

onix™

Installation Manual



Watts Radiant
Floor Heating & Snowmelting

A subsidiary of Watts Water Technologies, Inc.



Radiant Onix™



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

This refining process is based on the collective wisdom that comes from having an engineering and technical staff with over 200 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 Onix hose, and should not be used for the installation of our cross-linked polyethylene products, RadiantPEX® and WaterPEX®.

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 system, 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.

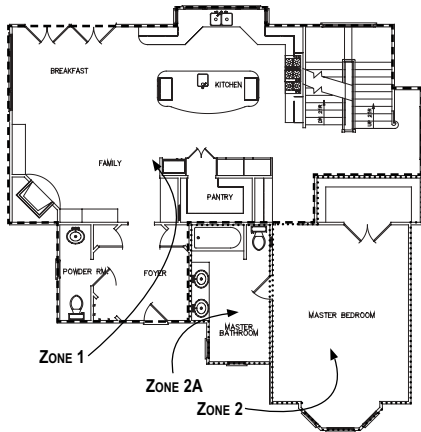


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Table of Contents

	<u>Section</u>	<u>Page</u>
	Introduction	6
	Heat Transfer Basics	6
	Onix™ Radiant Piping	6
	The Design Process	7
	Step 1: Initial Design Considerations	8
	Floor Coverings	8
	Tile Floors	9
	Hardwood Flooring	9
	Controlling Moisture	10
	Installation Cautions	11
	Carpet and Pad Flooring	12
	Step 2: Radiant Zoning	12
	1. Zoned by Floor Coverings	12
	2. Zoned by Occupancy	12
	3. Zoned by Construction	12
	4. Zoned by Mechanical Considerations	12
	Step 3: Manifold Location	13
	Step 4: Heat Loss Calculations	14
	Using RadiantWorks® Reports	14
	Zone List Report	15
	Assumption Report	15
	Heat Loss Report	15
	Applications	16
	Frame Floors	16
	Design Parameters	16
	Onix Spacing	17
	Perimeter Banding	17
	Staple-Up™ Applications	18
	Tools Required	18
	Fasteners	18
	Staple Gun	18
	Installation Steps	19
	Step 1: Install Manifolds	19
	Step 2: Zone Boundaries	20
	Step 3: Tubing Requirements	20
	Step 4: Drill Joists	20
	Step 5: Install Onix	20
	Step 6: Repeat With Next Circuit	21
	Step 7: Visual Inspection	22
	Step 8: Pressure Test	22
	Insulation Details	23
	TJI Joists	23
	Open Web Joists	23
	Layout Examples	24



Typical radiant zoning.



Staple-Up™ Applications

Table of Contents



Sandwich Applications



Slab on Grade Applications

<u>Section</u>	<u>Page</u>
Sandwich Applications	26
Tools Required	26
Fasteners	26
Installation Steps	27
Step 1: Install Manifolds	27
Step 2: Zone Boundaries	27
Step 3: Tubing Requirements	27
Step 4: Drill Joists	27
Step 5: Install Onix	28
Step 6: Secure the Onix	28
Step 7: Repeat With Next Circuit	28
Step 8: Visual Inspection	29
Step 9: Pressure Test	29
Insulation Details	29
Other Frame Floor Techniques	30
Walls and Ceilings	31
Poultry Netting	31
Recessed Walls	32
SubRay®	33
Cautions	34
Slab on Grade Applications	35
Site Preparation	35
Insulation Details	36
Type of Insulation	36
Control Joints	36
Design Parameters	36
Onix Spacing	36
Perimeter Banding	37
Tools Required	37
General Details	38
Installation Steps	39
Step 1: Pre-Pour Conditions	39
Step 2: Install Manifolds	39
Step 3: Determine Zone Boundaries	40
Step 4: Tubing Requirements	40
Step 5: Install Onix	40
Step 6: Secure the Onix	41
Step 7: Repeat With Next Circuit	41
Step 8: Visual Inspection	41
Step 9: Pressure Test	41
Step 10: The Concrete Pour	42

Table of Contents



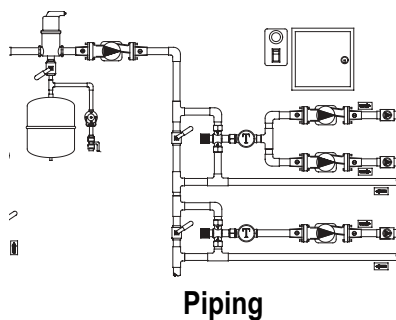
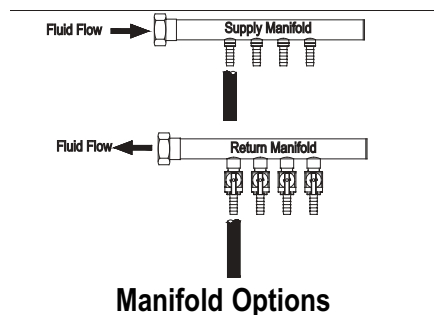
Thin-slab and Slab Cap Applications



Snowmelt Applications

<u>Section</u>	<u>Page</u>
Thin Slab and Slab Cap Applications	43
Design Parameters	43
Onix Spacing	43
Perimeter Banding	44
Tools Required	44
Fasteners	44
Installation Steps	45
Step 1: Install Manifolds	45
Step 2: Determine Zone Boundaries	45
Step 3: Tubing Requirements	45
Step 4: Install the Onix	45
Step 5: Securing the Onix	46
Step 6: Repeat With Next Circuit	46
Step 7: Visual Inspection	46
Step 8: Pressure Test	46
Insulation Details	47
Steel Decks	48
Snowmelt Applications	49
Site Preparation	50
Insulation Details	50
Design Parameters	51
Onix Spacing	51
Tools Required	51
General Details	53
Installation Steps	53
Step 1: Pre-Pour Conditions	53
Step 2: Install Manifolds	53
Step 3: Determine Zone Boundaries	54
Step 4: Tubing Requirements	54
Step 5: Install the Onix	54
Step 6: Securing the Onix	55
Step 7: Repeat With Next Circuit	55
Step 8: Visual Inspection	55
Step 9: Pressure Test	55
Step 10: The Concrete Pour	56
Miscellaneous	56
Steps	56
Glycol	57

Table of Contents



<u>Section</u>	<u>Page</u>
Appendix	58
Manifolds	58
Factory Supplied Manifolds	58
Field Constructed Manifolds	58
Manifold Set Up	59
Onix Circuit Balancing Valves	61
Onix Clamps	61
Field Repairs	61
Pressure Test	62
Nomograph	63
Pressure Drop Charts	64
Near Boiler Piping	69
Primary/Secondary	69
Point of No Pressure Change	69
Circulator Sizing	69
Step 1: Determine Zone Flow Rate	70
Step 2: Determine Circuit Flow Rate	70
Step 3: Determine Zone Pressure Drop	70
Step 4: Determine Supply/Return Pressure Drop	70
Step 5: Determine Complete Pump Spec	70
Expansion Tank Sizing	70
Mixing Options	72
Mix Valves	72
Injection Pump	73
General Schematics	75

Introduction

Welcome to the exciting world of radiant floor heating. 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.

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 an Onix™ Staple-Up™ 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.



Onix Radiant Piping

This manual is to be used with Watts Radiant's Onix tubing, an Ethylene Propylene Diene Monomer or EPDM for short. It should not be used to install PEX tubing.

Onix was created as a solution to some of the more challenging radiant installations. It was engineered with increased flexibility, crush and abrasion resistance, higher temperature limit and aramid fiber reinforcing. These features allow Onix to be installed easier and faster into more confining and challenging environments, such as crawlspace and stairways slabs.

Onix's unique multi-layer construction gives it added ability to resist jobsite abuse as well as extreme weather conditions. With an Aramid reinforcement layer, at normal operating temperatures, Onix's burst pressure more than doubles other radiant tubing. This equates to a longer life span and lower maintenance requirements.

Even though radiant floor applications will be where Onix is used the most, Watts Radiant has taken extra steps to design Onix for other applications,

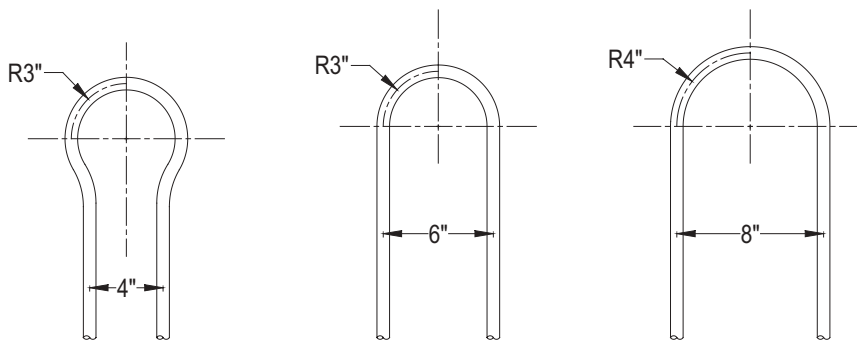
General Design Process



such as supply and return lines for baseboard and fan coils.

Onix has a revolutionary oxygen barrier, AlumaShield, a ductile aluminum that prevents unwanted oxygen permeation. Less oxygen in a hydronic sys-

an estimated life span of over 3,000,000 hours, or approximately 340 years under normal operating conditions. Independent lab testing has rated Onix among the most stable materials we have ever reviewed.



Typical bend radii for 3/8" diameter Onix. Larger diameter tubing will require larger bend radii.

tem means lower corrosion and longer life to system components such as boilers and pumps.

From a design stand point, Onix offers an additional advantage over other piping options - no linear expansion. Since Onix is a multi-extrusion EPDM product, it is dimensionally stable over its operational temperature range. No movement due to expansion means no unwanted wear of the tubing, no noise and no stress points.

All of these features relate to one major benefit - longevity. Onix carries

Onix Sizes

Watts Radiant offers a wide range of Onix sizes, from 3/8" to 1" internal diameter. It is a misconceived notion that a larger diameter tubing will offer greater heat output. A 3/8" circuit of Onix will generate the same amount of heat output as 1/2". The main difference is the flow capability. Larger

<u>I.D. Size</u>	<u>Bend Radius</u>	<u>Fluid Volume per 1,000 ft.</u>	<u>Typical Max Installed Length</u>	<u>Max Factory Length*</u>
3/8"	.3"	.625 gal.	.200 ft.	.600 ft.
1/2"	.4"	10.25 gal.	.300 ft.	.600 ft.
5/8"	.5"	16.0 gal.	.400 ft.	.600 ft.
3/4"	.6"	25.00 gal.	.500 ft.	.400 ft.
1"	.8"	45.00 gal.	.600 ft.	.200 ft.

*Lengths indicated are non-factory spliced lengths. Longer factory spliced lengths are available upon request.

diameter tubing allow for the same flow rates at lower head pressures, or friction loss. For most residential and light commercial heating, 200 ft. lengths of 3/8" Onix are used. For snowmelting and larger commercial applications, 1/2", 5/8" and even 3/4" Onix are used.

The Design Process

For all radiant projects, both large and small, a system design should be performed. 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 can be used to size a radiant heating system, however they 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.

Floor Coverings

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. 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 criteria concerning snowmelting systems will be discussed in the Snowmelting section.

Floor Coverings

More questions arise concerning floor coverings than any other item. The main misconception regarding floor coverings tend to center on whether or not carpet or wood can be used over a radiant floor.

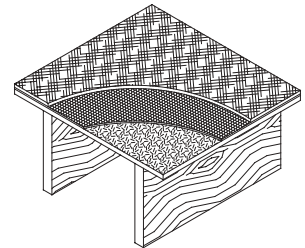
Virtually any floor covering can be used if the insulative value for that covering is accounted for in the radiant design and installation process. In a radiant floor heating system, the floor is the room's heat source. The floor gives off heat (energy) to the room because it is warmer than the surroundings - hot moves to cold. If we want to maintain a room temperature of 70°F, the floor has to be warmer than 70°F. The 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 what the floor type is, or what the construction details are as long as the required floor surface temperature is achieved.

There is a limit. In theory, we could heat any room to any temperature with the use of a radiant floor heating system. The limiting factor is us. 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

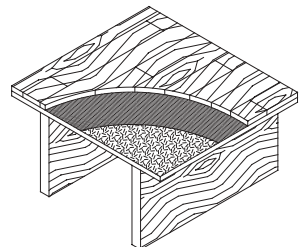
to stand on. This 85°F floor limit in turn limits the maximum BTU output of the floor to around 45 BTU/sq.ft.

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.²/°F while tile has a conductivity of 0.41 Btu/hr/ft.²/°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 tem-

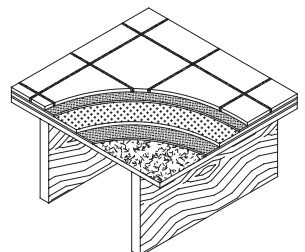
Carpet and pad are generally the most difficult of the floor coverings. This means a higher supply fluid temperature.



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



Tile and other stone floor coverings are the most efficient to use over a radiant system. The more conductive the floor covering the lower the required supply water temperature.



Floor Coverings

perature while a tile floor may only require 100°F.

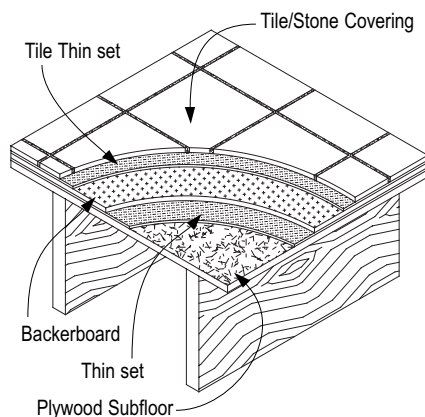
Even though the main goal is the same for all floor types, there are some special considerations that need to be maintained for each floor covering. The following should be used as a guide only. If more information is required, contact the flooring manufacturer for more specific information relative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

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 and adjust continuously over time as the environment changes. Tile installed over a slab



Typical tile/stone installation sequence over a frame floor.

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 manufacturers 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.

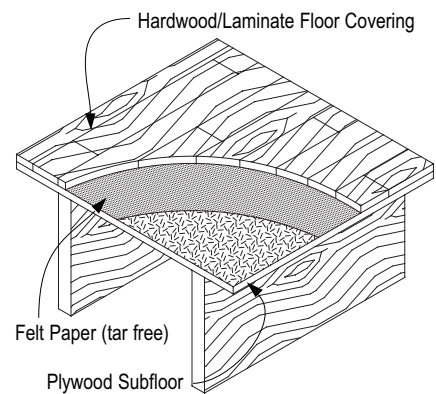
This is not to say certain precautions should not be followed. These installation techniques are the same for a radiant floor heating system as they are for a conventional forced air system.

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 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.



Typical hardwood installation sequence over a frame 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.

5. Room Moisture.

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

Floor Coverings

6. Use Strips, not Planks.

The narrower the board, the less movement it will create. The ideal 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.

Controlling Moisture

Hardwood floors are installed over a concrete slab or a wooden subfloor. 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 - for example, from the basement, crawl space or slab.

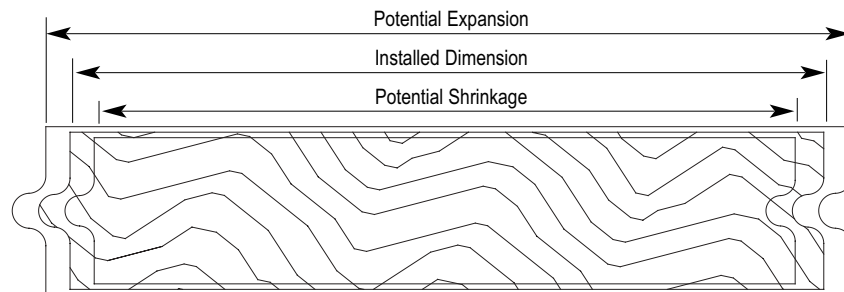
For a slab on or below grade, a minimum 6 mil plastic vapor barrier should be used under the slab to prevent the absorption of ground moisture through the concrete during the non-heating season. Verify with local code and building practices.

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.

There is a simple procedure for checking the presence of excessive moisture in the slab. Tape a 4 ft. x 4 ft. 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,

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.



Hardwood expansion.

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 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 particleboard as a subfloor.**

USDA Forest Service

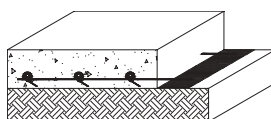
The following procedures are recommended by the USDA Forest Services *Wood Handbook*.

Cracks develop in flooring if (the wood) absorbs moisture either before

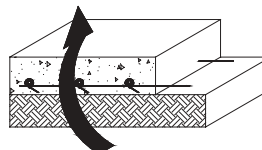
2. Do not allow the flooring to be delivered before the masonry and plastering are completed and fully dry, unless a dry storage space is available.
3. Have the heating plant installed before the flooring is delivered.
4. Break open the flooring bundles and expose all sides of the flooring to the atmosphere inside the structure.
5. 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.

% 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"

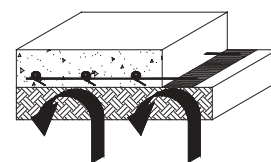
Standard slab on grade construction



Without a vapor barrier: moisture moves through a slab via capillary movement.



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



Floor Coverings

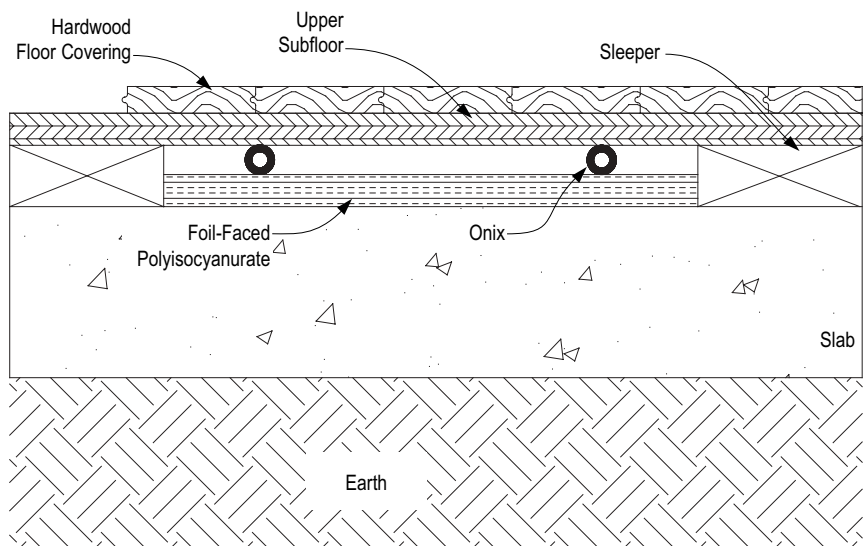
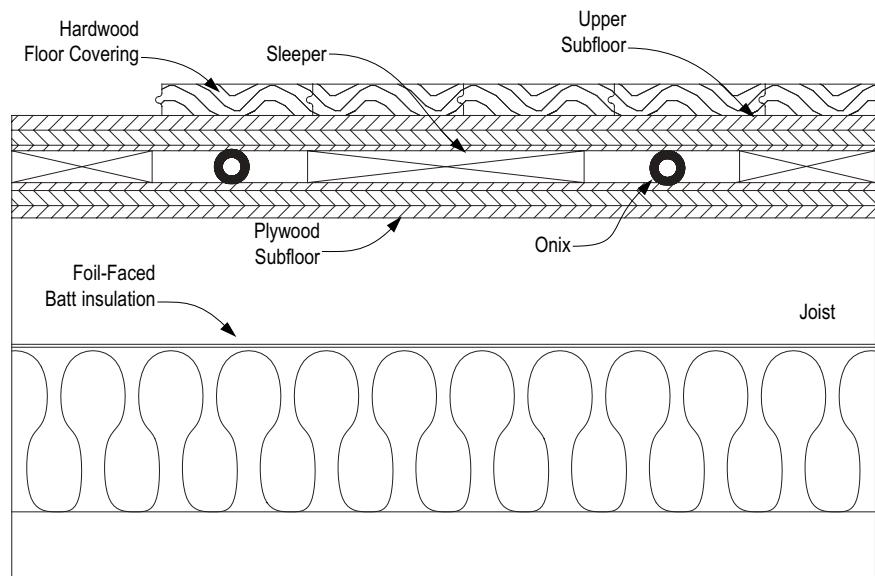
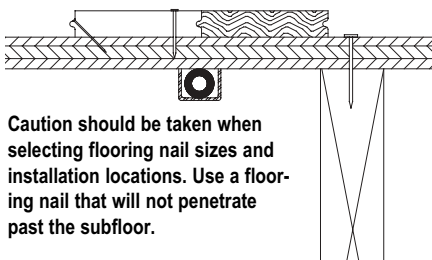
Cautions for Hardwood Floor Installations:

If the radiant heating system cannot be installed prior to the hardwood installation, an alternative form of heat 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 heating system, as some types of paper may give off an unpleasant odor when they are 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 the use of underfloor radiant installations under asphalt paper.

As a rule of thumb, standard 3/4" hardwood floor coverings with a 3/4" subfloor does not pose a problem to normal heat transfer. The efficiency 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 to help protect the tubing from nails and other attachment devices.



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 to help protect the tubing from nails and other attachment devices.

Floor Coverings

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.

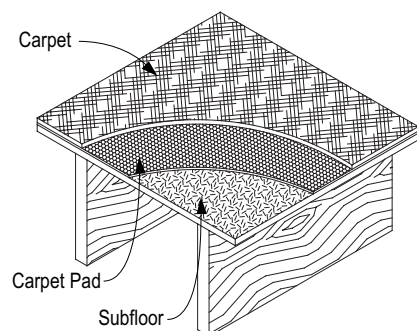
With respect to a radiant floor heating system, a carpet and pad floor covering is the most difficult to heat through. In general, the ideal floor covering would have an R-value of 2 or less. In most cases, since we are using a floor heating system, a thinner pad should be used. Try to keep the pad thickness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

Step 2: Radiant Zoning

Zoning is a way of controlling how the 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 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



Typical carpet and pad installation sequence over a frame floor.

Carpet Type	Thickness (in)	R-Value
Level Loop	.26	.064
Berber	.41	.083
High/Low Loop	.42	.086
Berber	.42	.096
Berber	.48	.10
Frise	.42	.11
Saxony	.41	.110
Saxony	.44	.115
Saxony	.50	.125
Saxony	.55	.132

Cushion	Thickness (in)	R-Value
Slab Rubber	.23	.062
Waffled Sponge Rubber	.43	.078
Prime Urethane	.40	.161
Hair & Jute Coated	.44	.171
Bonded Urethane	.50	.209

Carpet and Pad	Combined Thickness (in)	Total R-Value
Level Loop and Textured Rubber	.036	1.04
Level Loop and Froth	.025	1.23
Berber and Textured Rubber	.036	1.36
Berber and Froth	.025	4.54
Saxony and Textured Rubber	.036	1.62
Level Loop and Bonded Urethane	.032	1.67
Level Loop and Synthetic Fiber	.033	1.67
Saxony and Froth	.025	1.83
Level Loop and Grafted Prime	.036	1.88
Berber and Synthetic Fiber	.033	1.98
Berber and Bonded Urethane	.032	2.01

need 100°F supply water, while the family room right next to it with a carpet floor covering 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 might be varying joist directions or expansion joint locations.

4. Zoned by Mechanical

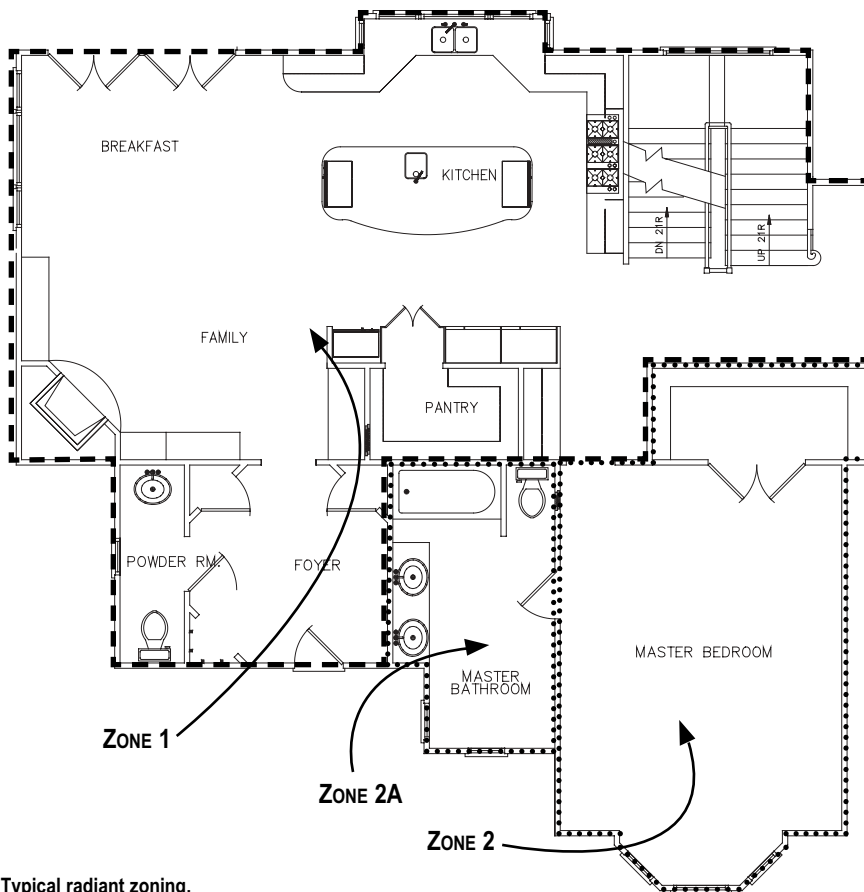
Considerations:

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 to exceed 85°F. For this reason, rarely is a carpeted room zoned with a tiled room.

