Q_s axis (left side of the chart).
- 3. Draw a horizontal line until it intersects the diagonal line for 3/8" RadiantPEX.
- 4. Drop a line vertically to read the pressure drop per foot of tubing (0.02 ft-hd/ft)
- 5. Find the total length of the tubing in the circuit including the distance to and from the manifold. In this example the manifold is located in the zone (total length 200')
- 6. Find the total pressure drop by multiplying the circuit length (in this case, 200') by the pressure drop per foot of heat (in this case 0.02 fthd/ft)

Note: Follow steps 1–6 for other circuits if the heat output and/or lengths are different. The pump head is chosen according to the circuit having the maximum pressure drop. The pump GPM is the summation of the GPM for all the circuits served by the pump.

There are many other uses for pressure drop charts as well. Water velocity is shown on the chart by the short diagonal lines that intersect the longer diagonal lines for each specific size of tubing. If the flow rate or the heat required is known, the water velocity can be found by tracing horizontally from either axis. In the above example, the water velocity is approximately 1.25 ft/sec. It is a good general practice to maintain water velocities above 1 ft./sec and below 5 ft/sec. For instance, 3/8" RadiantPEX in 200' lengths should be designed to transfer at least 3,000 BTU/hr, and
5/8" RadiantPEX in 200' lengths should ordinarily be designed to transfer at least 9,000 BTU/hr.

Flow rate per circuit at 20° F Δ T can be found by continuing horizontally from the heat required (Q_s) per circuit (on the left side of the chart) and reading the flow rate on the right side of the chart.

In the above example, the flow rate for each circuit is approximately 0.40

GPM at a Δ T of 20°F. The total flow rate to deliver 16,000 BTU/hr is 4 (circuits) x 0.40 = 1.60 GPM.

Note that if the flow rates are to be manually calculated, the required supply temperature can make a significant difference in the resulting calculations. All three of the following charts are for fluids at a temperature of 120°F. Systems with antifreeze solutions will experience a greater change in fluid properties as temperature conditions change. Do not use the following charts if the required fluid temperature is expected to change by more than 20°F.

Because of the lower heat carrying capability of glycol, a good rule of thumb is to add an extra 10% to the flow rate.

WARNING: NEVER USE AUTO-MOTIVE ANTIFREEZE IN ANY HYDRONIC SYSTEM.

Watts Radiant[™] Pressure Drop Chart for RadiantPEX[™]



Notes: 1. The heat required is the energy the boiler must deliver for the calculated heat output of a circuit. If only the net heat output of the circuit is known, multiply by 1.1 to get Q assuming the back and edges are insulated or space below is bacted.

- the circuit is known, multiply by 1.1 to get Q_s , assuming the back and edges are insulated or space below is heated. 2. If the ΔT is different from 20°F, the value of \tilde{Q}_s must be multiplied by 20/ ΔT .
- 3. Numbers from 1–7 in graph show the average water velocity in the hose (ft/sec).
- 4. This chart is for pure water only. It cannot be used for other liquid mixes.

This chair is for pure water only. It cannot be used for other liquid m

Typical pressure drop chart for water systems.



Notes: 1. The heat required is the energy the boiler must deliver for the calculated heat output of a circuit. If only the net heat output of the circuit is known, multiply by 1.1 to get Q_s, assuming the back and edges are insulated or space below is heated.

- 2. If the ΔT is different from 20°F, the value of \breve{Q}_{S} must be multiplied by 20/ ΔT .
- 3. Numbers from 1-7 in graph show the average water velocity in the hose (ft/sec).
- 4. This chart is for 50% propylene glycol/50% water mixture only.
- 5. Remember to correct the flow rate for the different heat carrying capacity of propylene glycol, as opposed to plain water.

Typical pressure drop chart for propylene glycol systems.



Notes: 1. The heat required is the energy the boiler must deliver for the calculated heat output of a circuit. If only the net heat output of the circuit is known, multiply by 1.1 to get Q_s, assuming the back and edges are insulated or space below is heated.