Rooms with similar heating intensities (BTUs per square foot) can be zoned together, as well. If a room has a greatly exaggerated load of 50 BTU

Zoning



Typical radiant zoning.

Supply Pipe Size	Max. Flow Rate (typical)
3/4"	.4 gpm
1"	10 gpm
1-1/4"	15 gpm
1-1/2"	22 gpm
2"	45 gpm

per square foot, like a Sunroom, it should not be zoned with a room that only requires 10 BTUs per square foot.

The above illustration uses the occupancy technique for zoning, dividing the waking areas from the sleeping areas. Zoning choices are subject to change as the design progresses. It is not uncommon to go back and rearrange rooms and zones to create a better overall design.

Step 3: Manifold Location

Each zone will generally have one manifold pair - a supply and a return. Watts Radiant offers a wide range of manifolds ranging from custom brass manifolds, to cast brass manifolds, and stainless steel. More information on manifold options can be found in the Watts Radiant product catalog.

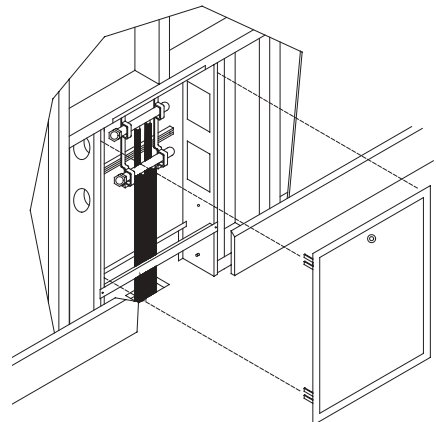
With respect to any design, the manifold location has a direct impact not only on the aesthetics of a room, but also on the tubing being installed.

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

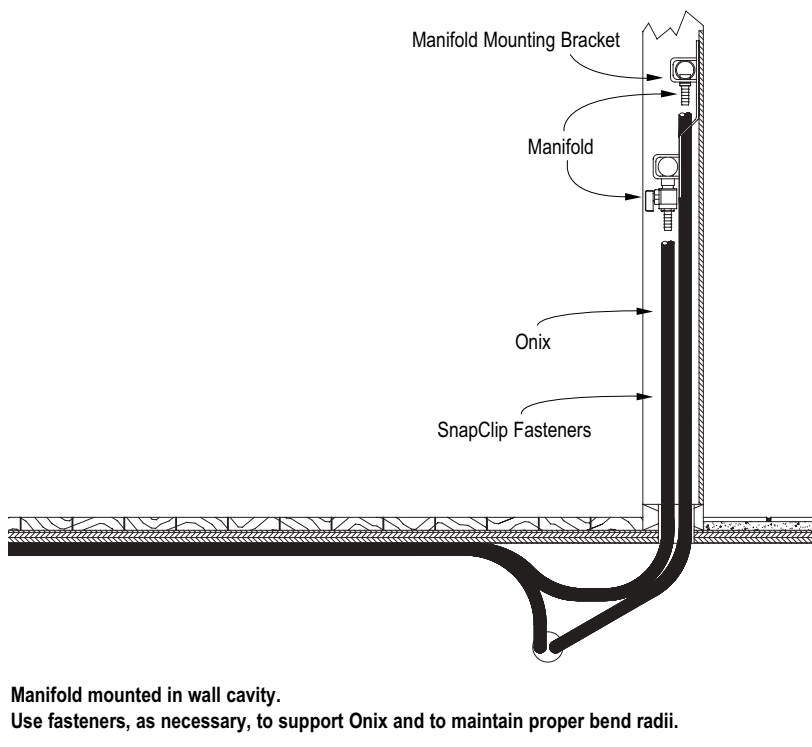
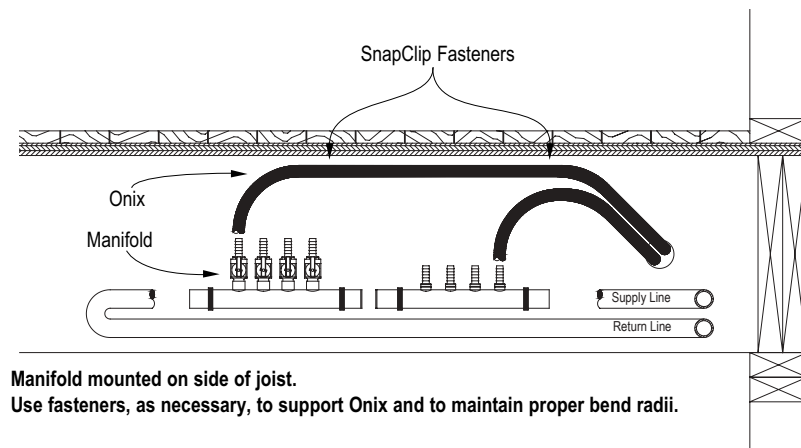
manifold to keep the assembly hidden from everyday view.

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 ft. circuits are adequate. For most commercial projects, 300 - 400 ft. circuits are used.
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 should be added to each circuit length. For example, if a zone calls for 180 ft. circuits, and the manifold is moved to a location 10 ft. away, then 20 ft. is added to the circuit. The circuit lengths required for this zone will be 200 ft.
4. Manifolds should be mounted horizontally, if possible. This allows for easier circuit connection to the manifold. Also, if a vent/purge assembly (recommended) is installed on the manifolds, they must be mounted horizontally in order to allow the vents to work properly without leaking.

5. Manifold sizes are based on the zone flow rates (in gpm). The smallest trunk size provided by Watts Radiant is 1". For commercial and snowmelt applications



Zoning



larger manifolds, 1-1/4" to 6" i.d., are available.

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 radiantly warmed, the human body does not need as warm an air tem-

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

perature to stay comfortable. With radiant heat, the indoor thermostat can be set 2½—3½ lower.

2. Indoor air movement and temperature gradient is greatly reduced. This reduces heat loss through the ceiling.
3. Due to heat storage in the radiant floor and surrounding walls, peak heating loads are reduced. This effect is greater in more massive construction.
4. 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.

Due to these factors, a typical radiant heated building often requires 10% to 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 to transfer information about a given project quickly without unnecessary guess work.

Zoning

RadiantWorks Zone List Report

ZONE 1 - MAIN LEVEL (Under-Floor)

Room Specifications							
Room Name	Primary Spacing [in]	Primary Area [ft ²]	Banded Spacing [in]	Banded Area [ft ²]	Heating Intensity [Btu/h ft ²]	Required Heat [Btu/h]	Radiant Capacity [Btu/h]
Foyer	8	118	---	---	15.7	1,853	2,421
Powder Room	4	42	---	---	27.2	1,144	1,147
Breakfast / Kitchen / Family / Pantry	8	520	4	180	17.2	12,012	13,832
Hall	8	135	---	---	16.0	2,154	2,484

Zone Specifications							
Supply Fluid [°F]	Delta T [°F]	GPM	Head [ft]	Radiant Panel Load [Btu/h]	Product Type	Tube Length [ft]	No. of Circuits
112	20	2.4	2.1	24,038	3/8" Onix	200	11

Pump Specs & Radiant Panel Load are calculated on the smaller of Required Heat or Radiant Capacity (+ back and edge losses)

RadiantWorks Assumption Report

Project Assumptions

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

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

Min Tube Length:	20 ft	Max Tube Length:	200 ft	Circuit Rounding:	20 ft
Supply Water Temp:	112.3 F	Delta T:	20 F	Manifold Distance:	0 ft
Joist Spacing:	16 in	Joint Thickness:	1.5 in	Joist Conductivity:	0.078 Btu/h-ft-F
Subfloor Thickness:	0.75 in	Subfloor Conductivity:	0.085 Btu/h-ft-F		

Foyer

Room Size Parameters:

Area:	118 ft ²	Perimeter:	44 ft	Total Area:	118 ft ²
Heated Floor Area:	118 ft ²	Unheated Floor Area:	0 ft ²		

Room Construction Parameters:

Space Below:	Crawl Space			Crawl Space Insulation:	Yes
Foil Faced Insulation Thickness:	3.5 in	Tube Spacing:	8		

Room Heat Loss Parameters:

Indoor Design Temp:	68 F	Max Eff. Surface:	85 F	Heating Intensity:	15.70 Btu/h ft ²
Floor Covering:	Tile Floor & Mudset	R Value:	0.16	Unheated Floor R Value:	19
ACH:	0.5	CFM:	7.867	Number of Stories:	1
Ave. Ceiling Height:	9 ft	Exp'd Ceiling Area:	118 ft ²	Ceiling R Value:	30

RadiantWorks Heat Loss Report

ZONE 1 - MAIN LEVEL (Under-Floor)

Calculated Heat Loss for Foyer @ 68 F Indoor

Description	Units	R-Value	Heat Loss [Btu/h]	Infil. Loss [Btu/h]	Total Loss [Btu/h]
Exposed Walls	59 ft ²	13	303	0	303
Doors	21 ft ²	2	635	0	635
Exposed Ceiling Area	118 ft ²	30	265	0	265
Infiltration	0.5 ACH			650	650
Totals			1203	650	1853

Zone List Report

Each Zone List contains important 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 Required Heat. If this is not the case, then the room will require auxiliary heat.

Assumption Report

The Assumption Report is a way to convey 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. If things are different from what is assumed, then changes to the heating design need to be made.

All projects change during the construction process. Windows get added to the living room, a fireplace is added to the family room, etc. Hardwoods replace carpet or a skylight goes into the master bathroom. In most cases, 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 simple construction change might require modifications to the radiant heating system, such as additional banding (tighter tube spacing along an exposed wall) or higher water temperatures and possibly a larger heat source.

Heat Loss Report

The Heat Loss Report is a room-by-room breakdown of exactly where heat loss is taking place. This information is used to identify those items that are causing an unusually high heating load. For example, assume the load for

Frame Floors

a room were 10,000 BTUs and the windows were single pane and had a total heat loss of 6700 BTUs. 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

As construction materials improve, installation details change. It would be impossible to try to fit all possible construction scenarios into this manual. Because of this, only the most common applications are discussed. Each 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 for design assistance.

Frame Floors

Introduction

Of all the radiant applications, frame floors offer the most installation flexibility. Over 80% of all residential radiant projects have at least one form of a frame installation. Of these, the Staple-Up™ application is the most common.

Frame floor projects allow for easy installation of a radiant system, for new construction or renovation. 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 Onix is in direct contact with the subfloor.

The second most important detail for a Staple-Up™ 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.

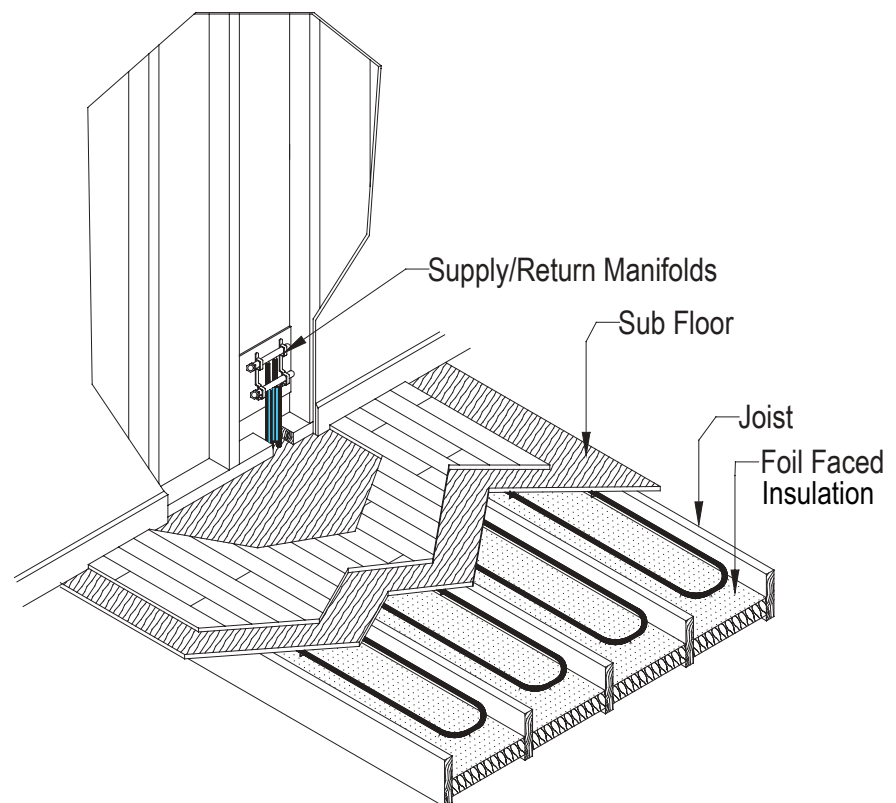
1. **Tight seal.** One of the largest areas of heat loss with any underfloor application is convective loss through the band joists and other perimeter areas. The tighter the joist cavity, the better the system will perform.
2. **Foil Face.** The foil on the insulation will ensure most of the heat and energy coming from the tubing is reflected up to the subfloor where it is distributed. The foil also spreads the heat out over the subfloor. This in turn reduces what has been called thermal striping.
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. The main goal is to keep the tubing from coming into contact with the 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% to 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



Typical Staple-Up Application

Frame Floors

increase or change, variances in the heating system will result.

Onix Spacing

Onix is generally installed 8 inches on center, to the underside of the subfloor for a Staple-Up or a sandwich application. Closer spacing may be used in areas of high heat loss, such as an exposed wall with a high percentage of glass. Higher tubing densities, up to 4 inches on center, 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.

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 surface temperature. The amount of radiant tubing and

the fluid temperature controls this surface temperature.

For most rooms, a standard 8" spacing will be more than adequate, with some 4" perimeter banding. In a few cases, where supply fluid temperature is limited, an entire room may be installed at a close 4" on center spacing. This may be seen in a sunroom or remodel condition, where the floor covering and/or high heat loss requires tighter spacing.

Watts Radiant's RadiantWorks design software generates a specific Nomograph for each room in the design. Nomographs are charts that 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

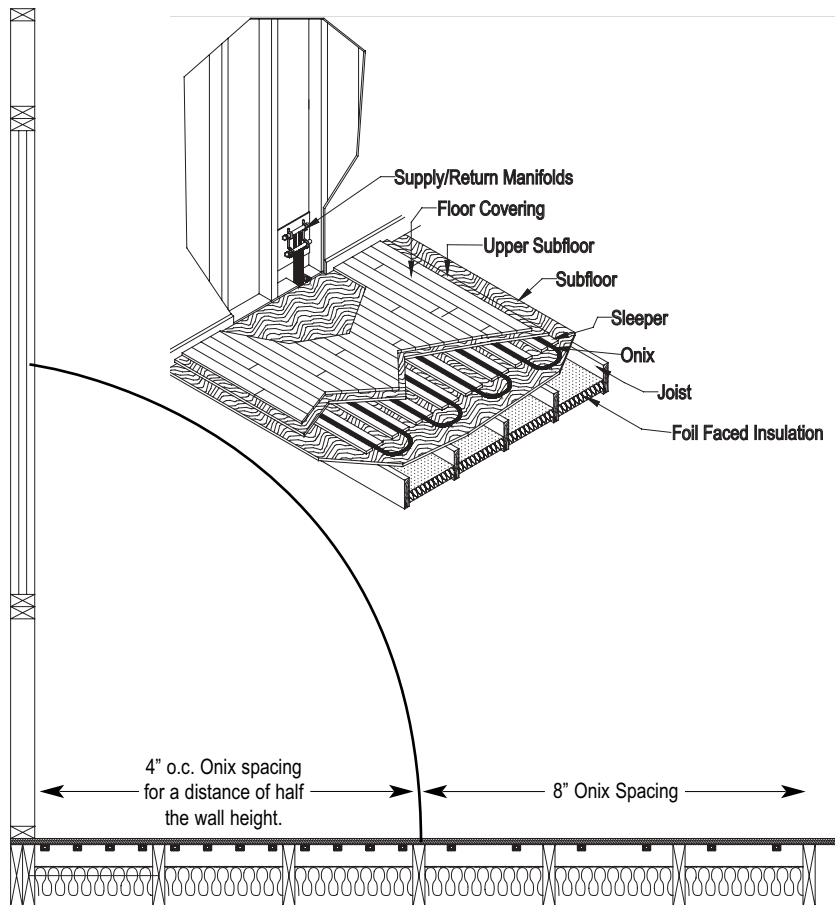
to any radiant design. More information on how to read and use a Nomograph can be found in the Appendix.

Perimeter Banding

Four, five or six inch Onix spacing is frequently used along outside perimeter walls. These high-density 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 70% of the height of the wall. Most banded widths will be 4 ft., or three joist cavities.

For example, in a home with 8" spacing in the main floor area, a 6' 8" high patio door would have radiant tubing on 4" centers a minimum of 40" in front of the door. This would correspond to double-spacing in the first three joist cavities. If possible, keep the number of Onix runs per joist bay an even number, either two or four. This will help keep installation time to a minimum.

For sandwich applications the same general guidelines are applied. Eight inch sleeper spacing is used for eight inch tube spacing.



Banding Areas.

Onix is often installed at closer spacings at the perimeter of exterior rooms to improve comfort.

Staple-Up

Staple Up™ Application



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 Onix Staple-Up™ radiant 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. Onix tubing and corresponding number of Onix Clamps.

Each Onix TorqueTite™ clamp will

require an in.-lb. torque wrench, while the SelfTite™ clamps need a pair of SqueezeTite™ Pliers. See manifold assembly section for more details. The number of Onix coils on the jobsite should correspond to the number listed in the Zone List report.

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 precut Onix coil without kinks and twists.

5. Field Repair Kit.

Each kit contains two barb-by-barb splices and four Onix Clamps.

6. Manifold Mounting Bracket.

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

7. Watts Radiant staple gun, staples and NailTites™.

8. Pressure test kit.

Each manifold pair must be pressure tested. This helps ensure each Onix connection has been performed correctly and to make sure no additional 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.

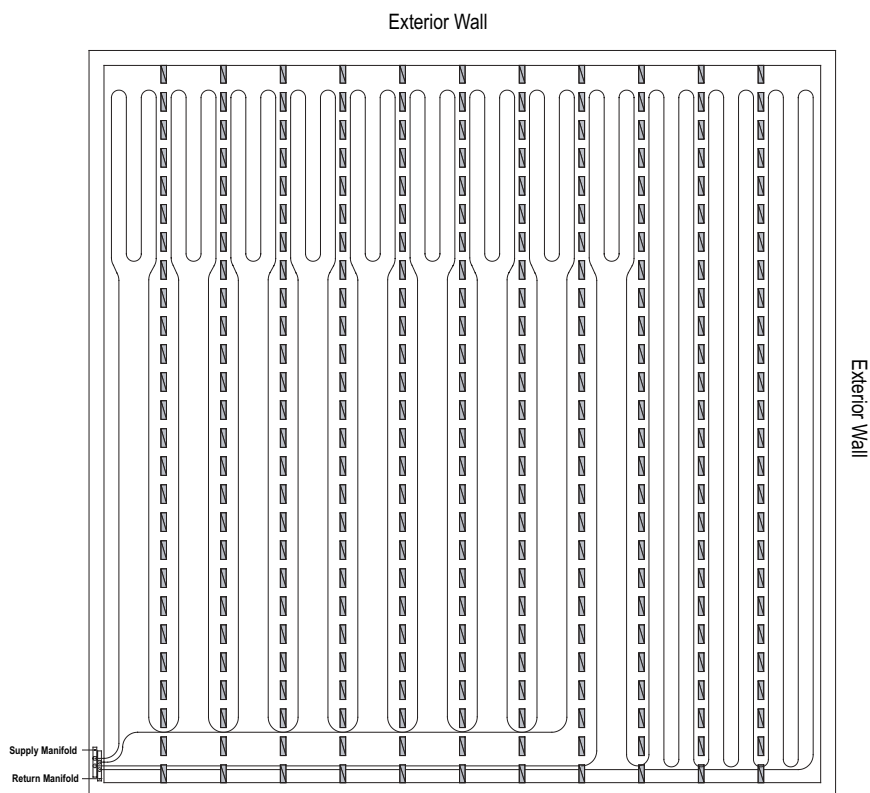
Fasteners

Although the Watts Radiant staple gun will be the most used attachment tool, other fasteners are available for those areas where the staple gun can not reach. Watts Radiant's NailTites™ are used to secure all types of Onix at turns and bends and in areas inaccessible to the staple gun. Both staples and NailTites must be installed every 6"—8" along each run of Onix to ensure consistent contact.

Watts Radiant Staple-Gun

The Watts Radiant staple gun is a pneumatic (air powered) tool. To operate correctly, it requires an air compressor capable of delivering 100 psi air. It is designed and sold only for the purpose of installing Watts Radiant Onix tubing and must not be used for any other purpose. If the gun generates multiple punctures or misfires, the gun may be faulty. Always repair a puncture with an approved Watts Radiant repair kit and have the gun repaired as soon as possible.

General Caution: Do not operate this tool before reading the following cautions and instructions. Misuse of this tool can cause serious injury. If unclear about its proper use, please call 1-800-276-2419 for further instructions.



Typical Onix banding at exterior walls.

Staple-Up

1. This tool may discharge when air pressure is connected or disconnected. Make sure the tool is unloaded or pointed in a safe direction before connecting/disconnecting a pressure hose.
2. Remember, any pneumatic staple gun is exactly that, a gun. Each staple gun has the ability to shoot staples at a velocity sufficient to kill or permanently injure anyone within range. Never point this tool at anything except a piece of Onix intending to be permanently fastened. Never squeeze the trigger when your finger, hand or any body part is in front of or close to the firing head.
3. Always wear safety glasses with side shields before operating this tool. Other workmen or visitors to the jobsite must wear adequate eye protection if they are within range of the tool. There is always a possibility that a staple could ricochet off a nail or knot in the subfloor and injure a bystander. **DO NOT attempt to staple into knots, even if the staple spacing needs to be extended. Never attempt to staple into concrete, metal, or any non-wooden surface.**
4. Use the correct staple gun and quality Watts Radiant staples to prevent tool jamming and Onix punctures. Watts Radiant staples are designed to a higher standard than conventional staples. Occasionally a staple will misfire and puncture the Onix when the staple clip is down to the last 5 to

10 staples. Always check to see if the clip is getting low and insert a new clip to avoid this potential problem.

Using the Onix Staple Gun

The Onix staple gun is specially modified both internally and externally by Watts Radiant. The Onix staple gun is fitted with a stainless steel guide plate (order 81005498) that is bolted to the underside of the gun. If stapling 3/8" Onix, make sure the smaller 3/8" opening is at the front of the gun. You should see 3/8" Onix stamped on the guide plate at the front of the gun. If stapling 1/2" Onix, unbolt the guide plate and turn it around so the larger 1/2" opening is at the front of the staple gun. You should see 1/2" Onix stamped on the guide plate at the front of the gun.

To staple Onix, position the guide plate over the Onix. Make sure the guide plate, at both front and back, is placed firmly against the surface. Before pulling the trigger, make sure that the tail end of the guide plate is also centered over the Onix. If the tail of the guide plate is not centered over the tubing, some of the staples may puncture the Onix. When the guide plate has completely contacted the plywood and is centered over the Onix tubing, pull the trigger and fire the staple.

To maintain good operation of the gun, 3 to 4 drops of pneumatic oil (5-weight, non-detergent machine oil) should be installed once daily during use into the air inlet of the staple gun. More oil drops may be used if the gun sees continuous heavy service, i.e., more than 3–4 hours at a time.

Onix Cautions

1. Examine each Onix circuit after it has been stapled in place. If the Onix has been over-compressed by a staple, remove the staple and apply a new one. The staple can acceptably deform the Onix slightly, 1/16" or less, without causing any difficulties.

2. Do not install Onix, or any other radiant system under floors containing an asphalt paper slip joint between the subfloor and finished floor, as an unpleasant smell may result.

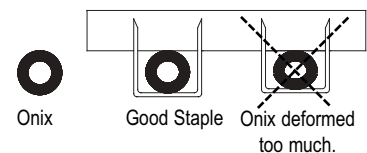
Installation Steps

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 a Staple-Up™ 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.

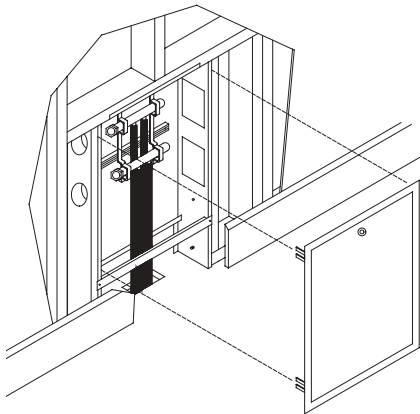
The most common installation pattern used in a Staple-Up™ application is a single serpentine layout. Other layout methods, such as counter flow, can be used, depending on the project requirements.

Step 1: Install Manifolds

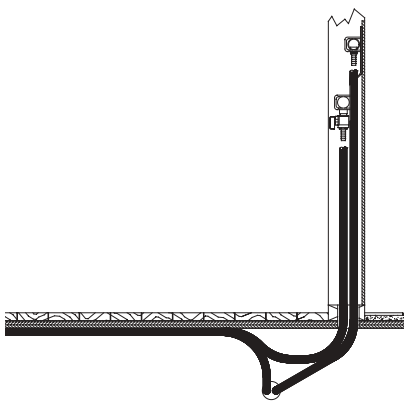
With the use of Watts Radiant's manifold brackets or manifold mounting enclosure, secure the manifolds to the joist or wall enclosure. If the manifolds are located in the wall above the radiant floor, drill holes to transfer Onix through the subfloor and into the joist cavity below. If the manifolds are located in the joist bay, simply attach the manifolds to the side of a joist or install a manifold enclosure horizontally to the joist. Follow local code guidelines when penetrating any framing members.



Staple-Up



Metal Manifold Enclosure located in wall.



Onix routed from Staple-Up to manifold in wall.

Step 2: Determine Zone Boundaries

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

Step 4: Drill Joist

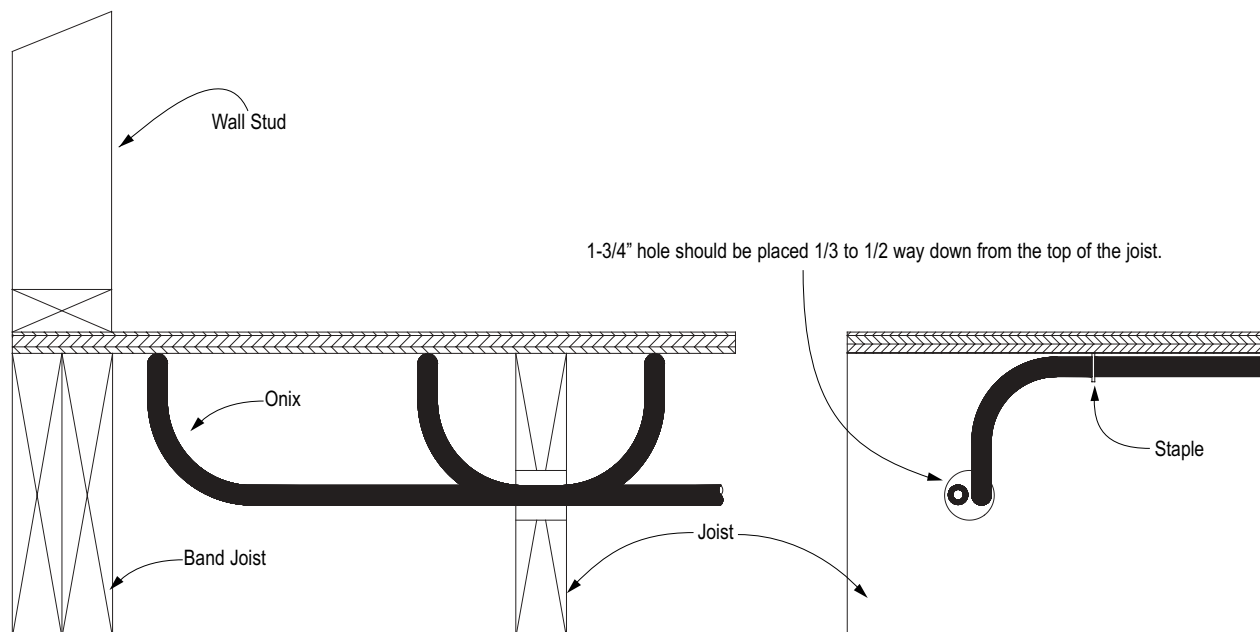
For this step, gather the following tools:

- 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" 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 middle of the joist. Any 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 pulling the Onix much easier.

Step 5: Install the Onix

Place the unwinder underneath the manifold with a coil of Onix placed over the center post and cut the binding straps on the coil. Pull one end of



Onix routed through joist in Staple-Up application.

Staple-Up

the Onix off the unwinder and loosely attach it to the first barb of one of the manifolds. Take a white paint pen, or other marker, and mark this end of Onix with a number 1, indicating the first circuit installed. Do the same to the other end of Onix, marking it with the number 1. This will help later in the installation process.

Do not push the Onix on more than the first barb at this point, just in case the circuit needs to be moved. Pull the free end of the Onix from the unwinder and fold the circuit in the middle to form a loop. Pull the loop (mid point of the circuit) through the series of pre-drilled holes to the last joist bay. Continue to pull the loop down the bay until the loop is 8" from the end.

When looking at the Onix in the first bay, one side will be fixed. This side is the side that is attached to the manifold. Staple this side of the tubing first, then staple the free side. This will allow any excess tubing that may have been pulled to be pushed back over to the next bay. Make sure to staple the Onix every 6"—8" on center. Staples placed farther apart than 8" can cause the Onix to pull away from the subfloor, resulting in a reduction in heat transfer to the subfloor.

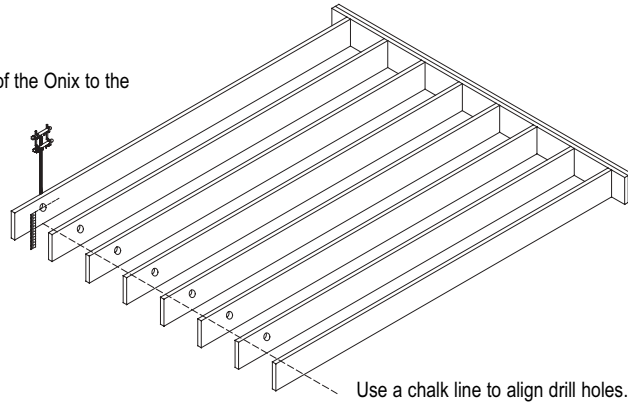
Continue, moving from bay to bay until all of the Onix is used. Stop when the free end of Onix that is still on the unwinder slips off. Take the free end and attach it to the return manifold.

It is always a good idea to connect the circuits to the manifolds in reverse return pattern, i.e. the first water in, is the last water out.

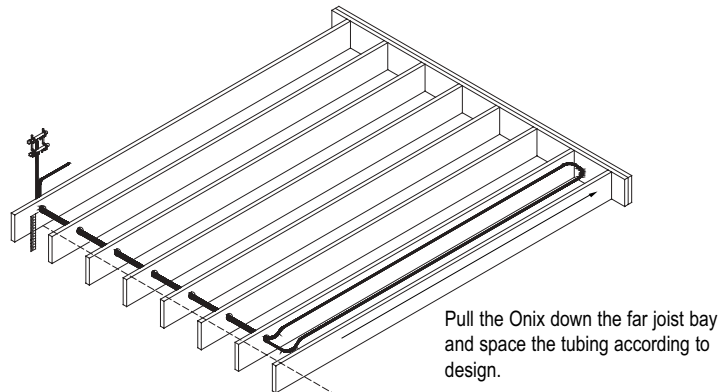
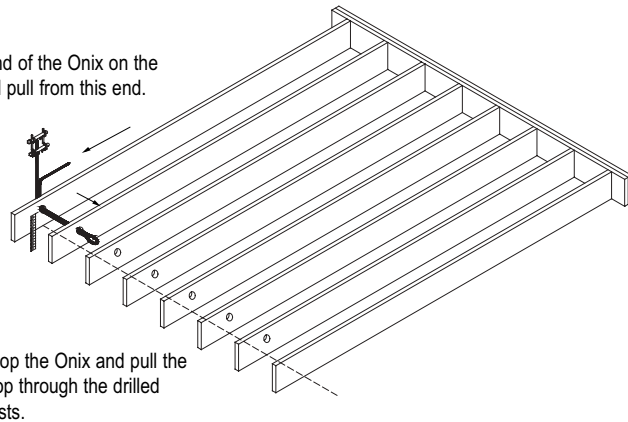
Step 6: Repeat With The Next Circuit

Repeat steps 4 through 6, keeping the new series of joist holes at least 8" away from the first to maintain structural integrity of the joist. Pull the Onix down to the first open bay, gen-

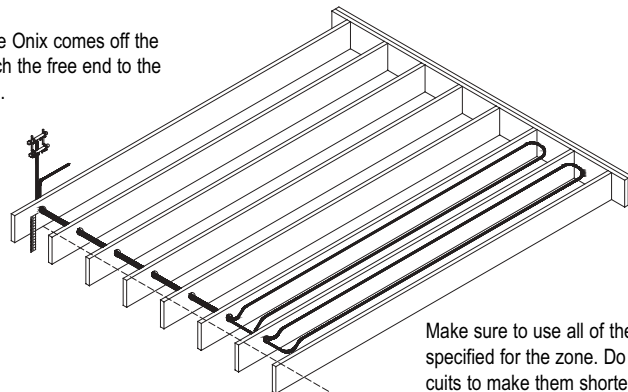
Attach one end of the Onix to the supply manifold.



Leave one end of the Onix on the unwinder and pull from this end.

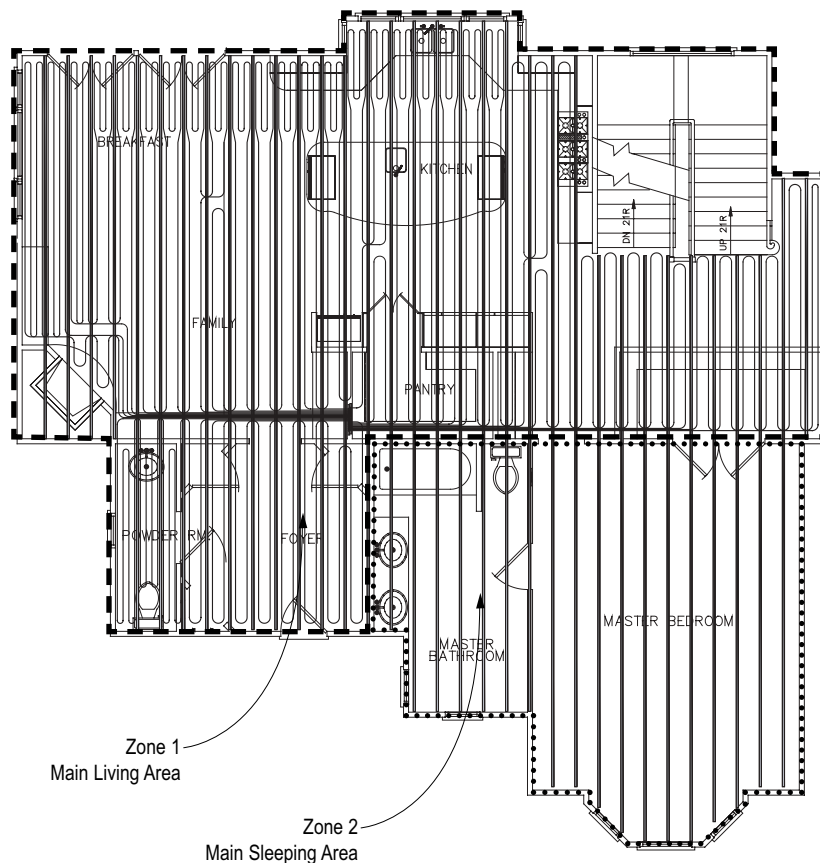


Repeat until the Onix comes off the unwinder. Attach the free end to the return manifold.

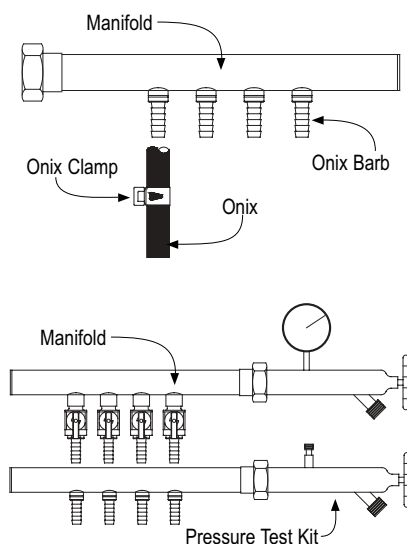


Typical Onix Staple-Up.

Staple-Up



Typical Staple-Up application.



erally next to the partially filled bay left from the last circuit. At the end of this bay, drill one hole to allow access into the partially filled bay. Run the Onix to fill this partial bay and the new bay. Continue as before, filling all subsequent joist bays.

Make sure to use as much of each circuit as possible. If the last circuit is too long, 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 is within 10% of the existing circuits. For example, if 200 ft. lengths were installed, the last circuit can be cut to a length of 180 ft. 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.

Step 7:

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 a damaged area is found, repair it using an approved Watts Radiant Repair Kit. More information on the repair kits can be found in the Appendix.

Step 8:

Final Assembly and Pressure Test

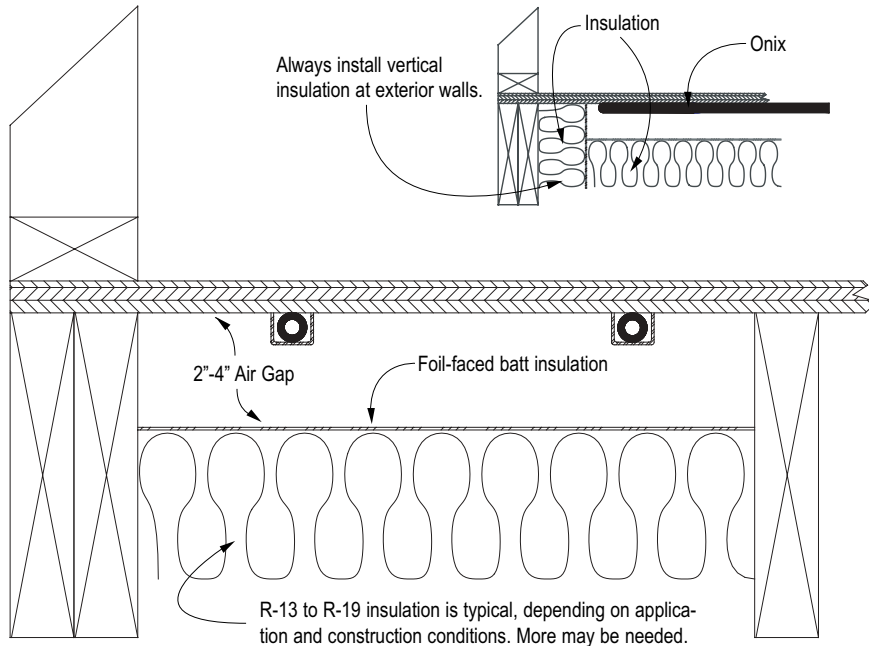
With the zone fully installed and inspected, finish the connections to the manifold. Begin by identifying corresponding ends to the same circuit. If the tubing has not been marked, select two circuit ends and blow through one, with a thumb placed over the other end. Air should be felt on the other side, confirming both ends of the same circuit have been selected.

Take one Onix Clamp and slide it over one end of tubing. Slide the clamp down about 2" from the end and push the Onix onto the first barb of the supply manifold, making sure the tubing covers the entire fitting. If the Onix is difficult to push onto the barb, lubricate the end of the Onix with some water.

Do not use soap, oil, WD-40®, or other petroleum or silicone based lubricants as they may damage the interior of the Onix tubing. Soap or lubricants may make the connects and splices leak, even at low pressures.

Slide the Onix Clamp back over the Onix and barb connection. If using SureClamps, do not over-tighten the clamp. Tighten the Onix Clamp to 25-30 in-lbs. using Watts Radiant's preset torque driver. If a torque driver is not available, tighten the clamp to snug and then one additional quarter turn. More information on how to install Onix Clamps can be found in the Appendix.

WD-40 is a registered trademark of the WD-40 Company.



Caution: DO NOT over tighten the clamps. Over tightening may cause an improper fit.

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 critical factors that can drastically 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 foil-faced 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: you must insulate the exterior band joists 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, but a foil-faced, high temperature board insulation, such as a polyisocyanurate or an extruded polystyrene, may be used. Make sure a proper thickness to R-value board is selected to provide the required minimum 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

As building technologies change, more and more projects are using TJI joists and open web trusses. These specially engineered building joists allow for greater loads and broader spans for larger construction needs. 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.

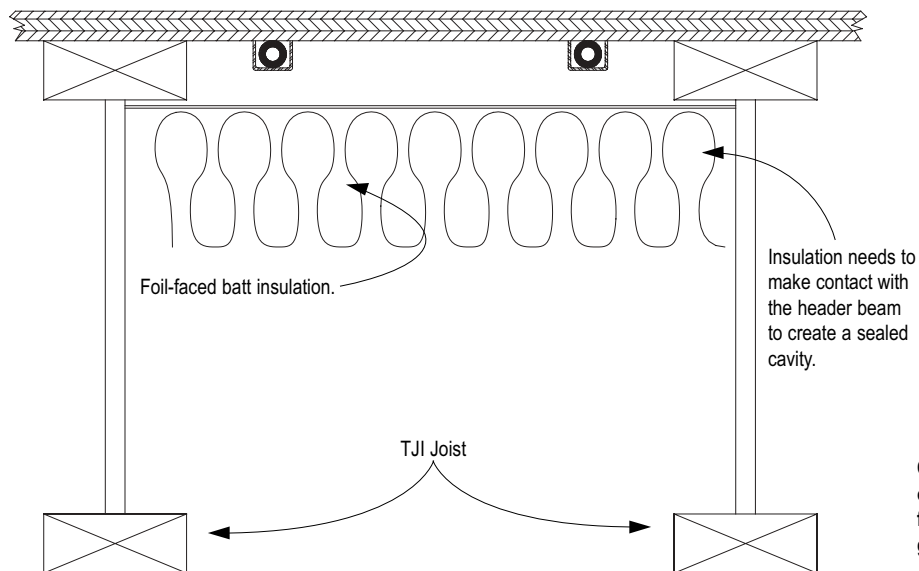
Note: Heat is often lost from a joist bay through holes drilled for plumbing and electrical lines. To prevent this, install foam spray insulation in these holes.

Open Web Trusses

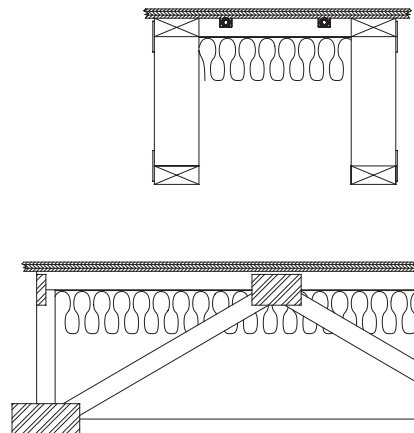
Cross bracing is applied to two main header beams to form a W style profile. This design allows for easy installation of radiant tubing and other components such as electrical and plumbing. However, since a tight joist cavity is desirable, some previously discussed guidelines need to be adjusted.

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.

Staple-Up



Typical TJI (Truss Joist International) cross-section.



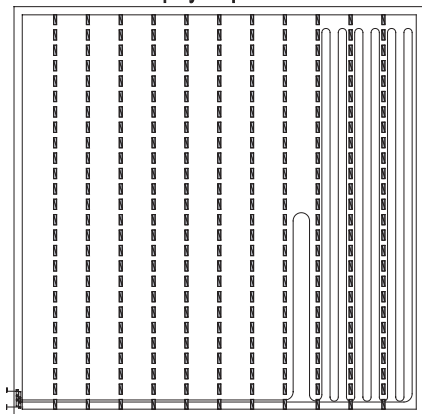
Open Web Trusses offer several advantages on large construction projects. Webb Truss floors can carry heavier loads and can span greater distances.

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 main-

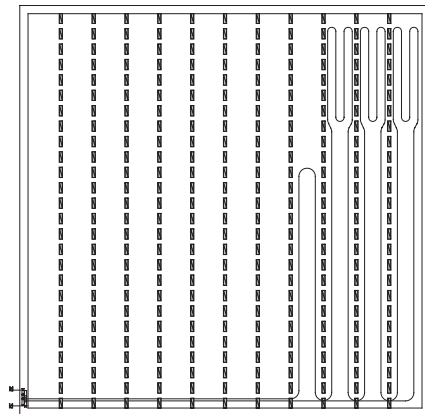
tained. It still remains critical that the insulation does not touch the radiant tubing.

Layout Examples

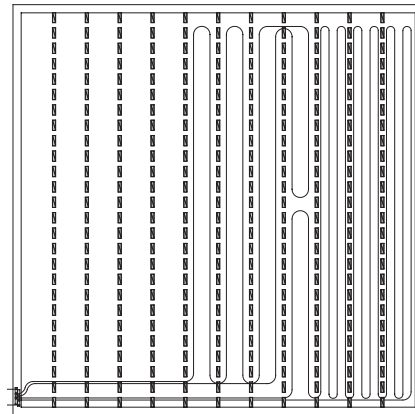
Frame Floor: Step by Step



This illustration shows a serpentine layout with a banded area running parallel to the exposed wall. The banded area is spaced at 4" o.c.



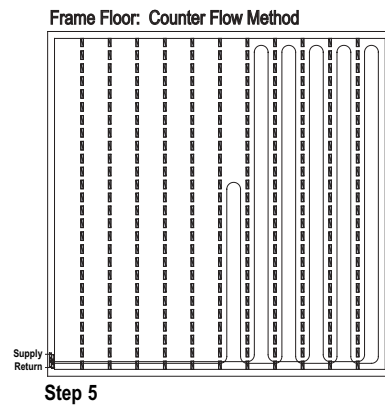
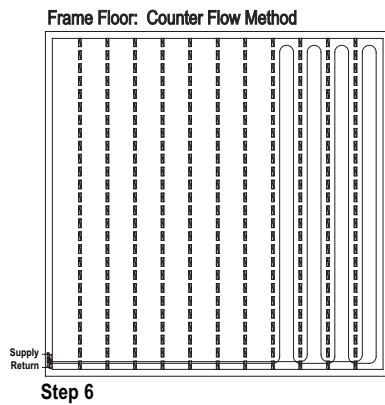
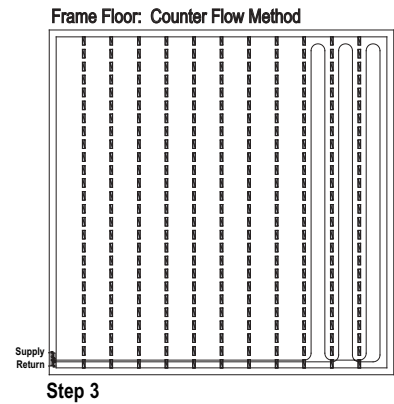
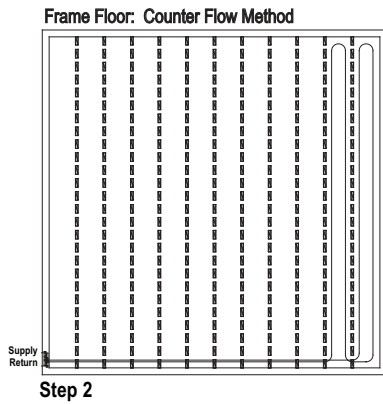
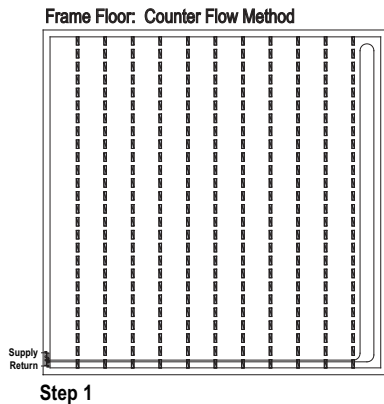
This illustration shows a serpentine layout with a banded area running perpendicular to the exposed wall. The banded area is spaced at 4" oc.



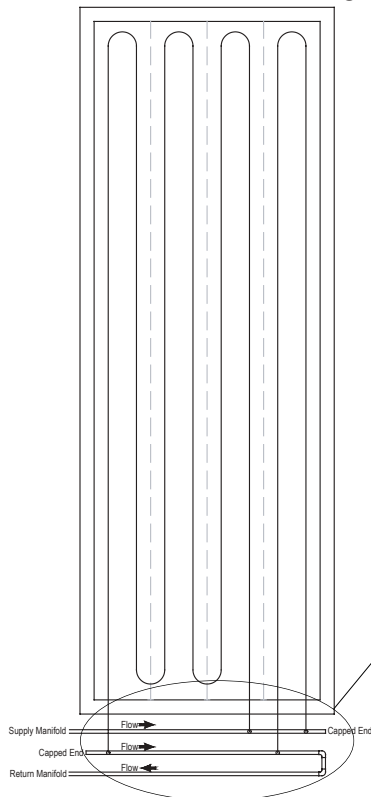
This illustration shows how to "pick up" a bay when the previous circuit terminates mid-run. The second circuit loops back down the open bay from the far end. The remainder of the circuit is installed in the same fashion as the first circuit.