- 2. If the ΔT is different from 20°F, the value of \ddot{Q}_{S} must be multiplied by 20/ ΔT . 3. Numbers from 1–7 in graph show the average water velocity in the hose (ft/sec).
- 4. This chart is for 50% ethylene glycol/50% water mixture only.
- 5. Remember to correct the flow rate for the different heat carrying capacity of ethylene glycol, as opposed to plain water.

Typical pressure drop chart for ethylene glycol systems.

RadiantPEX No-Sweat[™] Baseboard, Fan Coil, and Manifold Connections

Watts Radiant's RadiantPEX tubing offers a unique solution to a common problem associated with baseboard and fan coil systems. Running supply and return lines to these units can be a challenge, especially in renovation projects.

Different techniques are used to connect RadiantPEX to baseboard, fan coils, or manifolds. It is important to prevent RadiantPEX from exceeding its minimum allowable bend radius. If this radius can not be maintained, a copper elbow should be hard piped to the unit prior to the installation of the RadiantPEX barb fitting.

Connection Details

- 1. Choose the correct RadiantPEX size for the design flow rate (see below).
- 2. Choose the corresponding fitting (CrimpRing or T-20 Compression).
- 3. Solder the RadiantPEX barb, or RadiantPEX elbow, onto the baseboard, fan coil unit, or manifold. If an elbow is required, install this prior to installing the barb.
- 4. Slide the corresponding fitting over the RadiantPEX and then the RadiantPEX over the entire barb. Refer to the corresponding section of this manual for instructions on how to properly connect RadiantPEX fittings.

Follow additional installation instructions included with the RadiantPEX fittings.



Near Boiler Piping and Controls

The following schematics are provided as a guide for common applications. Other schematics are available from the local Watts Radiant representative.

Primary/Secondary

Generally, the best way to pipe a hydronic system is referred to as Primary/Secondary.

Primary/Secondary piping allows for better flow and temperature control over the various components. Each layout is broken down into two basic sections: The Primary loop, or boiler loop and the Secondary loop, or zone loop.

The Primary loop provides boiler protection. Boilers must be operated above their condensing point, unless they are condensing boilers. If a boiler operates in that condition, corrosion will begin to affect the boiler and will eventually lead to premature failure of the boiler.

In addition to condensation, boilers must operate at a maximum temperature rise, typically 20°–40°F. The primary pump is sized to ensure both of these conditions are maintained independent of the load or piping requirements of the individual zones.

The Point of No Pressure Change

The point of no pressure change is a condition that has been discussed in piping manuals for decades. The theory stems from how boiler pumps respond to pressure differentials. Circulators, in order to function properly, need to pump into the zone (load). This condition will always create a positive-to-positive rise across the impeller. The placement of the expansion tank will greatly affect how the primary pump achieves this goal.

The expansion tank controls where the pressure change in the system occurs. Expansion tanks always see the same pressure at their point of connection to the system. Points on either side of the tank will either be higher or lower depending on the primary pump location. To prevent cavitation and maximize longevity and efficiency, the primary pump must be positioned so it "pumps away" from the expansion tank.

There are several books solely dedicated to this piping practice which offer a very detailed explanation. For this manual, we will assume the following conditions:



- 2. The primary pump is positioned after the expansion tank in a "pumping away" position.
- 3. The primary pipe size is sized based on the boiler load and flow requirements.

How to Size a Circulator

Circulators, or pumps, are sized based on the required load and piping loss for a given zone. The heat load dic-





tates the required flow rate (GPM) for the zone. This can be calculated by using the following equation:

Pure Water

 $\mathbf{BTU} = \mathbf{GPM} \times \mathbf{500} \times \Delta \mathbf{T}$

<u>50% Glycol – 50% Water</u>

 $\mathbf{BTU} = \mathbf{GPM} \times \mathbf{455} \times \Delta \mathbf{T}$

For most heating systems using a 20°F temperature drop it can be assumed

1 GPM = 10,000 BTU/hr

So, a system requiring 100,000 BTU/hr will need 10 GPM of flow.