Staple-Up

Layout Examples

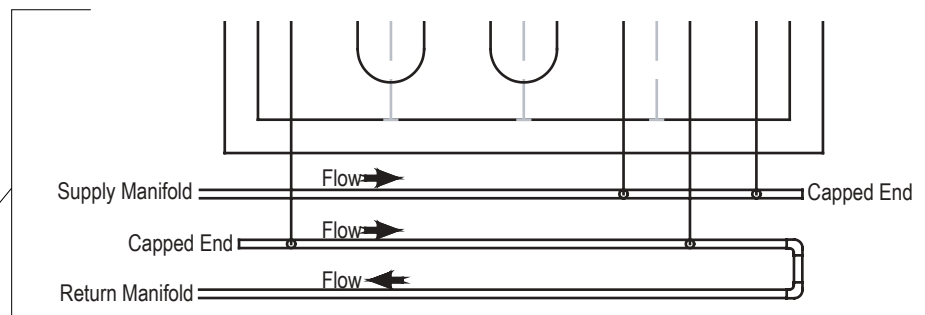


Frame Floor: Long Manifold



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.

For more information on long manifolds and other manifold options, refer to the Appendix.



Sandwich

Sandwich Application



Sandwich applications mimic Staple-Up™ in almost every way except one. In a Sandwich application, the Onix tubing is placed on top of the subfloor instead of beneath. Sleepers are installed every 8" or 16" on center, depending on the floor construction and floor covering requirements. 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.

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. For similar Sandwich installation techniques, refer to Watts Radiant's SubRay™ installation manual.

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

2. Onix tubing and Watts Radiant Clamps.

Each Onix TorqueTite™ requires an in.-lb. torque wrench for attachment, while the SelfTite™ clamps need a pair of SqueezeTite™ Pliers. See manifold assembly section for more details. The number of Onix coils on the jobsite should correspond to the number listed in the Zone List report.

3. Manifold.

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 Onix coil without kinks and twist.

5. Field Repair Kit.

Each kit contains two barb-by-barb splices and four Onix Clamps.

6. Manifold Mounting Bracket.

Each bracket is used to temporarily or permanently mount each manifold pair to the floor or wall.

7. Watts Radiant staple gun, staples and NailTites.

8. Pressure test kit.

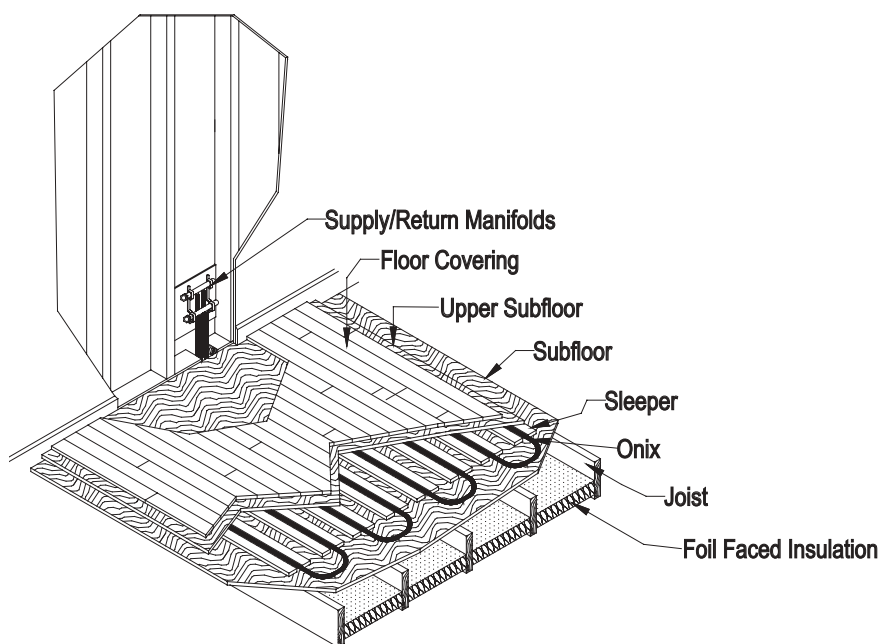
Each manifold pair must be pressure tested. This helps ensure each Onix connection has been assembled correctly and that no damage has been done to the tubing during installation.

9. Chalk line.

Fasteners

One advantage Onix has over other tubing options is its natural tendency to remain where it is placed. If some added support is needed, such as around bends or tight corners, regular duct tape can be used to secure the Onix. In some cases, a quick setting adhesive, such as Liquid Nails™ can be used.

DO NOT use the Watts Radiant staple gun with an Onix sandwich application. The staples will become the high point, preventing the Onix from



Sandwich application over frame floor.

Sandwich

contacting the subfloor. This will reduce the heat transfer potential of the system.

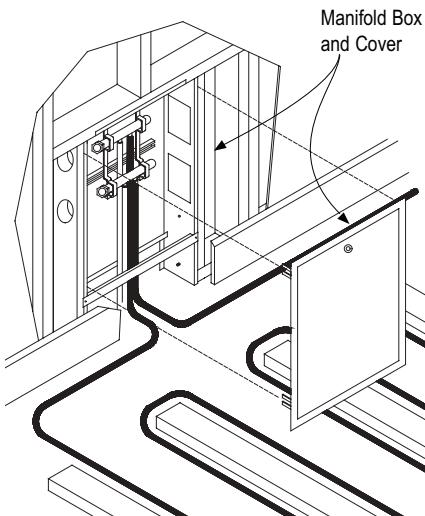
Installation Steps

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.

The most common tube layout pattern is a single serpentine, although in some cases a double serpentine may be used.

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 Onix 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

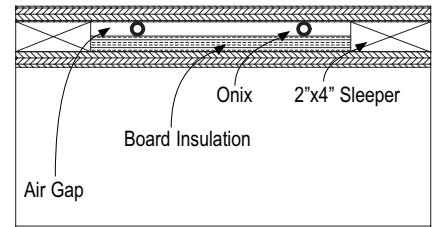
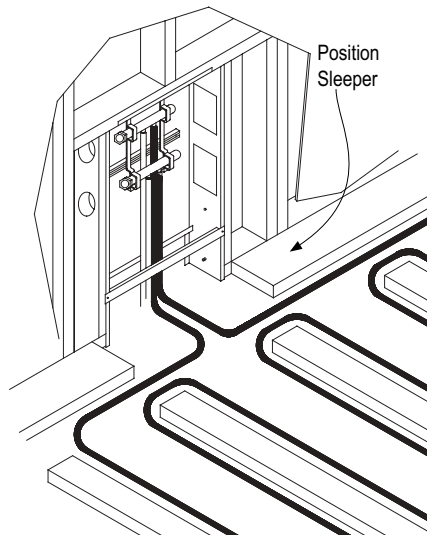
Before Onix is installed, visually inspect the area to determine the zone boundaries. This helps determine where the first circuit is to be placed, while identifying any obstacles that may be in the way.

Step 3: Confirm Tubing Requirements

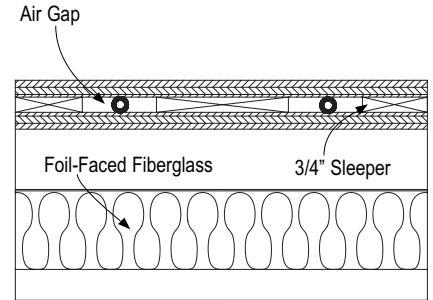
Measure the distance from the manifolds to the farthest point in the zone. The minimum Onix circuit must be at least twice this distance. If not, the Onix will not be long enough to reach the farthest point and be able to return to the manifold.

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 3/4" sleeper should be used with 3/8" Onix. If the system is to be insulated on top



Joist side view showing Sandwich application using rigid foil-faced polyisocyanurate insulation.



Joist side view showing Sandwich application using foil-faced batt insulation.

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" space for the Onix. Most systems insulated on top of the subfloor need a 2 x 4 sleeper with a 3/4" insulation board.

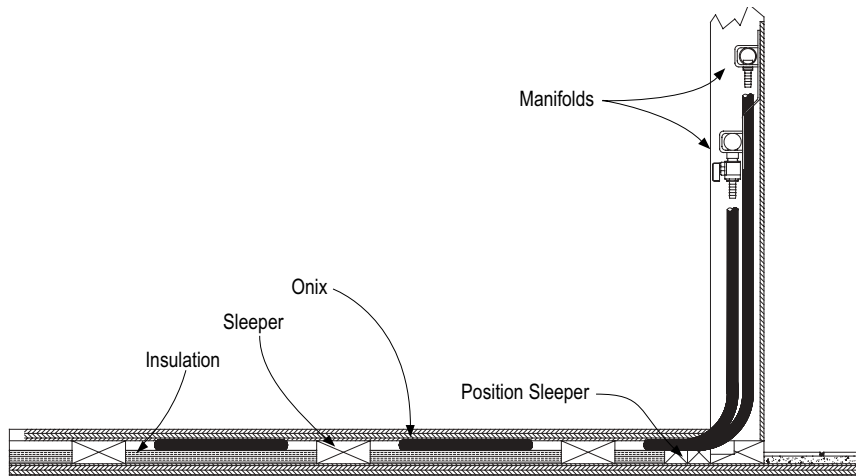
Note: For best heat transfer, Onix should be touching the upper sub-floor.

Place a position sleeper around the zone and all interior walls. This position sleeper will help keep the Onix away from exterior and interior wall construction. This is important to help prevent damage to the tubing that may be caused by wall placement or floor covering installation, such as carpet strips or other anchor points.

If insulating below the floor in the joist cavity, sleepers are usually 6"—7" wide, leaving a 1"—2" gap between sleepers.

If insulating between the sleepers, sleepers are usually a standard 2 x 4 leaving a 14"—16" gap between sleepers. This spacing is based on a standard 3/4" subfloor being applied on

Sandwich



top. If a thinner subfloor is to be used, a tighter sleeper spacing will be required. This is usually done by adding a sleeper between each run of Onix.

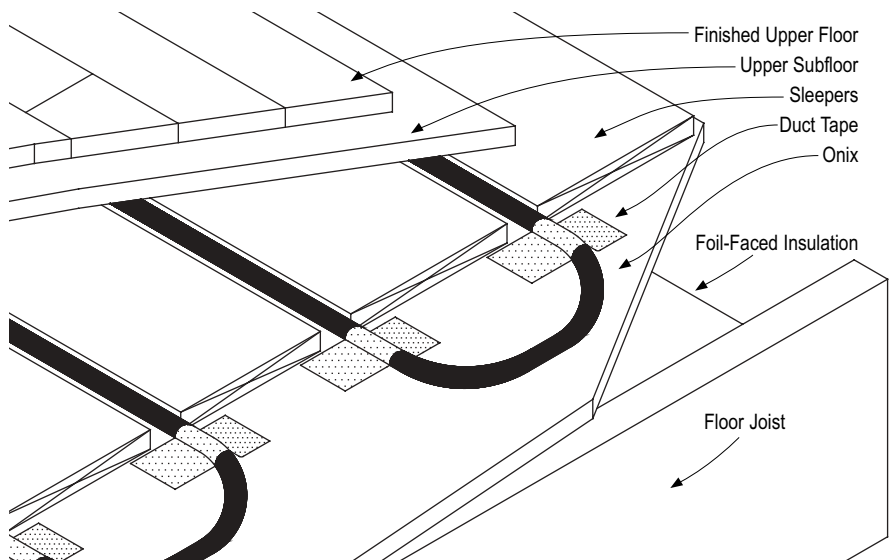
Whenever possible, run the sleepers perpendicular to the joist direction. This will help add stability and stiffness to the floor.

Step 5: Install the Onix

Place the unwinder underneath the manifold with a coil of Onix placed over the center post and cut the binding straps on the coil. Pull one end of the Onix off the unwinder and loosely attach it to the first barb of one of the manifolds. Take a white paint pen, or other marker, and mark this end of Onix with a number 1, indicating the first circuit installed. Do the same to the other end of Onix, marking it with the number 1. This will help later in the installation process.

Do not push the Onix on more than the first barb at this point, just in case the circuit needs to be removed.

Pull the free end of Onix from the unwinder and begin placing it along the position sleeper to the far end of the room/zone. Alternate sleepers in between Onix runs. It is generally easier to install full sleeper lengths and then cut transition points in a sleeper run with a circular saw.



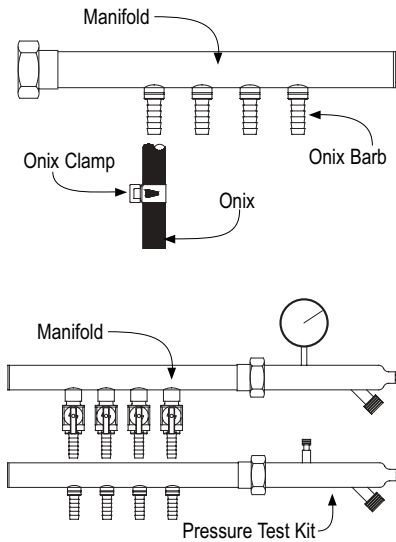
Step 6: Secure the Onix

Most sandwich applications do not require any special fasteners to secure the Onix in place. However, there may be times when added support is necessary, such as around tight bends or if the tubing has to follow a defined path, such as around a corner. In these cases, duct tape can be used to hold the tubing in place. Staples or other fasteners are not recommended for Sandwich applications with Onix. The staples will prevent direct contact with the new subfloor and will reduce the heat transfer capabilities of the system.

Step 7: Repeat With The Next Circuit

Repeat steps 4 through 6, keeping the new series of sleepers spaced according to the required tubing 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.

Make sure to use as much of each circuit as possible. 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 as long as the remaining length is within 10% of the existing circuits. For example, if 200 ft. lengths were installed, the last circuit can be cut to a length of 180 ft. 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.

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 Repair Kit. More information on the repair kits can be found in the Appendix.

Step 9: Final Assembly and Pressure Test

With the zone fully installed and inspected, finish the connections to the manifold. Begin by identifying corresponding ends to the same circuit. If the tubing has not been marked, select 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 a single circuit have been selected.

Take one Onix Clamp and slide it over one end of tubing. Slide the clamp down about 2" from the end and push the Onix onto the first barb of the supply manifold, making sure the tubing covers the entire fitting. If the Onix is difficult to push onto the barb, lubricate the end of the Onix with some water.

Do not use soap, oil, WD-40®, or other petroleum or silicone based lubricants as they may damage the interior of the Onix tubing. Soap and lubricants may make connections and splices leak, even at low pressures.

Slide the Onix Clamp back over the Onix and barb connection. If using

TorqueTite clamps, do not over-tighten them. Tighten the clamp using a preset in.-lb. torque driver. More information on how to install Onix Clamps can be found in the Appendix.

Caution: DO NOT over tighten the clamps. Over tightening may cause an improper fit.

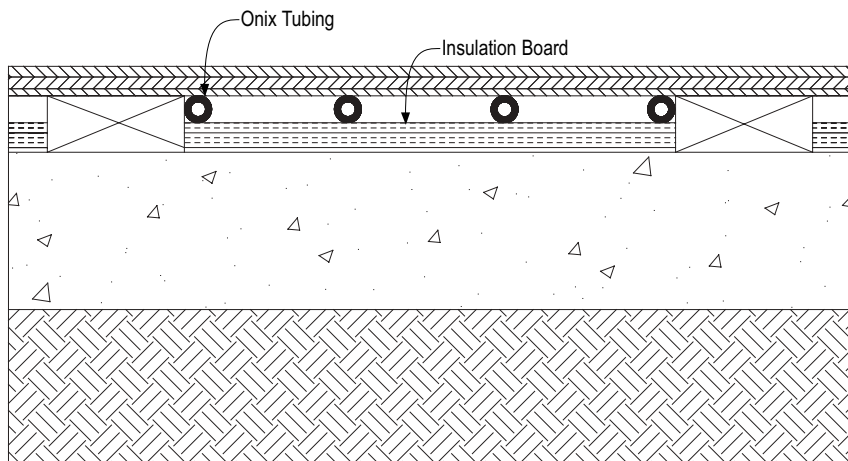
For detailed information on the proper steps to conducting a pressure test, refer to the Appendix.

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 on the sides of the tubing, not below the tubing. If the system is to be insulated 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 a Staple Up™ application. The insulation should be a minimum of 3-1/2", or R-13, foil-faced 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



The same techniques are used when installing a Sandwich application over a slab. The use of an extruded polystyrene (Dow® Blue Board®) is recommended for this application.

Sandwich

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.

In the case of a Sandwich over Slab application, especially a basement remodel, a non foil-faced 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 sea-

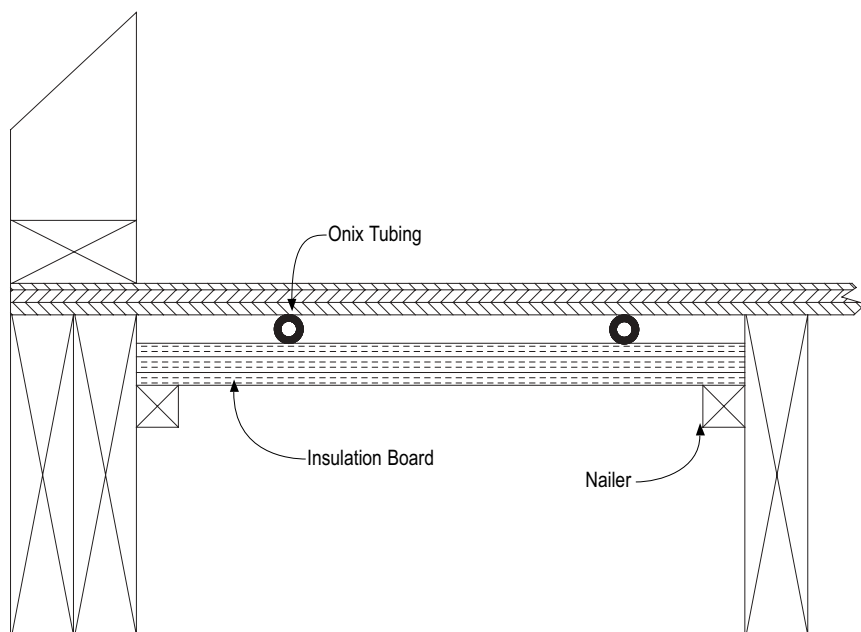
sonal water table levels. An extruded polystyrene board will withstand moisture conditions better than a polyisocyanurate.

Other Frame Floor Techniques

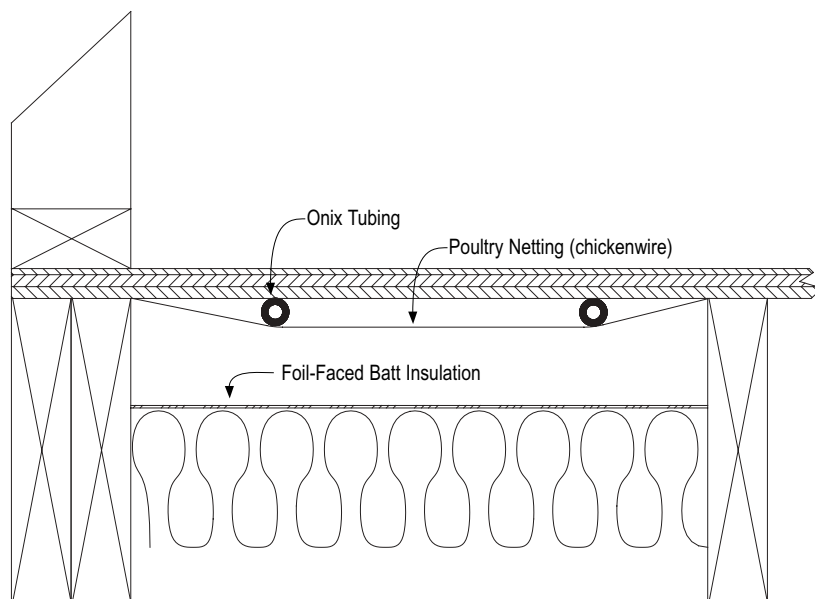
Occasionally construction details prevent tubing from being installed either from underneath via a Staple-Up or from on top with the use of a Sandwich. In these conditions, a

recessed floor approach can be used. This type of application mimics a staple up in every way except how the tubing is secured. The following examples require the original subfloor to be removed, leaving exposed joists in the area.

Insulate the joist cavity first, then install the corresponding support system. It is important to install the support system in such a way that when the subfloor is replaced, contact with the Onix is maintained, but not too much to cause the tubing to flatten. Likewise, renovation projects tend to pose a problem in basements where a concrete floor is already in place. In this situation, a sandwich over slab application is used. This application is installed in the same manner as a sandwich over a frame floor.



Insulation board is used to support the Onix tubing and to provide a thermal break to the floor below. Onix must be in direct contact with the underside of the subfloor.



Poultry netting (chickenwire) is used to support the Onix. A foil-faced batt insulation is used below the Onix with a two inch air gap, foil facing upwards.

Walls and Ceilings

Walls and Ceilings

Radiant floors produce a limited amount of energy, usually around 45–50 BTU/sq.ft. This limit is set by the maximum floor surface temperature of 85°F. Most of the time this will be seen in areas like sunrooms. In cases like this where auxiliary heat is required, supplemental heat may be added in the form of baseboards or fan coils.

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

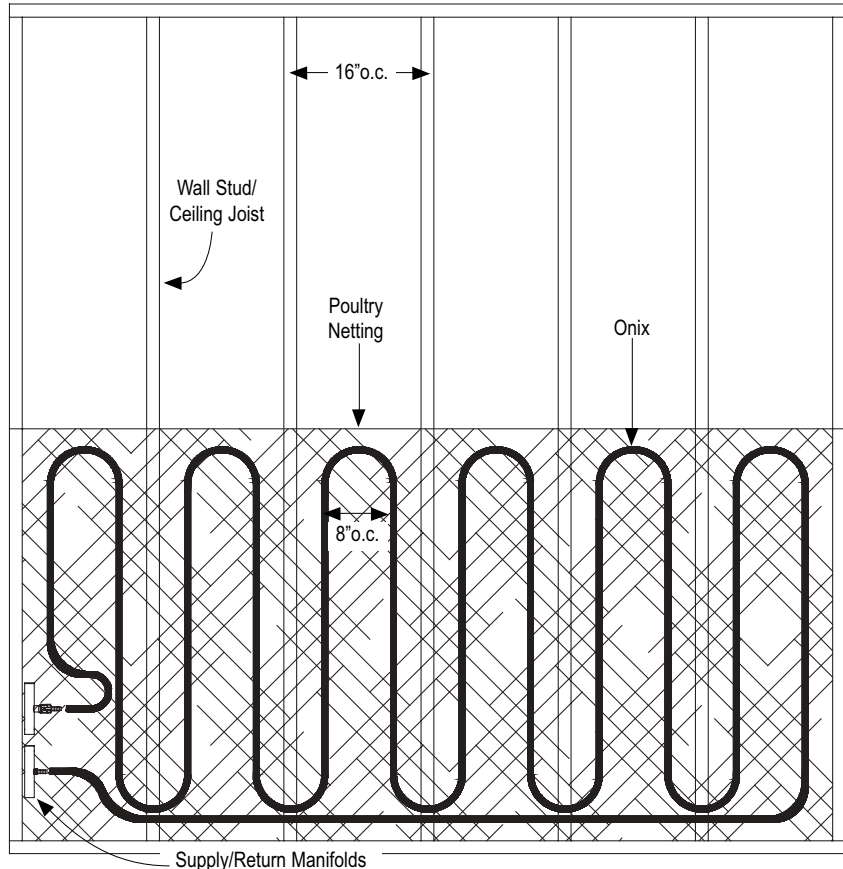
Tubing can be installed in an interior wall or ceiling to increase the radiant surface area for a given room.

Walls and ceiling panels may also be used in cases where installation prohibits 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 for further details.

Caution: In all wall or ceiling applications, Onix must be installed so it is in contact with the wall or ceiling.



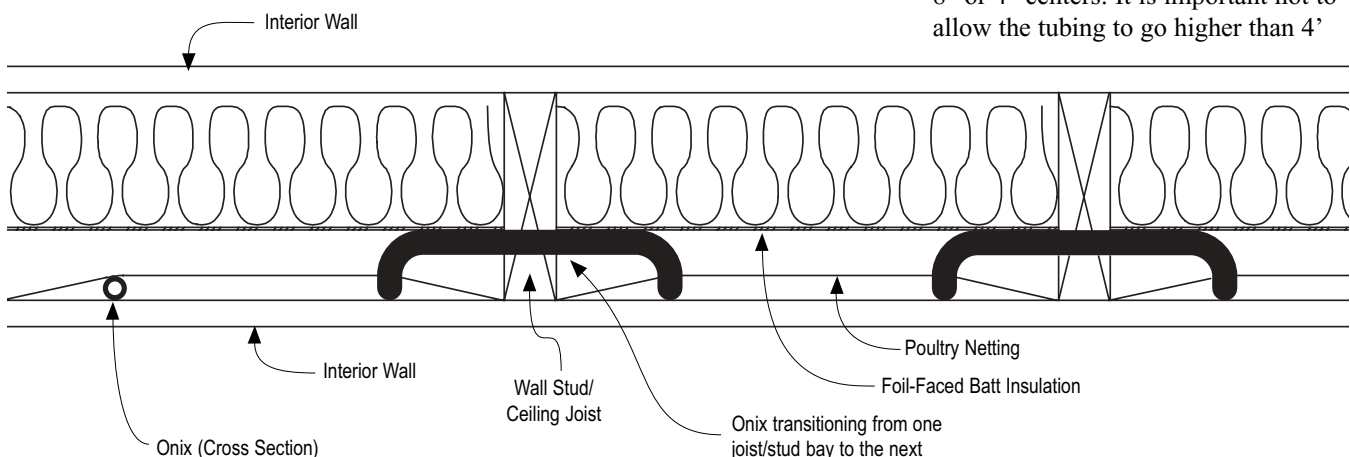
Typical wall or ceiling application using poultry netting (chicken wire).

Poultry Netting

Poultry Netting (chicken wire) can be used to support the Onix in the wall cavity. Only install a radiant system in an interior wall. Exterior walls can have potentially higher back and edge losses and will increase the risk of freezing in the case of a power failure.

Foil-faced insulation should be installed first with the foil facing the tubing. Poultry netting is then installed over the joists with just enough slack to allow the wire some movement back into the wall cavity.

Onix is attached to the netting with the use of cable ties and spaced either on 8" or 4" centers. It is important not to allow the tubing to go higher than 4'



Cross section of a wall or ceiling application using poultry netting (chicken wire).

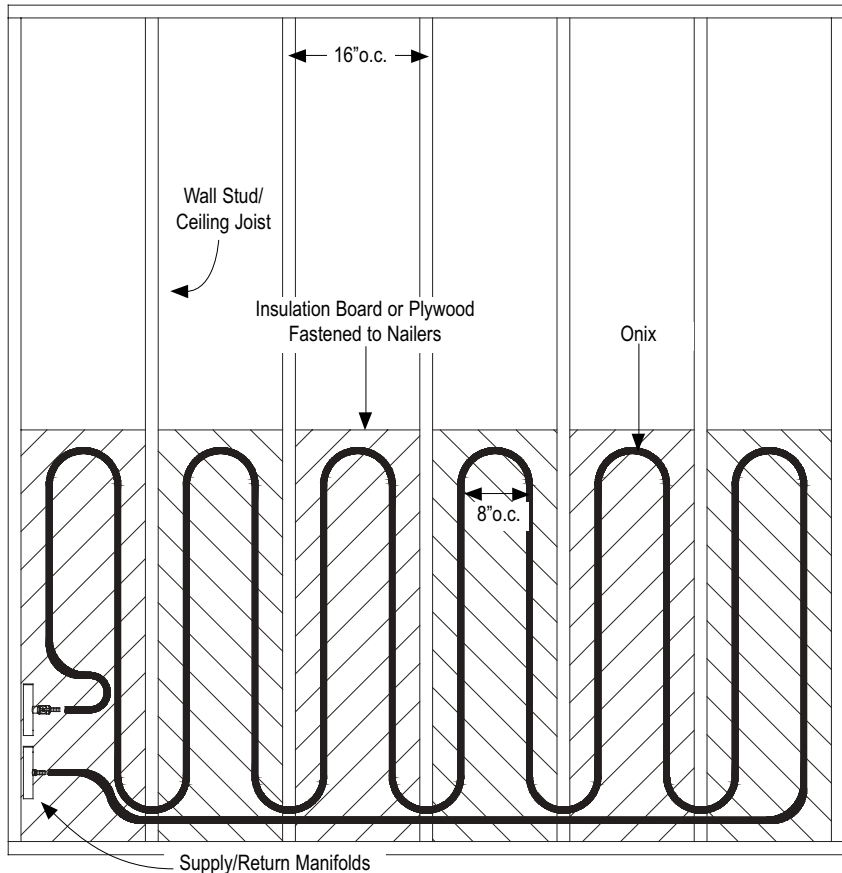
Walls and Ceilings

off the floor. Tubing higher than this is subject to damage from nails as pictures and other objects are hung on the walls.

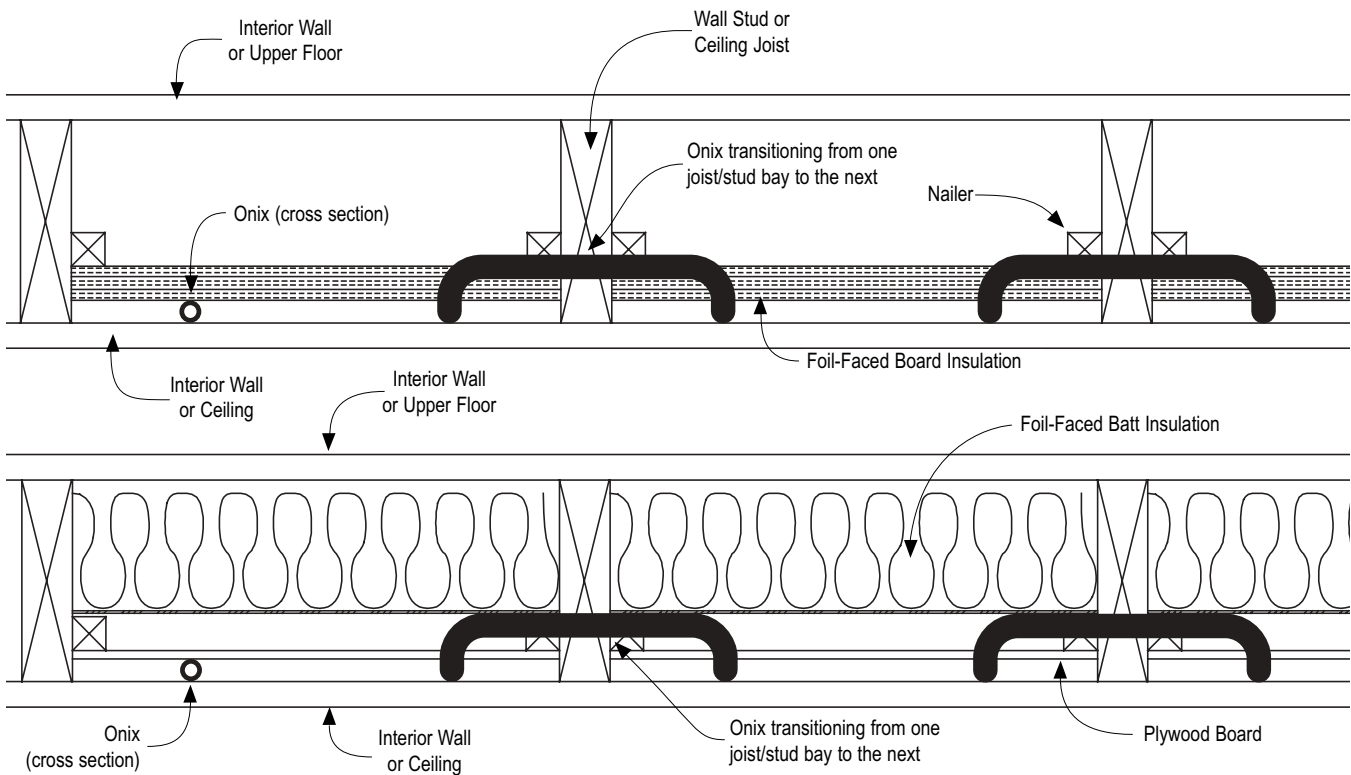
Walls are typically installed with their own manifold pairs as it tends to be difficult to transition tubing from the floor to the wall. Also, this allows for greater ease when trying to balance a system. In most cases, the wall will use less tubing and typically shorter tubing lengths than can be installed in the floor or ceiling.

Recessed Wall

Another 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 a 1/4" plywood. Both will be supported by runners attached to the sides of the studs or rafters.



Typical wall or ceiling application using a recessed insulation or plywood board.



Cross sections of a wall or ceiling application using a recessed insulation or plywood board.

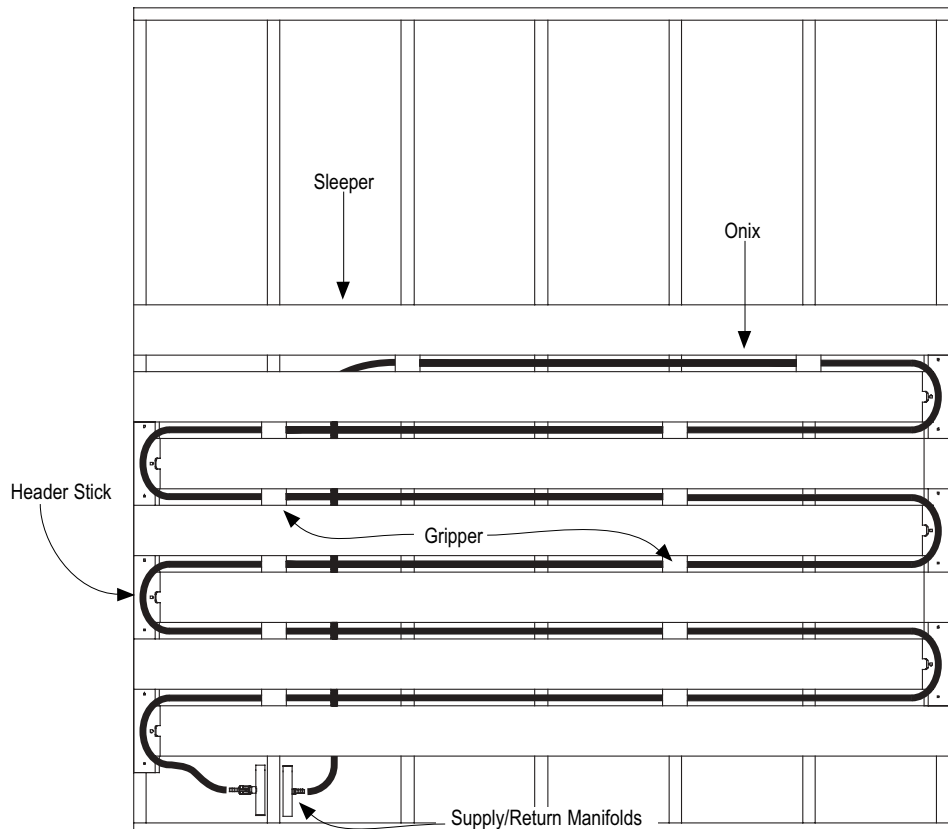
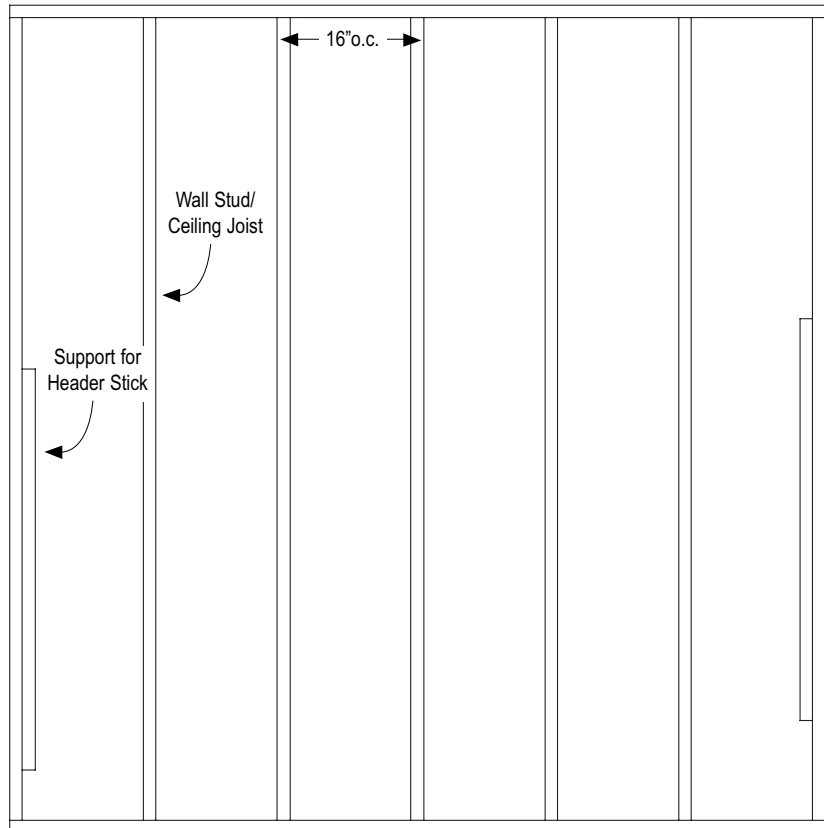
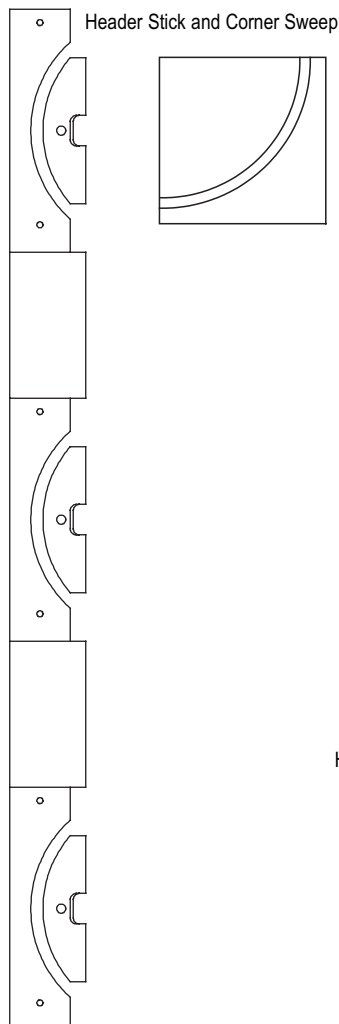
Walls and Ceilings

If a plywood drop board is used, a foil-faced insulation needs to be install behind the plywood.

SubRay[®]

In some cases, the wall or ceiling cavity may not be deep enough to allow for the Onix, insulation and support material. In these cases, Watts Radiant SubRay 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 18 mm SubRay product to accommodate the 3/8" Onix tubing.



Walls and Ceilings

SubRay Sleepers are installed across the studs or joists with Grippers installed every fourth stud or joist to keep the Onix in place.

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

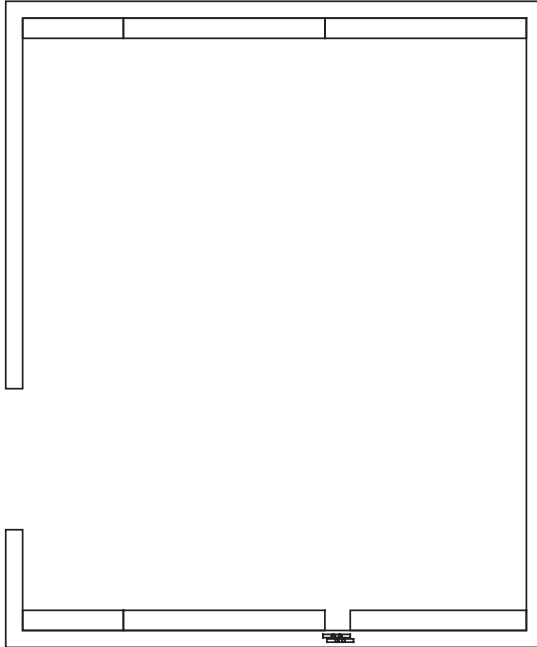
Refer to the SubRay Installation Manual for more product and installation information.

Caution

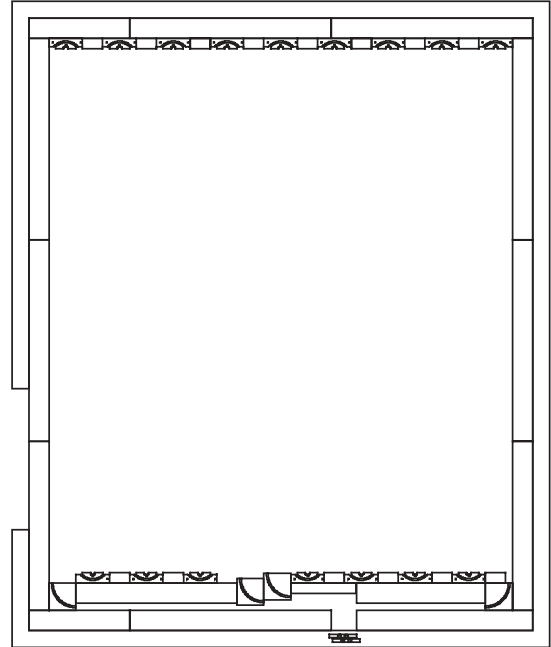
One limitation to walls and ceilings is the maximum allowable temperature the dry-wall can maintain. According to the National Gypsum Company, the

maximum operating temperature for wallboard and ceiling board is 125°F. Due to this limitation it is advised not to allow supply fluid temperatures to exceed 120°F. From a design perspective, it is advised not to allow the surface temperature to exceed 90°F.

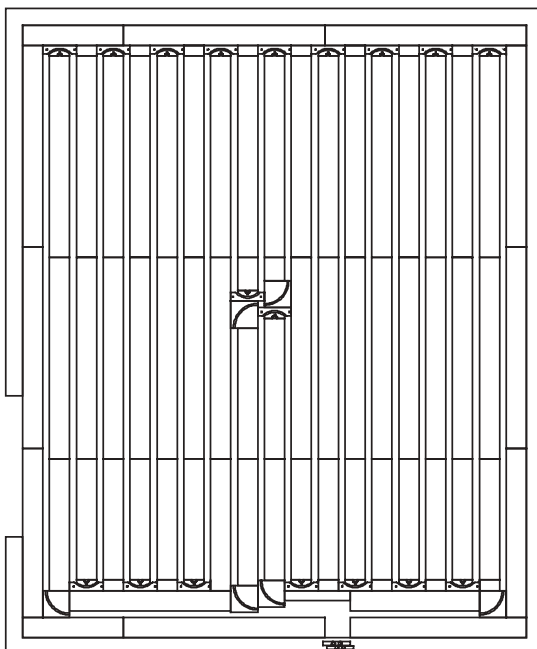
If a different wall material is to be used, consult that product's manufacturer for specific temperature limits.



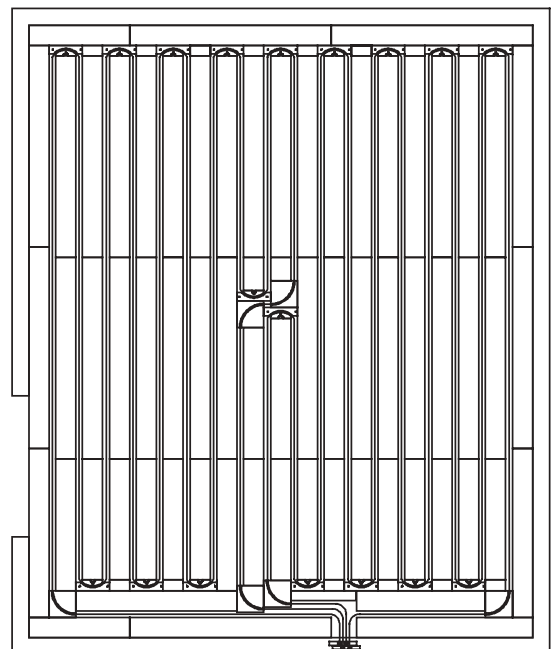
Step 1: Locate Manifolds in ceiling area



Step 2: Install Header Sticks



Step 3: Install Sleepers and bend supports



Step 4: Install Onix

Concrete Slab

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. Sub-surface water will rob heat from a

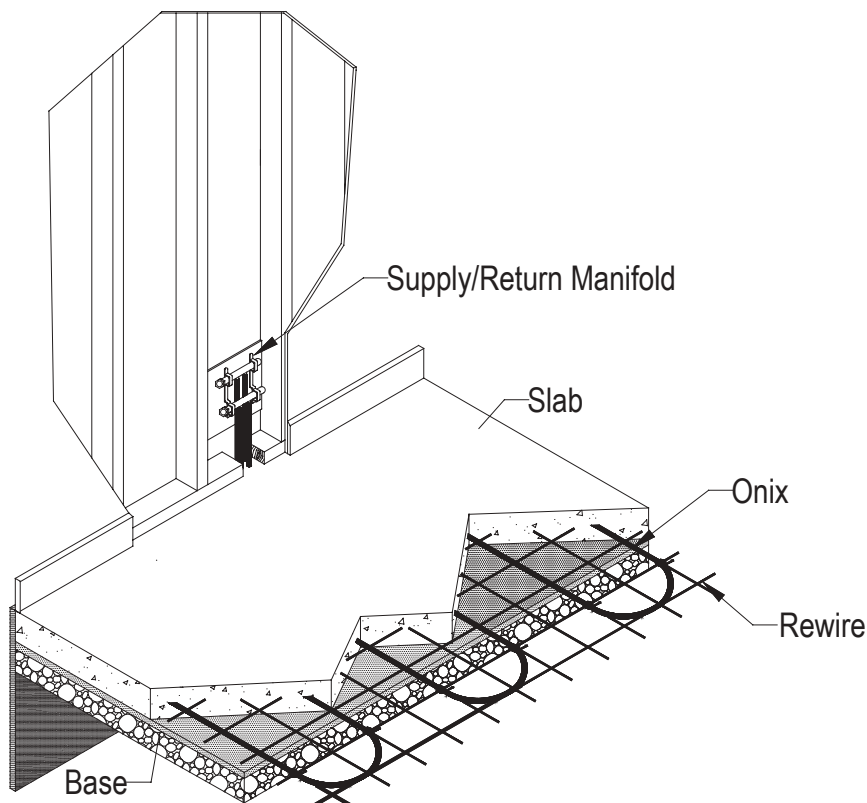
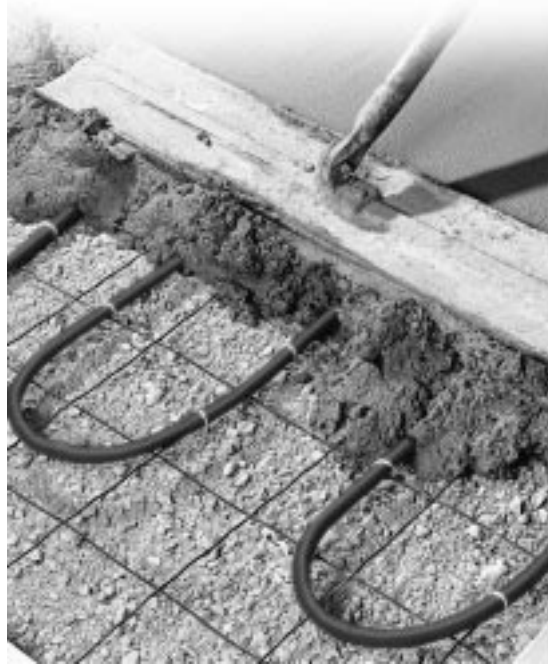
radiant slab faster than a boiler can produce it. Basements and slabs installed in hillsides should have good drainage to carry any subsurface groundwater away from the site. The slab should be placed above an ample amount of crushed rock or gravel.

Radiant slabs placed on low-lying, poorly drained soil or sand should have at least one inch of extruded polystyrene (Dow® Blue Board®) insulation under the entire slab - even in southern climates.

A radiant slab should never be placed directly on top of clay or organic sub-soil, 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 used.

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 one to two inches 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.



Insulated Slab on Grade.

Concrete Slab

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 slab's required start up time by isolating the heating mass from the ground mass below. Typically the system will see a reduction of about 10% in overall operational efficiency if a horizontal 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 poly-

styrene 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. Always check with an architect or structural engineer to ensure the appropriate insulation is used.

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 support structures still have to be installed, 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

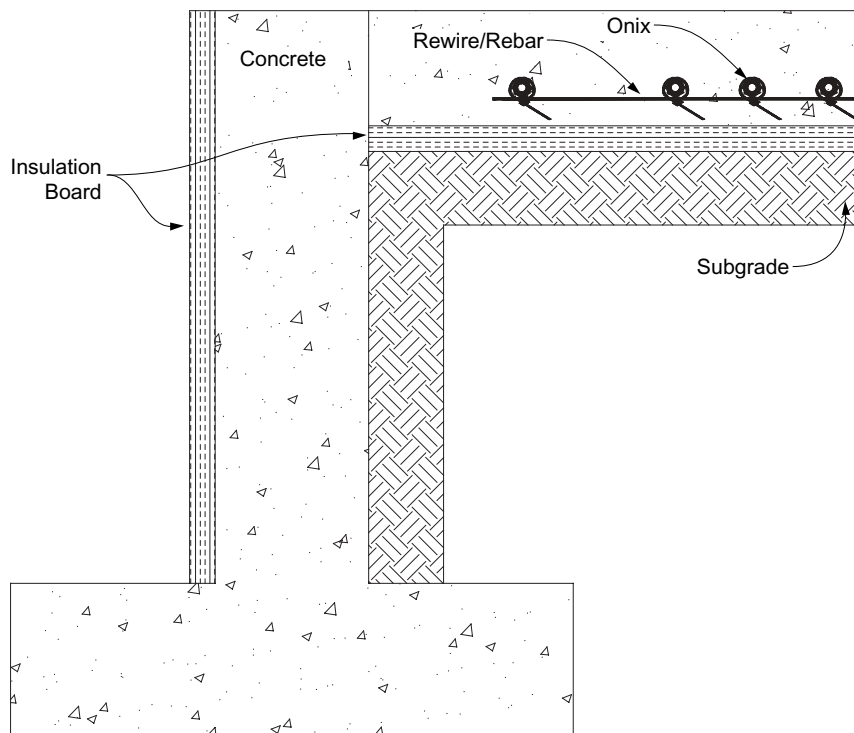
Concrete slabs will expand and contract due to thermal changes. To prevent damage to the slab, expansion joints are used to control this movement. In some cases cut joints are used to control where cracking is to occur. Make sure the tubing is protected according to the requirements of the control joint.