The other performance factor in sizing a circulator is the head pressure. Head pressure is the friction loss associated with the water moving against the inside surface of the tubing or pipe. The circulator should be sized to overcome this loss, while moving the required volume of system fluid. The zone head pressure is the pressure drop seen through the RadiantPEX circuits in a given zone. It is calculated using the pressure drop charts and is added to the pressure drop associated with the supply and return piping.

Because the RadiantPEX circuits are always plumbed in parallel, the pressure drop for an individual circuit is the same as the zone pressure drop.

Example:

Zone "A" calls for 20,000 BTU/hr to be delivered to a zone with 5 200' circuits of 3/8" RadiantPEX. The manifold is located 20' from the mechanical room.

Step 1:

Determine the zone flow rate.

The flow rate for the zone is 20,000/10,000 = 2 GPM

Step 2:

Determine the circuit flow rate. The flow rate through each circuit is 2 GPM/5 Circuits = 0.40 GPM per circuit.



Typical pump sizing chart. Make sure zone circulators are sized to include supply and return piping in addition to the zone piping requirements.

Step 3: Determine the zone pressure drop

Using the pressure drop chart for water, the pressure drop per foot of tubing is 0.02 ft-hd/ft tubing. This gives a zone pressure drop of $0.02 \times 200 = 4.00$ ft-hd.

Step 4:

Determine the pressure drop of the supply/return lines.

Assuming 3/4" supply lines are installed, with a flow rate of 2 GPM. 0.015×40 (supply and return distance) = 0.60 ft-hd.

Step 5:

Determine complete pump spec.

The required pump load is 2 GPM at (4.00 + 0.60) or 4.6 ft-hd.

The actual pump required for this zone is selected using the given manufacturer's guidelines. This is usually done with the use of a pump curve chart. The chart is set up showing the pumps capacity at various pressure drops. Choose the pump that best reflects the needs of the system.

For this example, pump #2 is the best choice.

This information is readily available on a pump sizing chart. These charts are created by the pump manufacturer for each pump model and should be consulted before selection of a pump can be made.

Expansion Tank Sizing

Water will expand as its temperature increases. Since a hydronic heating system with an expansion tank is a closed system, the internal fluid volume is fixed. A simple ratio of how the volume, pressure and temperature of the system interact can be modeled by using a simplified version of the ideal gas law.

$\mathbf{PV} = \mathbf{T}$

(Pressure × Volume = Temperature)

With a fixed system volume, if the initial water temperature is 50° and it is raised to 180°, the internal pressure will increase, since the volume can not change. By quadrupling the internal temperature, the internal pressure will also quadruple, changing it from an initial 15 psi to 60 psi. This can damage system components and/or cause relief valves to discharge.

In order to keep the internal pressure roughly the same, the system volume has to change. The question is by how much? What tank size would be required if the temperature changed from 50° to 180° and the fluid volume was 20 gallons (approximately 2400' of radiant tubing). Since we are dealing with an incompressible fluid, elevation will factor into the total expansion rate of the system. A stepby-step form can be found in this section, along with other useful charts for determining component volumes.

Step 1:

Determine the initial volume of the system. To do this, calculate the volume of fluid in the tubing, supplyreturn piping, and all other mechanical components.

Step 2:

Determine the static pressure of the system. The static pressure is the force exerted on the system from the weight of the water above the mechanical room. The relative elevation change of the system will dictate how much static pressure is in the system.

Step 3:

Determine the fill pressure of the system. This is the static pressure plus a factor of safety. In our case, 3 psi is more than enough to account for minor piping variations within a floor.

Step 4:

Find the allowable volume increase, which is a percentage, in the system. This percentage will be determined by maximum pressure rating for the system, which is usually dictated by the pressure relief valve.

Expansion Tank Sizing form

Step 1: System Volume

Determine the amount of fluid in the radiant tubing, supply and return lines and near boiler piping (include boiler and other accessories).

		<u>Pipe Length</u> \times	$\underline{Volume/Foot}^* =$	Fluid Volume						
	Radiant Piping Supply/Return Piping									
/	Boiler Volume (see boiler manual)									
		Total	Volume (TV):							
e	Total System Volume Includes: Boiler (see manufactur Fancoils Radiant Supply/Return	er's specifications) Lines	Optional Buffer Tank Radiators Additional Hydronic Components							
	Tank Size = $\frac{\text{Expansion Vol}}{\text{Acceptance Fa}}$	actor (AF)								
5	Fill Pressure = (# floors * 3	.87 + 7 psi) + 14.7 =	:	_						
	Expansion Volume $(EV) = T$	Fotal Volume (TV) ×	Expansion Factor*	•						
	EV =									
ıl	$AF = \frac{(Relief Pressure + 14)}{(Relief Pressure + 14)}$.7) - Fill Pressure .7) =	=							
	Tank Size = $\frac{(EV)}{(AF)}$ =									

* Expansion Factor can be found on the following page.

Step 5:

Find what the actual volume increase will be for the fluid. This is done by multiplying the initial volume by the corresponding temperature factor. The higher the temperature, the more expansion the fluid will undergo.

Step 6:

Find the expansion tank volume by dividing the actual volume increase by the percentage.

There are several educational books on the market that describe primary/secondary piping arrangements. For more detailed information, please read these other publications. This manual is designed to give a basic understanding of primary/secondary piping and to offer several piping schematics as well as some corresponding electrical diagrams. Watts Radiant is not responsible for the performance or functionality of these illustrative diagrams to any particular project. Please consult a professional mechanical contractor or a Watts Radiant representative for detailed advice.

System Volume Chart

Tubing ID	RadiantPEX Fluid Capacity	Type M Copper Fluid Capacity
3/8" ID	0.53 gal/100 ft.	8.31 gal/1000 ft.
1/2" ID	0.96 gal/100 ft.	13.2 gal/1000 ft.
5/8" ID	1.4 gal/100 ft.	18.1 gal/1000 ft.
3/4" ID	1.9 gal/100 ft.	27.0 gal/1000 ft.
1" ID	3.1 gal/100 ft.	45.5 gal/1000 ft.
1-1/4" ID	N/A	68.2 gal/1000 ft.
1-1/2" ID	N/A	95.4 gal/1000 ft.

Expansion Factors

Wa	iter	Glycol									
System <u>Temperature</u>	Expansion <u>Factor</u>	System <u>Temperature</u>	Expansion <u>Factor</u>								
105	0.004	105									
110		110									
115		115									
120		120	0.0096								
125		125									
130	0.012	130	0.0144								
135	0.013	135	0.0156								
140	0.015	140									
145		145									
150		150									
155	0.020	155	0.024								
160	0.022	160	0.0264								
165	0.023	165									
170	0.025	170									
175	0.026	175	0.0312								
180	0.028	180	0.0336								
185	0.030	185									
190	0.032	190	0.0384								
195	0.033	195	0.0396								
200	0.035	200									
205		205	0.0444								

Mixing Options

Controlling the supply fluid temperature to the zones is one of the more critical features of the mechanical system design. There are several ways to achieve this goal, including 3-way mix valves, 4-way mix valves, injection pumps, and even standard ball valves. The most common means is to use either a three way mix valve or an injection pump.

Mix Valves

Non-electrical mix valves are designed to provide a fixed supply temperature whenever there is a call for heat.

This reduced temperature is achieved by allowing a controlled amount of high temperature boiler water to mix with the cooler return water from the zone. It is important to choose a mix valve that has enough flow volume for the zone design.

Mix valves are sized based on a Cv value. This value corresponds to the pressure drop generated by a certain amount of flow. If a valve is rated with a Cv of 5, then the valve can move 5 GPM of fluid at 1 psi drop (2.31' of head) through the valve.