Design Parameters

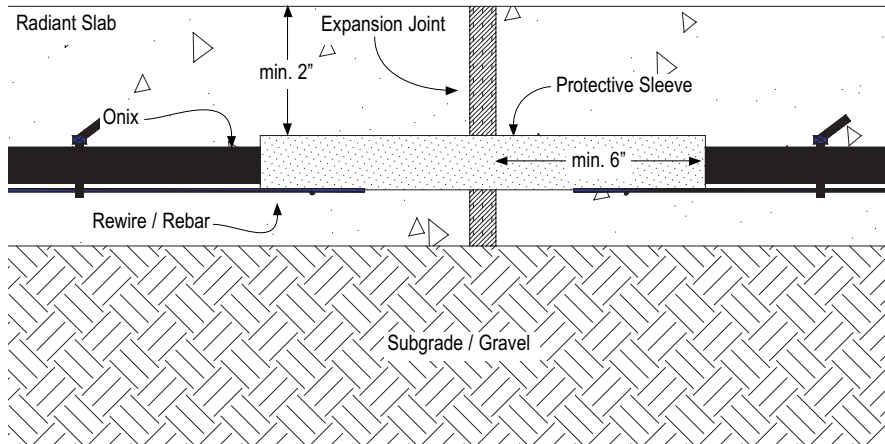
For proper radiant design it is important to know the type of layers used in the floor construction. As these layers increase or change, variances in the heating system are required. Concrete is a very conductive material, allowing for a wider spread in heat transfer throughout the mass. However, certain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

Onix Spacing

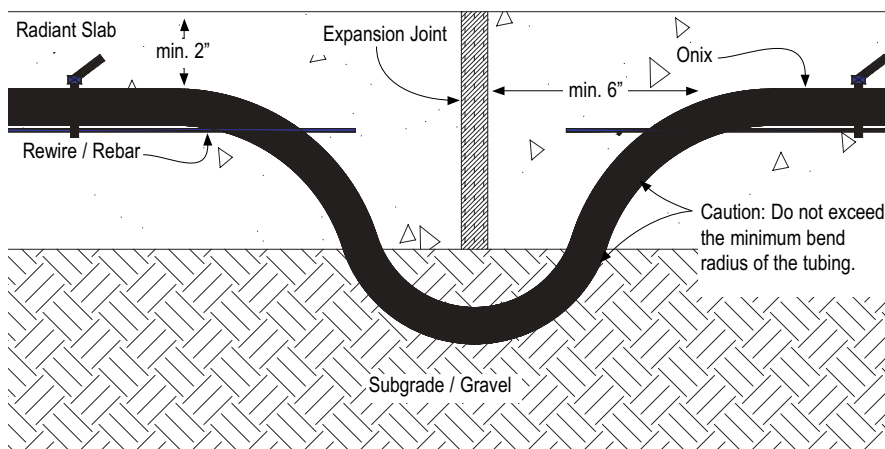
Most residential slabs will use 12" tube spacing with some perimeter banding. In a few cases, where control over supply fluid temperature is needed, an entire room may be installed at 6" on center. This may be the case in a high heat loss sunroom or pool area.



Concrete Slab



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



Onix routed below expansion joint into subgrade.

For certain industrial or commercial projects the spacing may be greater.

Onix is generally installed on either rewire/rebar for concrete slab 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" o.c. spacing is sometimes preferred in bathrooms, kitchens and entries. Closer tube spacing, up to 6 inches on center, 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

Four, five or six inch Onix spacing is frequently used along outside exposed perimeter walls. 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 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. Most banded widths will be 4 ft. wide or half a standard wall height.

For example, in a home with 12" spacing in the main floor area, a 6' 8" patio door would have radiant tubing on 6" centers a minimum of 40"—48" in front of the door.

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.

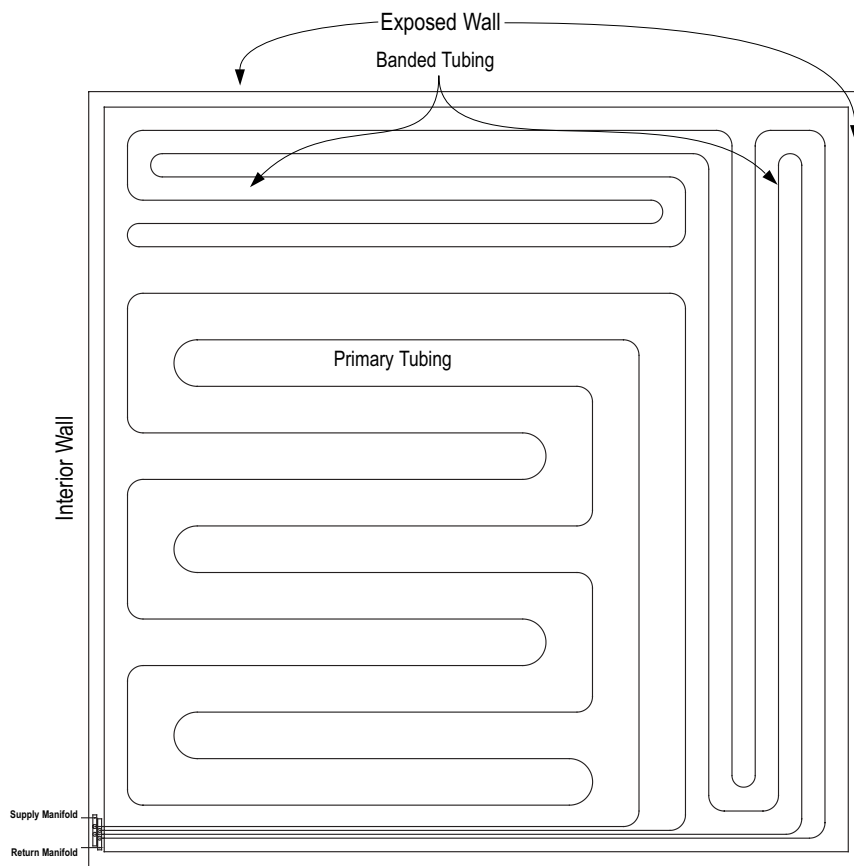
1. RadiantWorks Reports.

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

2. Onix tubing and corresponding Onix Clamps.

Each Onix TorqueTite clamp will require an in.-lb. torque wrench for installation, while the SelfTite clamps need a pair of SqueezeTite Pliers. See manifold assembly section for more details. The number of Onix coils on the jobsite should correspond to the number listed in the Zone List report.

Concrete Slab



Typical slab tubing layout.

3. Manifold.

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

4. Unwinder.

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

5. Field Repair Kit.

Each kit will contain two barb-by-barb splices and four Onix Clamps.

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 staple gun, staples and NailTites.

8. Pressure test kit.

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

9. Installation Accessories

- 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.
- Cable Ties, ClipTies®, ScrewClips™ or other fasteners.

Since rewire/rebar is commonly used in concrete slabs for structural integrity, it is common practice to attach Onix to the rewire/rebar. This is com-

monly done with the use of nylon cable ties or Watts Radiant ClipTies and Clipper tool. Each secures the Onix 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, some additional attachment devices can be used to secure the Onix. Watts Radiant's Foam Staples or Foam Clips can be used to secure the Onix tubing directly to the insulation board. Standard Onix 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" to 18" on center. This will prevent the Onix from shifting during the concrete pour. (See Watts Radiant catalog or binder for more information on fasteners and tools.)

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.

Concrete Slab

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 examples 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.

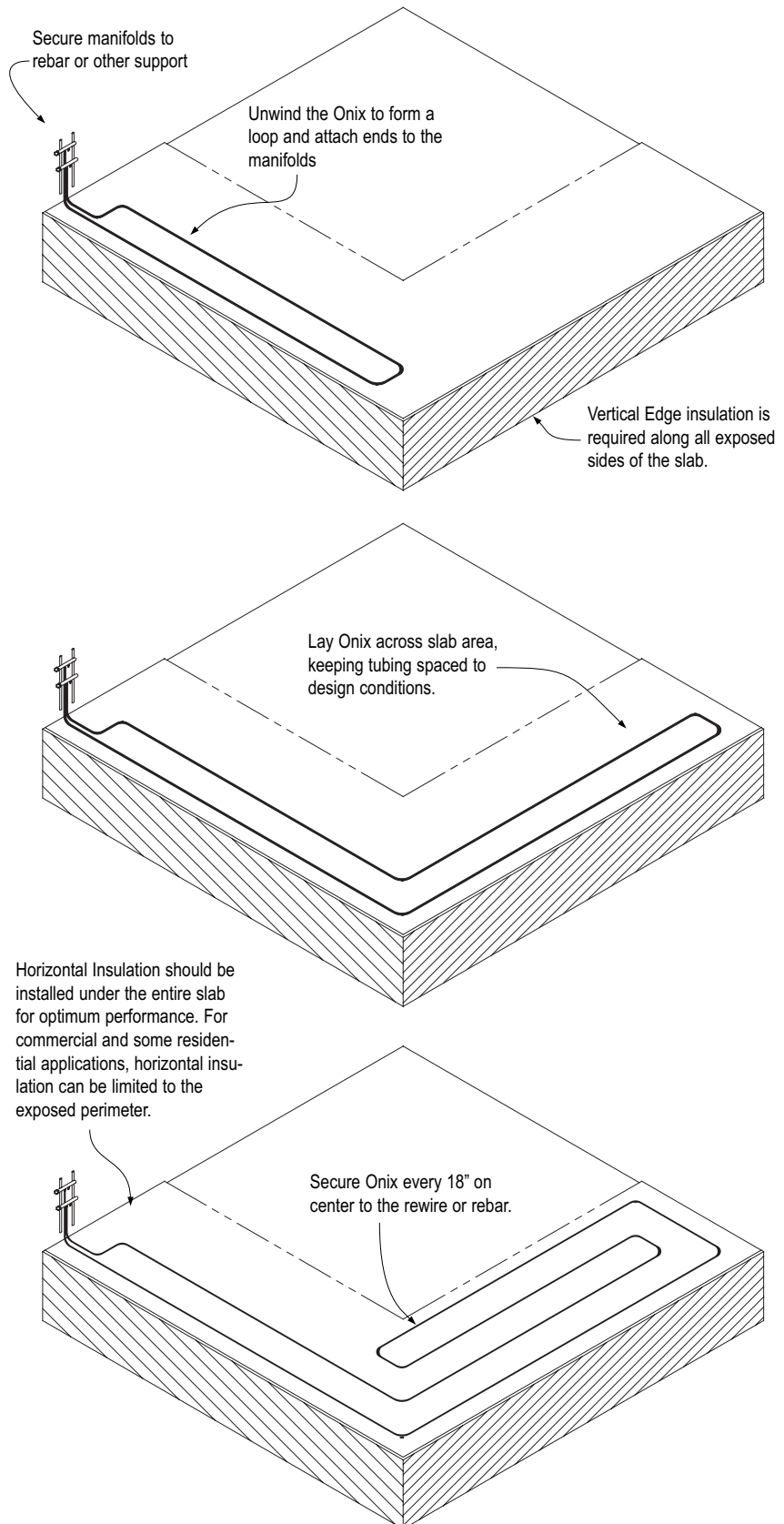
The most common installation pattern for slab applications is a double serpentine layout, although in some cases a single serpentine may be used.

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.

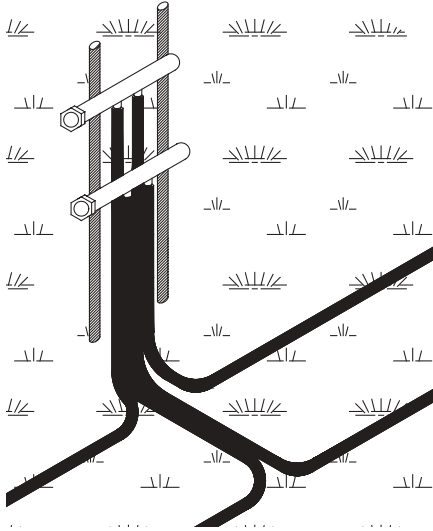
Step 2: Install Manifolds

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.



Typical slab installation. Onix is installed using a double serpentine pattern.

Concrete Slab



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 Onix circuits (2–5 ft. is recommended). A Watts Radiant manifold box can be used to secure the manifolds within the new wall. Watts Radiant SnapClips and StrapDowns can be used to organize Onix coming from the floor and into the wall.

Step 3: Determine Zone Boundaries

Before Onix 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. Make sure the minimum circuit length is at least twice this distance. If not, the Onix will not be long enough to reach the farthest point of the zone and return.

Step 5: Install the Onix

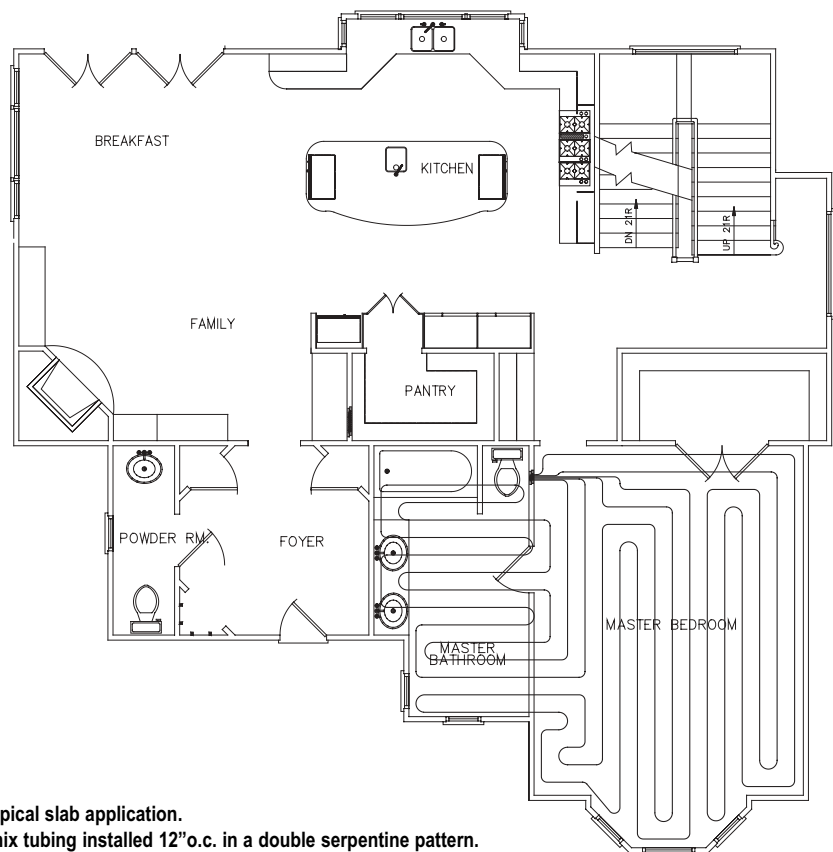
Place the unwinder underneath the manifold with a coil of Onix placed over the center post and cut the binding straps on the coil. Pull one end of the Onix off the unwinder until the entire coil is unwound. Loop the coil so the two ends meet back together, forming a loop. Loosely attach both ends of the coil to the manifolds, one to the supply and one to the return manifold. Take a white paint pen, or other marker, and mark each end of Onix with a number 1, indicating the first circuit installed. This will help later in the installation process.

Do not push the Onix on more than the first barb at this point, just in case the circuit needs to be removed. Take both runs of Onix and begin laying both sides of the circuit in the slab area. This method will naturally create a double serpentine layout. Continue

this process with the next circuit, beginning where the first circuit ends.

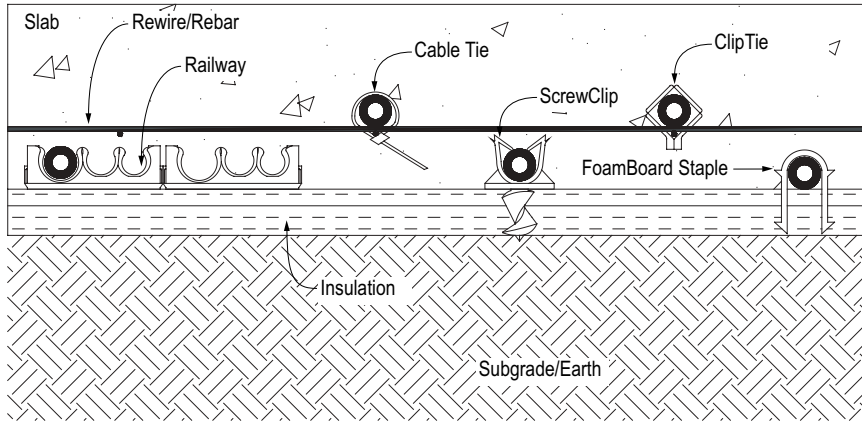
Begin at the manifold and grasp both runs of the Onix loop, maintaining a hand spacing approximately the same distance apart as the desired tube spacing. This spacing should be the same as indicated in the design.

Lay the first run of Onix along the perimeter walls to the farthest point in the zone, keeping the Onix 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. Onix can be run underneath interior walls as long as the Onix is deep enough in the slab to prevent nails in wall plates from damaging the circuits. Continue until the middle of the circuit is reached.



Typical slab application.
Onix tubing installed 12" o.c. in a double serpentine pattern.

Concrete Slab



Various tube fasteners for slab applications.

This double serpentine layout places the cooler return end of the circuit next to the warmer supply end. This layout helps bring the finished floor surface to an even temperature in the shortest time possible.

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: Securing the Onix

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 Onix attaches directly to the rewire/rebar by the use of cable ties or ClipTie clips. If the slab is poured without the rewire/rebar, other fasteners can be used that will secure the Onix directly to the foam insulation beneath the slab.

After no more than three circuits have been roughly laid out, tie down enough of the bends in the circuits to temporarily hold the Onix in place. Lay out all of the remaining circuits in the zone before tying down more than the bends. This helps eliminate time and wasted fasteners in the event circuits need to be moved or adjusted. Repeat this process until all of the cir-

cuits with the zone are in position. Leave 2'—5' slack on each circuit in case the manifold position needs to be adjusted from its temporary location.

After all circuits are in place and any adjustments have been made, fasten the Onix to the wire mesh or insulation board every one to two feet. This will keep the Onix from shifting or floating during the concrete pour. If cable ties are used, do not pull the ties so tight that the Onix is flattened or pinched shut. Also, make sure all tails of the cable ties are either cut off or turned downward to prevent any unwanted surface protrusions.

Step 7: Repeat With The Next Circuit

Repeat steps 4 through 6, keeping the next circuit spaced according to the design. Make sure to use as much of each circuit as possible. If the last circuit is too long, which sometimes happens, try not to cut it to make 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 is within 10% of the existing circuits. For example, if 200 ft. lengths were installed, the last circuit can be cut to a length of 180 ft. 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.

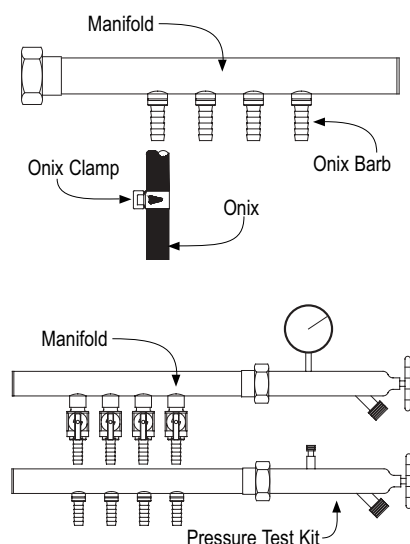
Step 8: Visual Inspection

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

Step 9: Final Assembly and Pressure Test

With the zone fully installed and inspected, finish the connections to the manifold. Begin by identifying corresponding ends to the same circuit. If the tubing has not been marked, select two circuit ends and blow through one, with a thumb placed over the other end. Air should be felt on the other side, confirming a single circuit has been selected.

Take one Onix Clamp and slide it over one end of tubing. Slide the clamp down about 2" from the end and push



Concrete Slab

the Onix onto the first barb of the supply manifold, making sure the tubing covers the entire fitting. If the Onix is difficult to push onto the barb, lubricate the end of the Onix with some water.

Do not use soap, oil, WD-40®, or other petroleum or silicone based lubricants as they may damage the interior of the Onix tubing. Soap or lubricants may make connections and splices leak, even at low pressures.

Slide the Onix clamp back over the Onix hose and barb connection. If using TorqueTite clamps, do not over-tighten. Tighten the TorqueTite clamp using a preset torque driver according to the settings stated on the instructions that come with the clamps. More information on how to apply the Onix clamp connections can be found in the Appendix.

Caution: DO NOT over tighten the clamps. Over tightening may cause an improper fit.

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

Step 10: 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.

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 Slabs

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 1.5" and the floor load anywhere from 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.

Onix Spacing

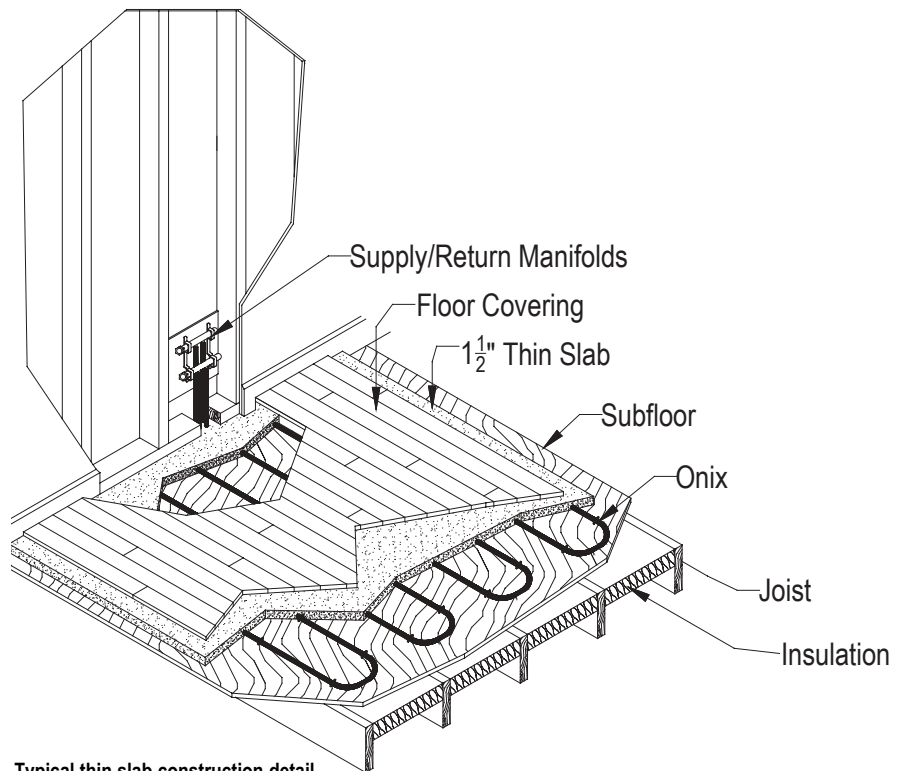
Most thin slabs will use 12" tube spacing with some perimeter banding. In a few cases, where control over supply fluid temperature is needed, an entire room may be installed at 9" or 6" centers. This may be the case in a high heat loss sunroom or pool area.

In a Thin Slab over Frame Floor application, Onix 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, tube talons may be used to secure the Onix.

Closer spacing may be used in areas of high heat loss, such as an exposed wall with a high percentage of glass; 9" o.c. spacing is sometimes preferred in bathrooms, kitchens and entries. Closer tube spacing, up to 6 inches on center, 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.



Typical thin slab construction detail.

Thin Slabs

Perimeter Banding

Four, five or six inch Onix spacing is frequently used along outside exposed perimeter walls. These high-density 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. Most banded widths will be 4 ft. wide or half a standard wall height.

For example, in a home with 12" spacing in the main floor area, a 6' 8" patio door would have radiant tubing on 6" centers a minimum of 40"—48" in front of the door.

Tools and Materials Required

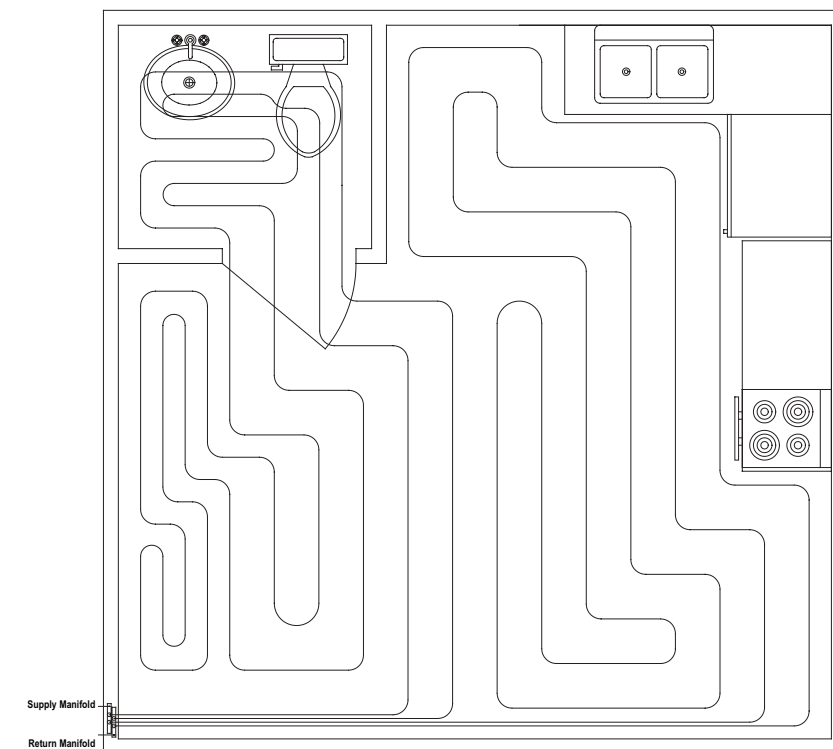
It is a good idea to make sure all materials are present and in good working order before beginning a radiant installation. The following is a list of the most common items needed for a typical Thin Slab installation.