If only one zone is being pumped through a mix valve, make sure the zone flow requirement is below the Cv value of the pump. If multiple zones (pumps) are to be supplied by one valve, then make sure the combined flow of the zones does not exceed the Cv value of the valve. See following pages for sample piping schematics.

To determine the pressure drop through the mix valve at a given flow rate, use the following equation.

$$\left[\frac{\text{GPM}}{\text{valve Cv rating}}\right]^2 \times \text{S.G.} = \text{P}$$

S.G. is the specific gravity of the fluid. For water this is 1, for glycol this is 1.15. P is the pressure drop through the valve.

The total pressure drop for the zone is the combination of the pressure drop found through the zone, supply/return piping and the mix valve.

Most manufacturers will provide this information in a graph similar to what is seen for pump sizing. Consult the corresponding mix valve manufacturer for more sizing information.



Injection Pump Sizing

Injection systems incorporate a series of sensors, some on the control piping to measure fluid temperatures, while other sensors are located outside to measure outside air temperature. With this information the injection control is able to calculate the actual heat load and required water temperature at any given time.

Why is this important? Non-electrical mix valves are set to provide a fixed temperature all the time. This temperature is set to handle the heating load on the coldest day of the year. This temperature is only reached for a small percentage of the time. For the rest of the heating season, a mix valve is providing temperatures that will be higher than required for the heat load at most times. Reset systems are continuously optimizing the heating system by modulating the supply temperature. This helps reduce the possibility of potential thermal swings associated with mild fall and spring days.

Injection pumps are sized the same way zone pumps are sized.

Pure Water:

BTU/hr = GPM \times 500 $\times \Delta T$

50% Glycol - 50% Water:

BTU/hr = GPM \times 455 $\times \Delta T$

As a rule, an injection pump will be sized for a smaller flow rate than the combined secondary zones.

Appendix

Each zone is designed around a $20^{\circ}F \Delta T$. This is done for comfort and response of the heating system. The injection pump, on the other hand, is only responsible for transferring BTUs. This can be done with a higher ΔT value. As the ΔT increases, the resulting GPM rate will decrease while still providing the same BTU delivery.

For example, assume a zone supply temperature of 120°F, a zone return temperature of 100°F and a boiler supply temperature of 180°F. The zone flow rate is 10 GPM. What size does the injection pump need to be?



The system load can be figured using the equation for water:

BTUs = $10 \times 500 \times 20 = 100,000$

The required flow rate for the injection pump can now be determined.

 $100,000 = \text{GPM} \times 500 \times (180 - 100)$

GPM = 2.5

The ΔT is figured using the supply temperature and return temperature across the injection loop. This is the boiler supply temperature minus the zone return temperature.

Note: In most cases the pressure drop across the injection loop will be minimal.

Piping and Electrical Diagrams

One zone off boiler



Piping Schematic





Multiple zones off boiler

The schematic shown illustrates a multi-zone system, where two non-electric mixing valves are being used.



Piping Schematic



•••••	 	 												
••••••	 	 	•••••											
••••••	 	 												
						 		 				•••••		
								 				•••••		

Notes



Notes

•••••	 	 	 	 	 	 		 	 	 		 	 	 	
•••••	 	 	 	 	 	 		 	 ·····	 		 	 	 	
•••••	 	 	 	 	 	 		 	 	 		 	 	 	
	 	 	 	 	 	 		 	 	 		 	 •••••	 	
•••••						 			 			 	 		
•••••		 	 	 	 	 		 	 	 		 	 	 	
	 	 	 	 	 	 	ļ	 	 ļ	 ļ		 ļ	 	 	
			:												

Radiant works better with RadiantWorks.



RadiantWorks was used to calculate heat loss variables for our SubRay[®] Underfloor radiant system.

RadiantWorks aided the design of the radiant heating system for this all-concrete residence.