1. RadiantWorks Reports.

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

2. Onix tubing and corresponding number of Watts Radiant Onix Clamps.

Each Onix TorqueTite clamp will require an in.-lb. torque wrench for installation, while the SelfTite clamps need a pair of SqueezeTite Pliers. See manifold assembly section for more details. The number of Onix coils on the jobsite should correspond to the number listed in the Zone List report.



3. Manifold.

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 Onix coil without kinks and twist.

5. Field Repair Kit.

Each kit will contain two barb-by-barb splices and four Onix Clamps.

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 staple gun, staples and NailTites.

8. Pressure test kit.

Each manifold pair must be pressure tested. This helps ensure each Onix connection has been performed correctly and to make sure no addition-

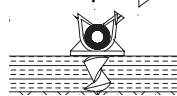
al damage has been done to the tubing during installation.

9. Installation Accessories

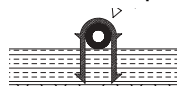
- Spray Paint: For marking out zones and subzones, as well as areas not to be heated.
- Electrical Tape: For temporarily mounting the manifolds or taping ends of tubing together.
- Cable Ties, ClipTies, Screw Clips or other fasteners.

Fasteners

Screw Clips



Foam board Staple



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 Onix at turns and bends and in areas inaccessible to the staple gun. Both staples and NailTites

Thin Slabs



need to be installed every 12"—18" along each run of Onix.

In a few cases, where it is impractical to insulate in the joist cavity, a board insulation 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 Screw Clips and Foam Staples may be used to secure the tubing directly to the insulation board.

To speed the installation of the Onix 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 Screw Clips are used, a Watts Radiant ClipTwister® tool can be used. It 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.

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.

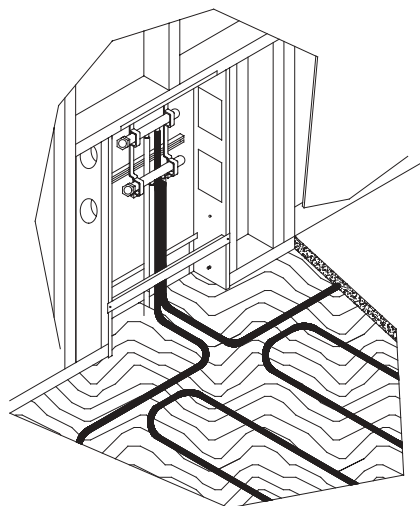
The most common installation pattern to use in a Thin Slab application is a single serpentine layout, although in some cases a double serpentine may be used.

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 Onix 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 Onix 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 Onix will not be long enough to reach the farthest point and still have enough length to return to the manifold.

Step 4: Install the Onix

Place the unwinder underneath the manifold with a coil of Onix placed over the center post and cut the binding straps on the coil. Pull one end of the Onix off the unwinder and loosely attach it to the first barb of one of the manifolds. Take a white paint pen, or other marker, and mark this end of Onix with a number 1, indicating the first circuit installed. Do the same to the other end of Onix, marking it with the number 1. This will help later in the installation process.

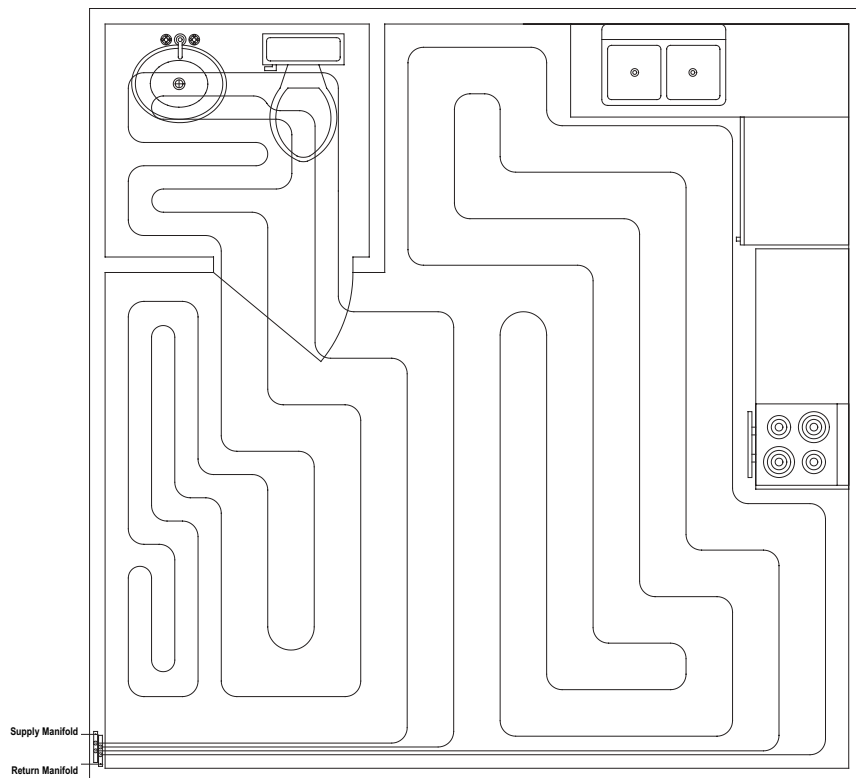
Do not push the Onix on more than the first barb at this point, just in case the circuit needs to be removed.

Lay the first run of Onix along the perimeter walls to the farthest point in the zone, keeping the Onix 6"—8" from the wall. This helps protect the tubing from possible penetrations when the floor covering is installed.

Run the Onix back and forth in a serpentine pattern. When the other end of the Onix slides off the unwinder, stop and secure the Onix in place back to the manifold. Connect the loose end to the other manifold.

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

Thin Slabs



and construction details may make one method easier to install.

Walls and Built-Ins

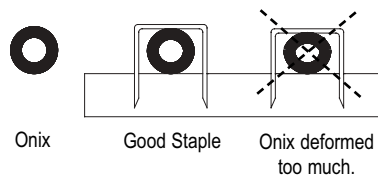
In most thin slab applications, built-ins such as cabinets, showers and walls are already in place before the thin slab is poured. This also means these items are in place before the radiant tubing is installed.

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 Onix tubing through doorways when ever possible.

Step 5: Securing the Onix

Most thin slab applications will require some form of fastener, depending on the construction details. When a thin slab is being installed over a sub-floor, 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 flatten or deform the Onix. Other applications may use a

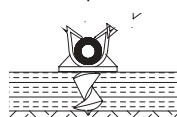


foam installation board below the thin slab. In these applications, FoamBoard Staples or ScrewClips can be used. In each case, secure the Onix to the floor every 18".

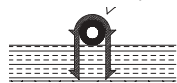
Step 6: Repeat With The Next Circuit

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" on center. Don't space the tubing wider than 12" on center as possible thermal striping may occur. Likewise, spacings tighter than 6" on center is not advised due to possible structural conflicts with the thin slab material. If tighter spacing is

Screw Clips



Foam board Staple



required, contact Watts Radiant for further advice.

Make sure to use as much of each circuit as possible. If the last circuit is too long, which sometimes happens, 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 is within 10% of the existing circuits. For example, if 200 ft. lengths were installed, the last circuit can be cut to a length of 180 ft. 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.

Step 7: Visual Inspection

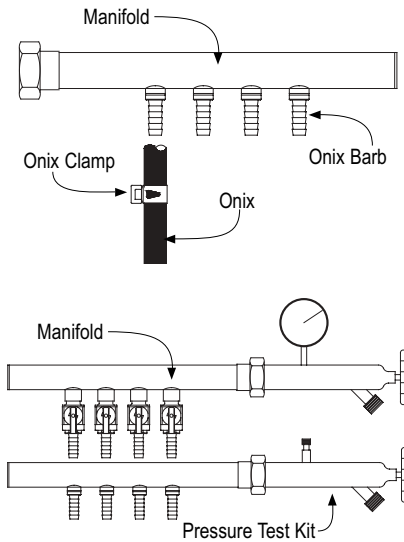
After all the circuits are installed, take a few minutes to walk each circuit and visually inspect the tubing for possible damage caused during installation. If a damaged area is found, repair it using an approved Watts Radiant Repair Kit. More information on the repair kits can be found in the Appendix.

Step 8: Final Assembly and Pressure Test

With the zone fully installed and inspected, finish the connections to the manifold. Begin by identifying corresponding ends to the same circuit. If the tubing has not been marked, select two circuit ends and blow through one, with a thumb placed over the other end. Air should be felt on the other side, confirming a single circuit has been selected.

Take one Onix Clamp and slide it over one end of tubing. Slide the clamp down about 2" from the end and push

Thin Slabs



the Onix onto the first barb of the supply manifold, making sure the tubing covers the entire fitting. If the Onix is difficult to push onto the barb, lubricate the end of the Onix with some water.

Do not use soap, oil, WD-40®, or other petroleum or silicone based lubricants as they may damage the interior of the Onix tubing. Soap or lubricants may make the connects and splices leak, even at low pressures.

Do not over-tighten the Onix TorqueTite clamp. Tighten TorqueTite clamps using an in.-lb. torque wrench. More information on how to make the TorqueTite or SelfTite connection can be found in the Appendix.

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

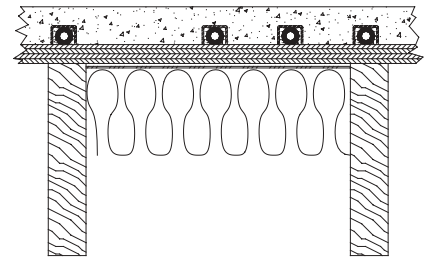
gap. At this point, the main goal is to prevent heat migration downward. If the system is insulated in the joist cavity, a standard paper faced insulation can be used. Make sure to install the insulation tight against the subfloor to minimize any convective losses that may be generated. The actual R-value 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, one inch extruded polystyrene insulation board is recommended to isolate the new pour from the existing. If a one-inch 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.

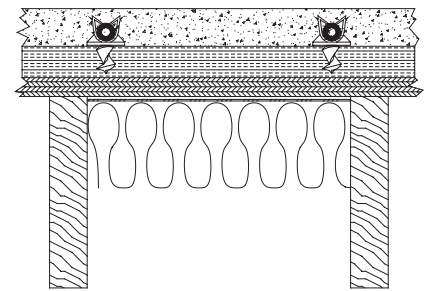
Thin Slab with Sleepers

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.

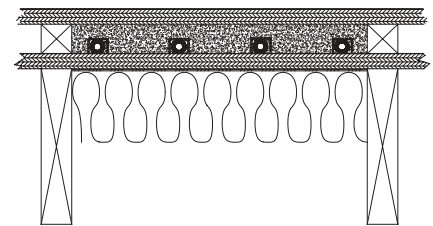
Caution: The thin-slab surface must contact the upper wood floor or subfloor. Thin slab can shrink during curing, creating an air gap.



Onix 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 are used to secure the Onix to the foam insulation board. Additional insulation may be added below, in the joist cavity, for an increased R-Value.



Onix 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.

Steel Decks

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 office mezzanines 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 what Onix spacing should be used.

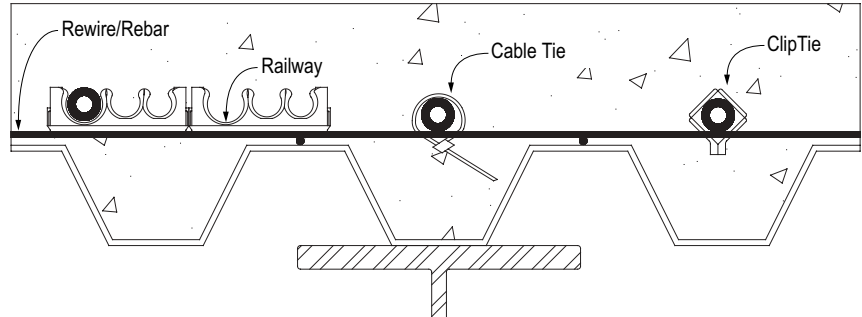
When possible, install the Onix perpendicular to the ribbing on the steel deck. There is only one area a steel deck application can be insulated, that being under the steel deck. In this configuration, it is almost impossible to insulate under a steel deck system with batt insulation, since the support members tend to be farther apart than the typical 16'' o.c.

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

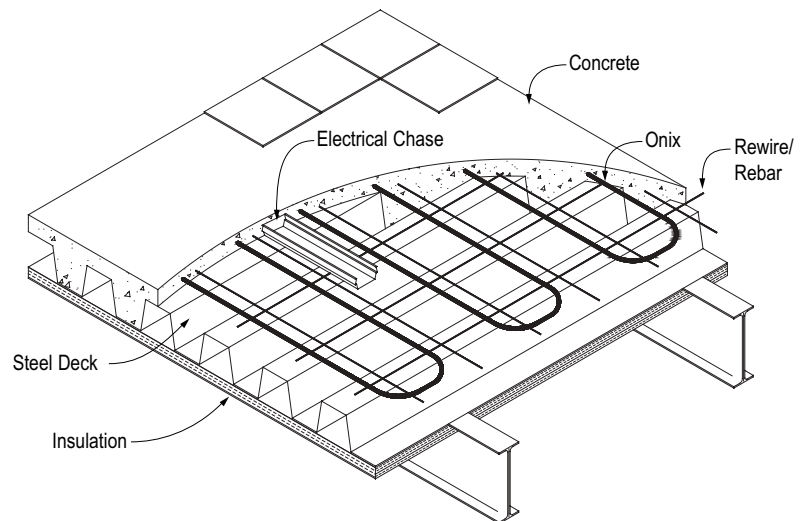
Precast Slabs

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.

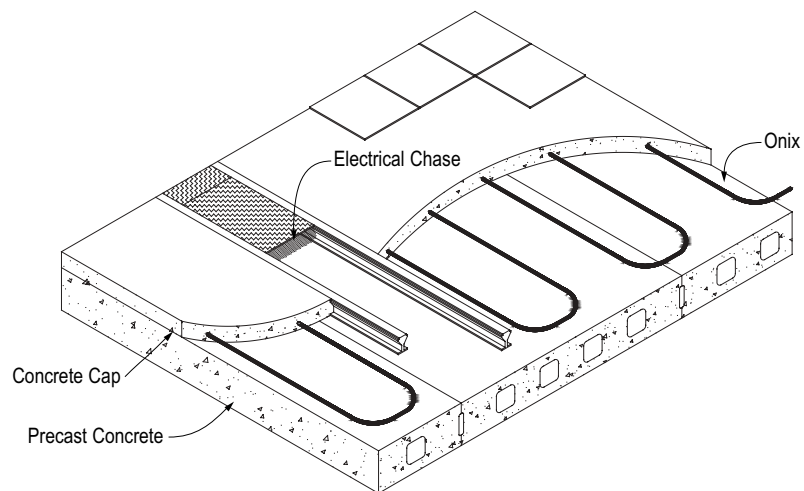
Likewise, rewire/rebar may or may not be used in the cap pour. Fastener types are chosen based on the approved construction requirements.



Various tube fasteners for steel deck slab applications.



Typical Slab over Steel Deck application. Insulation board is usually installed below the steel deck, minimum 1'' thick.



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.

Snowmelt Applications

Introduction

Radiant snowmelt and ice removal systems for concrete and 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

Onix can be installed under brick pavers for the purpose of snow melting. 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 Onix installed under brick pavers:

1. Concrete.

The easiest and most predictable substrate is concrete, where Onix 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

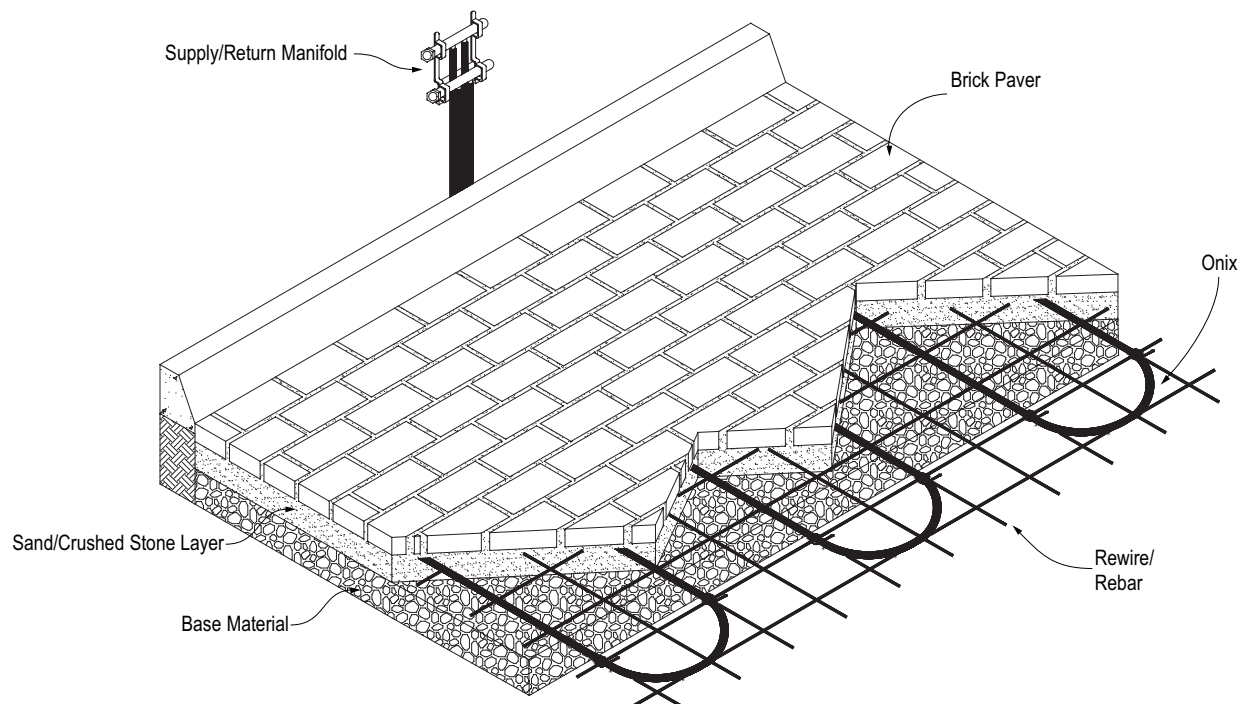
the concrete, and the slab will meet the load requirements of the expected traffic.

2. In the First Course of Base Material.

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



Onix installed in a sand and brick paver application.

Snowmelt

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 outside the snowmelt zone, 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 Onix 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 one to two inches 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

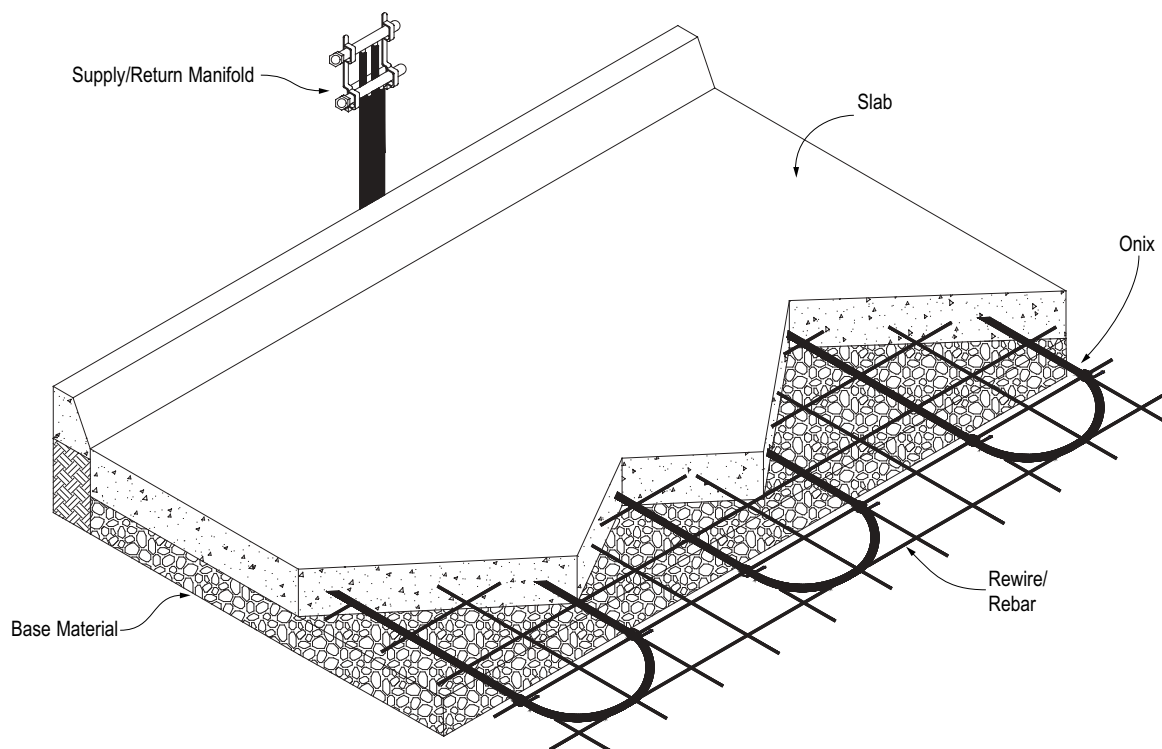
Unlike a interior slab applications where the insulation is recommended, snowmelt systems do not require insulation. This is due to:

1. Loading.

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

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.



Onix installed in a slab on grade snowmelt application.

This is not to say insulation 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 to be used, a non-foil faced, high-density, extruded polystyrene (such as Dow® Blue Board®) should be used.

The use of a foil-faced insulation is not required or recommended when insulating a snowmelt slab. Foil-faced insulation are 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 advise 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® Blueboard® 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.

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.

Onix Spacing

Most snowmelt systems will use 9"—12" tube spacing with some areas, such as steps or in front of door open-

ings, installed on 6" centers.

Tools and Materials Required

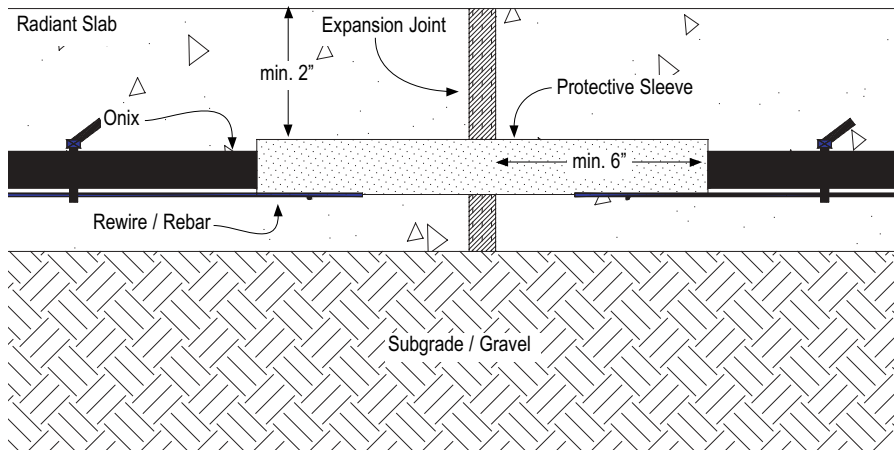
It is a good idea to have all materials present and in good working order before beginning an installation. The following is a list of the most common items needed for a typical snowmelt installation.

1. RadiantWorks Reports.

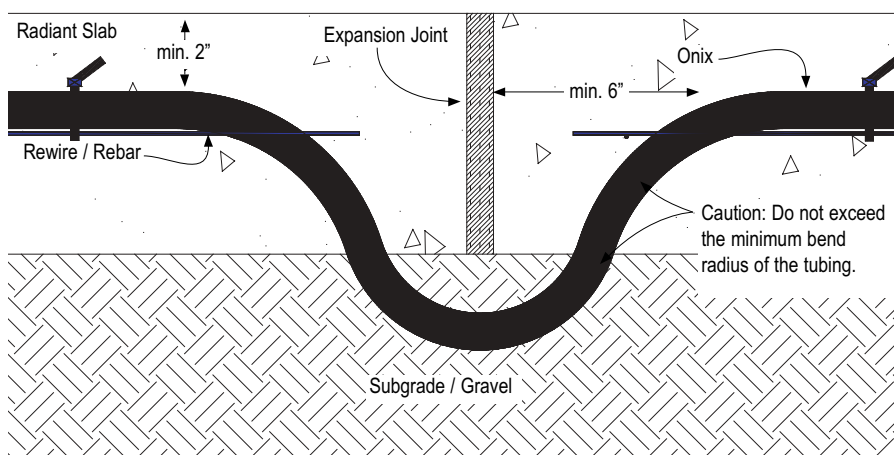
These reports help ensure the proper amount of tubing is installed in each area, along with the correct manifold size.