RadiantWorks[®] was the first full-featured radiant design software and it's still the best. The 2003 version cuts hours off design time by linking your project to customer-friendly schematics, cross sections, and installation manuals.

RadiantNorks RadiantSource

This software designs all types of floor heating and snowmelting systems. RadiantWorks will also calculate annual operating costs for snowmelting and radiant heating systems. As the designer, simply enter all project parameters, and let RadiantWorks do the hard work. RadiantWorks will:

- Design radiant floor heating and snowmelting projects.
- Design electric floor heating projects.
- Create unique heat output nomographs for every room in the project.
- Display pictures of all system components and radiant applications.
- Quote custom HydroControl mechanical packages.
- Cut your design time by hours.

The latest enhancements to RadiantWorks include:

- Estimated annual energy usage for radiant floors.
- Estimated annual energy usage for snowmelting.
- Search projects for specified criteria.
- Ability to choose a printer on reports.
- Zones can now be sorted alphabetically.
- Nomographs now have a sliding axis for applications that might not fit on the standard Nomograph form.
- Designer information field added to the Edit Project window.
- There is now a File Open history in the File Menu on the Main form.
- The Zone Edit window now shows generic pictures of the currently choosen application.
- Project and designer information now displayed on report headers



Call today for your copy of RadiantWorks.

www.wattsradiant.com

800-276-2419

Radiant Floor Applications

RadiantPEX UnderFloor[™] with LockDowns[™]

Installing RadiantPEX UnderFloor using Watts Radiant LockDown fasteners is a popular installation method. RadiantPEX is secured to the LockDown every 24" OC to the bottom of the subfloor.

Foil-faced fiberglass insulation is installed (foil side facing up), leaving a 2"-4" air gap between the foil and the underside of the subfloor. Always insulate exterior band joists in this application to prevent external heat loss.

SubRay[™] over Frame Floor

SubRay is installed on top of a new or existing frame floor where access underneath is limited or completely inaccessible. Hardwood floor coverings can be installed directly on top of the SubRay sleeper, reducing the already low profile even further.

Install either 15-mm SubRay for 3/8" RadiantPEX, or 18-mm SubRay for 1/2" RadiantPEX.

Always install insulation under the floor between the joists. Non-foil-faced insulation can be installed if the insulation is in direct contact with the subfloor (no air gap). If an air gap is to be present, install foil-faced insulation.

SubRay[™] over Slab

SubRay is installed on top of a new or existing slab floor. SubRay's low profile reduces the increased height of the finished floor, allowing for easier installation, and reduced construction modifications to existing items such as doors and cabinets. Hardwood floor coverings can be installed directly on top of the SubRay sleeper, reducing the already low profile even further.

Install either 15-mm SubRay for 3/8" RadiantPEX or 18-mm SubRay for 1/2" RadiantPEX.

It is recommended to install an insulation layer on top of the existing slab prior to the installation of SubRay. In cases where a lower profile is required, or in areas that are not conducive to an insulation board due to weight loads, a plywood layer may be used.

RadiantPEX UnderFloor with Plates

RadiantPEX UnderFloor using Watts Radiant plates is another popular installation method. RadiantPEX is secured to the subfloor using 5" × 24" aluminum plates with a maximum 6" spacing between plates. The aluminum plates ensure conductive contact is maintained with the subfloor.

Foil-faced fiberglass insulation is installed (foil facing up), leaving a 2"-4" air gap between the foil and the underside of the subfloor. Always insulate exterior band joists in this application to prevent external heat loss.

Thin Slab over Frame Floor

Staple the RadiantPEX down to the wood subfloor. Install a minimum of 3/4" of concrete mix above the top of the RadiantPEX; more may be required depending on structural loading. Use one of the new gypsum-based mixes, or fiber-reinforced concrete.

Always install insulation under the floor between the joists. Non-foil-faced insulation can be installed if the insulation is in direct contact with the subfloor (no air gap). If an air gap is to be present, install foil-faced insulation.