2. Onix tubing and corresponding Onix Clamps.

Each Onix TorqueTite clamp will require an in.-lb. torque wrench for

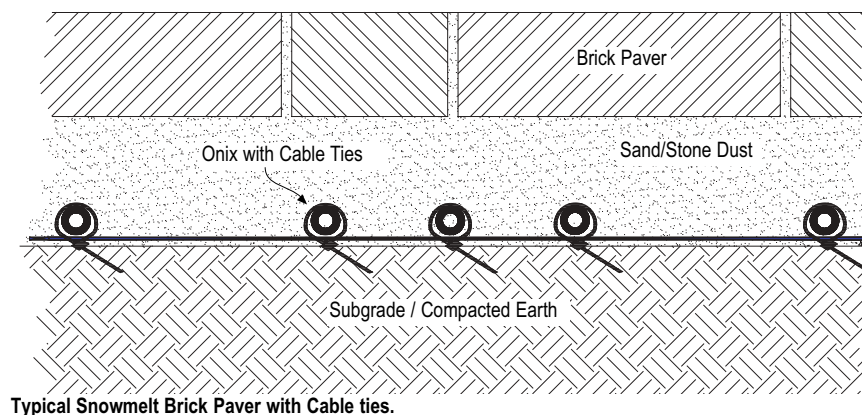
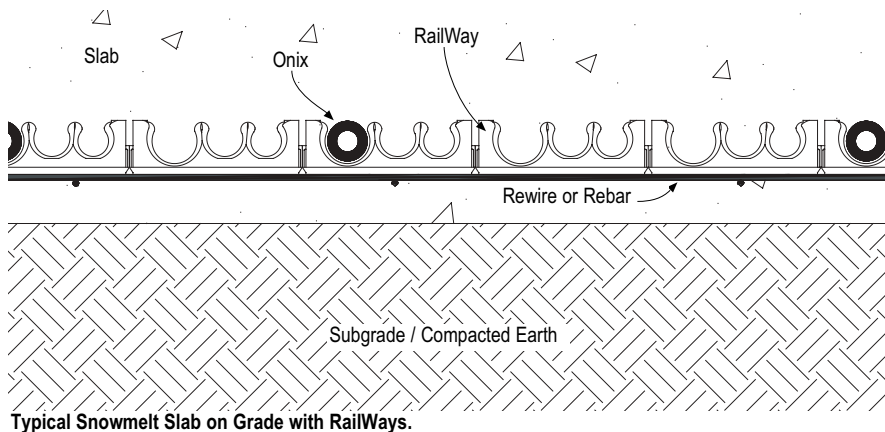
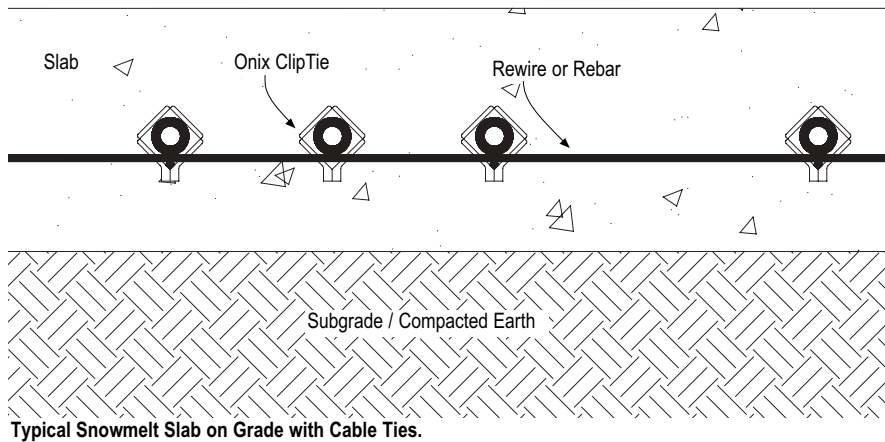


Onix sleeved at expansion joint with foam insulation or PVC conduit.



Onix routed below expansion joint into subgrade.

Snowmelt



installation, while the SelfTite clamps need a pair of SqueezeTite Pliers. See manifold assembly section for more details. The number of Onix coils on the jobsite should correspond to the number listed in the Zone List report.

3. Manifolds

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

4. Unwinder.

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

5. Field Repair Kit.

Each kit will contain two barb-by-barb splices and four Onix Clamps.

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 staple gun, staples and NailTites.

8. Pressure test kit.

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

9. Installation Accessories

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

Since rewire/rebar is commonly used in concrete slabs for structural integrity, it is a good practice to attach Onix to the rewire/rebar. This is done with nylon cable ties or Watts Radiant ClipTies and Clipper tool. Each will secure the Onix 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 Onix. 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 Onix tubing directly to the insulation board.

For any attachment method, it is important to secure the tubing to the rewire/rebar every 12" to 18" on center. This will prevent the Onix from shifting during the concrete pour. (See Watts Radiant catalog or binder 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 1" layer of sand or stone dust between the top of the tubing and the bottom of the paver.

Installation Steps

Manifold locations, final concrete thickness and zoning details are just a few items that can affect how a slab 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.

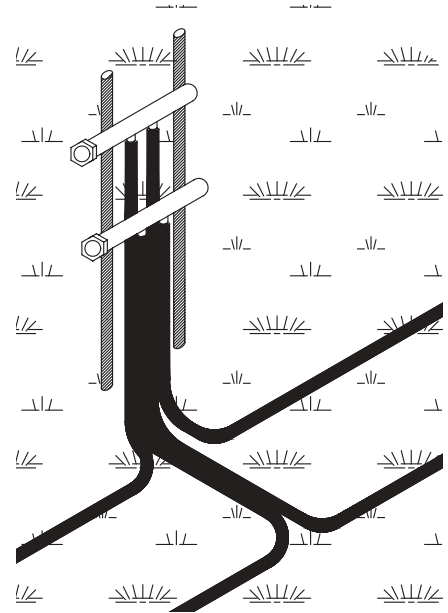
The most common installation pattern for slab applications is a double serpentine layout, although in some cases a single serpentine may be used.

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

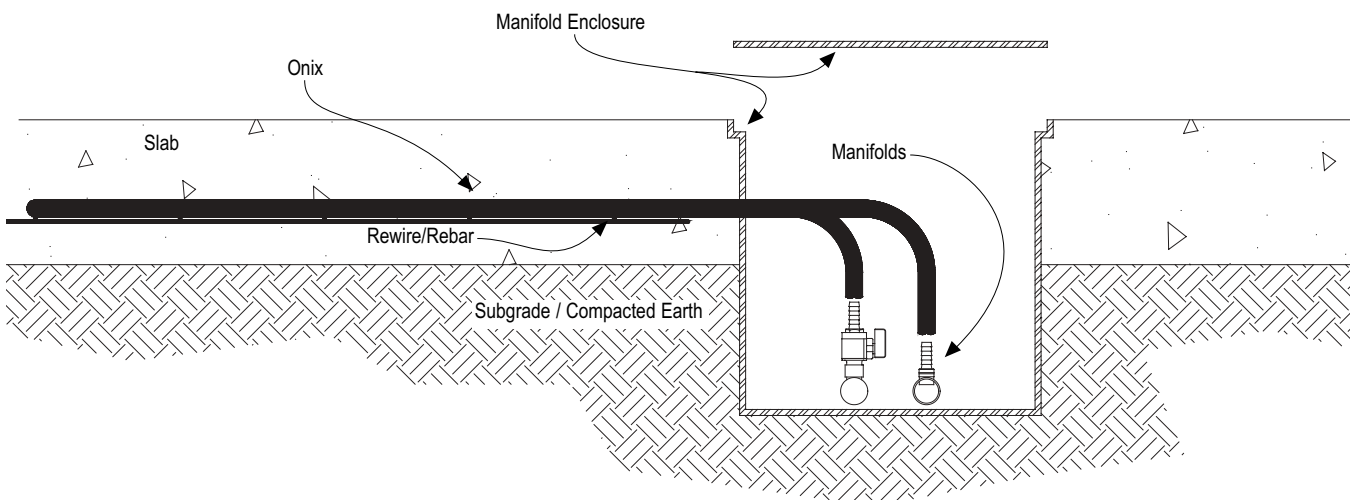
Locate where the manifolds are to be installed. In most snowmelt systems, the manifolds will be located in an environmentally resistant box and placed in the ground. Some applications may allow the manifolds to be mounted in a structural wall, such as in the exterior wall of a garage. With either method, it is important to sup-



port 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. Remember to keep the manifolds high enough to allow for the thickness of the concrete, paver or any other structural items that may need to be installed after the pour.

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.



Snowmelt

Make sure to leave plenty of slack in all Onix circuits (2–5 ft. is recommended). A Watts Radiant manifold box can be used to secure the manifolds within a structural wall. Watts Radiant SnapClips and StrapDowns can be used to organize Onix coming from the floor and into the protective enclosure.

Step 3: Determine Zone Boundaries

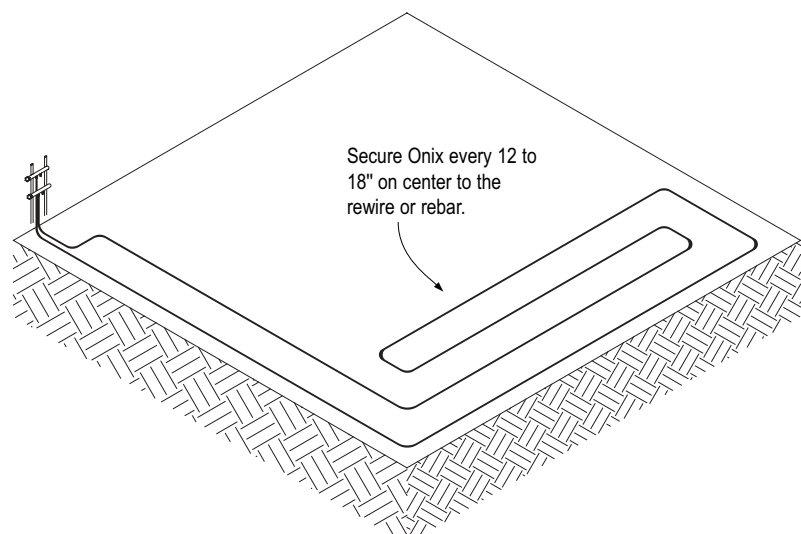
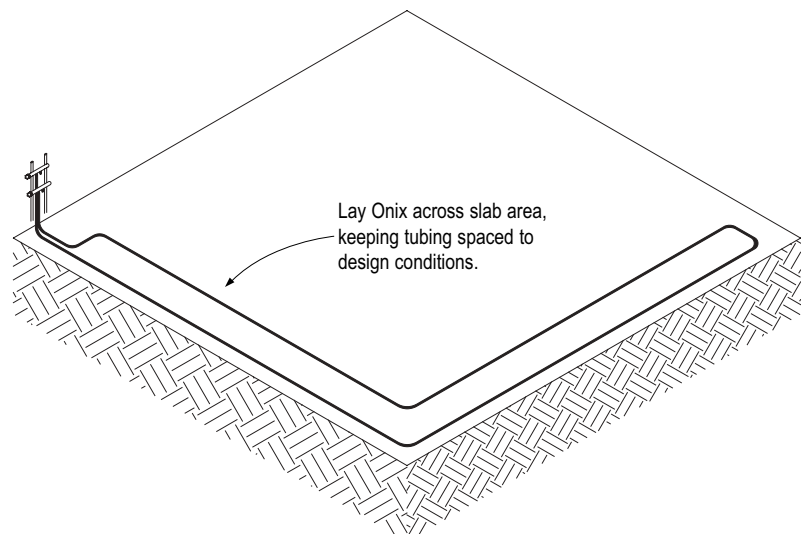
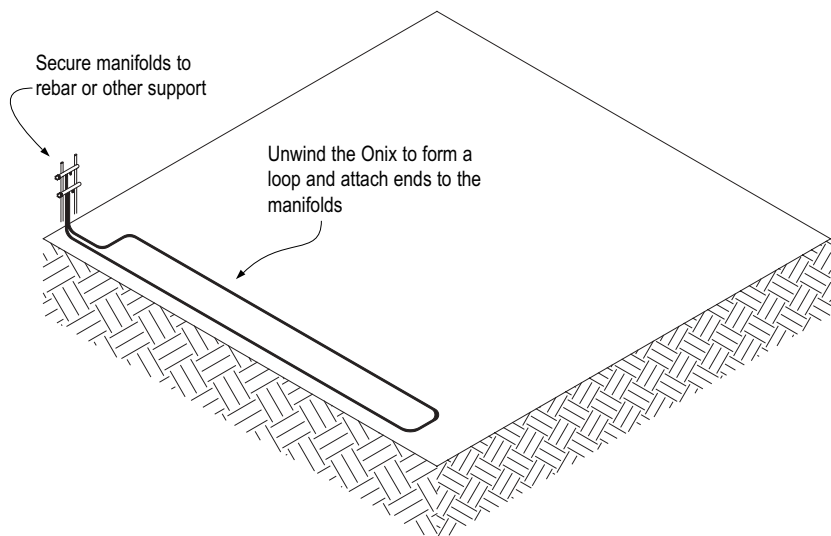
Before Onix is installed, visually inspect the area to determine the zone boundaries. This helps determine where the first circuit is to be placed, while identifying any obstacles that may be in the way.

Step 4: Confirm Tubing Requirements

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

Step 5: Install the Onix

Place the unwinder next to the manifold with a coil of Onix placed over the center post and cut the binding straps on the coil. Pull one end of the Onix off the unwinder until the entire coil is unwound. Loop the coil so the two ends meet back together, forming a loop. Loosely attach both ends of the coil to the manifolds, one to the supply and one to the return manifold. Take a white paint pen, or other marker, and mark each end of Onix with a number 1, indicating the first circuit installed. This will help later in the installation process.



Typical slab snowmelt installation. Onix is installed using a double serpentine pattern.

Do not push the Onix on more than the first barb at this point, just in case the circuit needs to be removed. Take both runs of Onix and begin laying both sides of the circuit in the slab area, maintaining a hand spacing approximately the same distance apart as the desired tube spacing. This method will naturally create a double serpentine layout. Continue this process with the next circuit, beginning where the first circuit ends.

Lay the first run of Onix along the perimeter to the farthest point in the zone, keeping the Onix 6"—8" from the edge of the slab. Continue until the middle of the circuit is reached.

This double serpentine layout places the cooler return end of the circuit next to the warmer supply end. This layout helps bring the snowmelt surface to an even temperature in the shortest time possible.

Step 6: Securing the Onix

Slab applications usually require some form of tubing fastener, depending on the construction details. In this application, the Onix attaches directly to the rewire/rebar using cable ties or ClipTie clips. If the slab is poured

without the rewire/rebar, other fasteners can secure Onix directly to foam insulation, or to the ground beneath the slab. For more information on the available fasteners, consult the Watts Radiant Product catalog or contact the local Watts Radiant representative or visit the Watts Radiant website.

After no more than three circuits have been roughly laid out, tie down enough of the bends in the circuits to temporarily hold the Onix in place. Lay out all of the remaining circuits in the zone, again tying down only the bends. This helps eliminate time and wasted fasteners if circuits need to be moved or adjusted. Repeat this process until all of the circuits in the zone are in position. Leave 2'—5' slack on each circuit in case the manifold position needs to be adjusted from its temporary location.

After all circuits are in place and any adjustments have been made, fasten the Onix to the wire mesh or insulation board every one to two feet. This will keep the Onix from shifting or floating during the concrete pour. If cable ties are used, do not pull the ties so tight that the Onix is flattened or pinched shut. Also, make sure all tails of the cable ties are either cut off or turned downward to prevent any unwanted surface protrusions.

Step 7: Repeat With The Next Circuit

Repeat steps 4 through 6, keeping each circuit spaced according to the design. Use as much of each circuit as possible. If the last circuit is too long, which sometimes happens, try to avoid making 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 is within 10% of the existing circuits. For example, if 200 ft. lengths were installed, the last circuit

can be cut to a length of 180 ft. and still maintain a balanced system.

Step 8: Visual Inspection

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

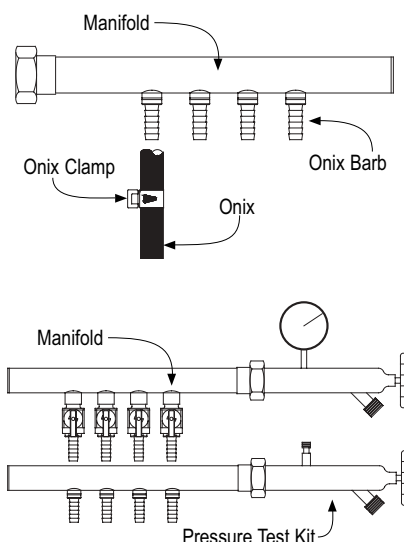
Step 9: Final Assembly and Pressure Test

With the zone fully installed and inspected, finish the connections to the manifold. Begin by identifying corresponding ends to the same circuit. If the tubing has not been marked, select two circuit ends and blow through one, with a thumb placed over the other end. Air should be felt on the other side, confirming a single circuit has been selected.

Take one Onix Clamp and slide it over one end of tubing. Slide the clamp down about 2" from the end and push the Onix onto the first barb of the supply manifold, making sure the tubing covers the entire fitting. If the Onix is difficult to push onto the barb, lubricate the end of the Onix with some water.

Do not use soap, oil, WD-40®, or other petroleum or silicone based lubricants as they may damage the interior of the Onix tubing. Soap or lubricants may make the connects and splices leak, even at low pressures.

Slide the Onix Clamp back over the Onix and barb connection and tighten. If using TorqueTite clamps, do not over-tighten. Tighten the TorqueTite



Snowmelt

clamp using an in.-lb. torque driver. More information on how to make the Onix Clamp connection can be found in the Appendix.

Caution: DO NOT over tighten the clamps. Over tightening may cause an improper fit.

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

Step 10: The Concrete Pour

To help detect possible damaged caused during the concrete pour, keep the system under pressure. If damage is done, locate the area in question and remove the damaged section 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.

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.

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.

1. Tread Area 2. Riser Area

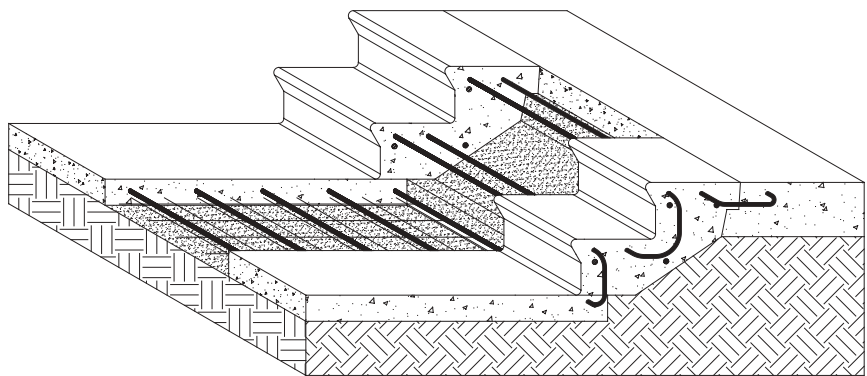
These two areas are where ice and snow will have the greatest build up. The edge of the tread is where the least amount of melting will take place since it will be the farthest from the tubing. It is also the area that will cause the most hazards. When selecting an installation technique, keep these factors in mind.

The finished covering may also influence which installation method is used; for example a standard slab ver-

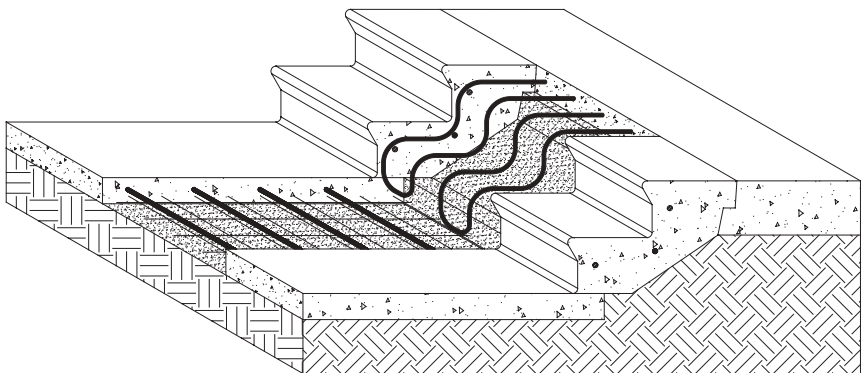
sus a stone cap over the slab. In addition, the riser height will be a factor in determining how much tubing can be installed.

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

Onix installed parallel 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. If there is room, a run of tubing can be ran along the face of the riser to help melt snow and ice that may build up at the outer edge of the step.



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



Onix installed running perpendicular to the step. When running perpendicular to the step, make sure there is enough room to make proper bends between the riser and tread and still maintain the minimum coverage requirement.

Perpendicular installations may be easier to install on long narrow steps. 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.

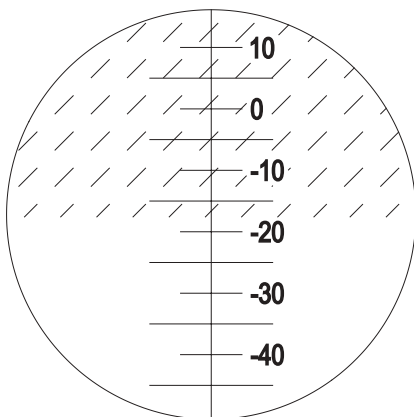
In both applications it is important to keep the Onix 2"—3" away from the surface of the concrete. In some cases it may be ideal to install a designated manifold for the steps. This allows for a dedicated vent/purge assembly to be used for purging the tubing located in the steps.

Glycol

Any hydronic system that is exposed to near or below freezing conditions must have propylene glycol installed as the working fluid. Propylene 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. 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) for the circulators.

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.

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.

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°F.

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 re-filled 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.

Appendix

Manifolds

Copper and Brass Manifolds

Manifolds are used to transition from supply/return piping to Onix. 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:

Custom Tubular (Copper and Brass)

Custom Tubular Manifolds are custom fabricated to each project's specifications with any number of circuits in diameters from 1" to 6".

CazzBrass

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, with flow meters, or with balancing valves.

Stainless Steel

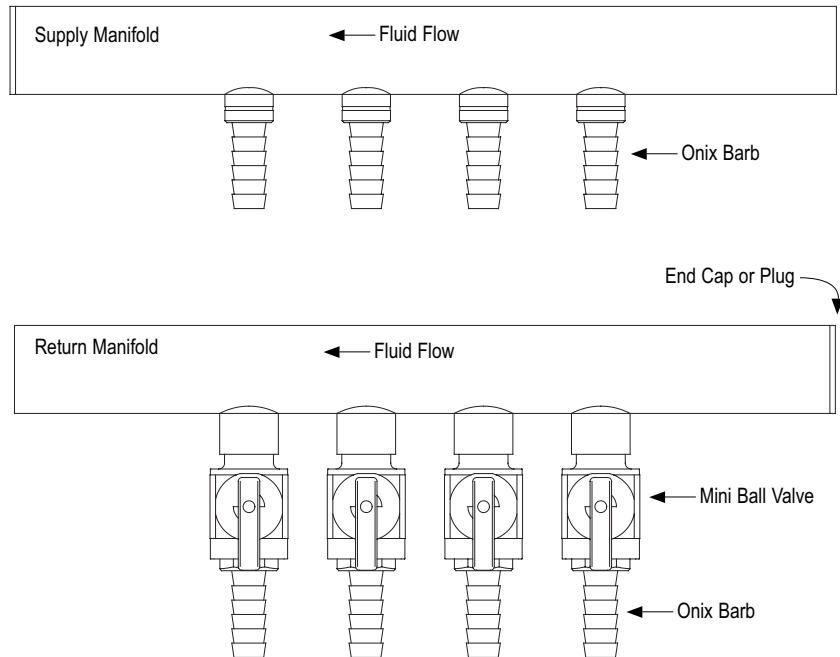
Stainless steel Manifolds are constructed of tubular stainless steel and range from 2 to 12 circuits. Each pair comes with flow meters, circuit balancing valves and mounted brackets.

CustomCut (copper)

CustomCut manifolds are pre-made 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.

Swedged (copper)

Swedged manifolds are pre-made manifolds with 3, 4, or 5 circuits. One end of a Swedged manifold



Typical Copper or Tubular Brass Manifold Pair.

is flared so it can directly couple to another Swedged manifold. For example, a 3- and a 4-branch Swedged manifold can be field coupled to form one 7-branch manifold assembly.

For more information on the various manifold options see our Radiant Catalog, or visit us on the Web 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.

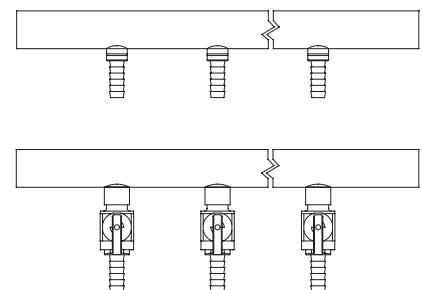
Do not use clamps or Onix Barbs not supplied by Watts Radiant.

Connections made with barbs or clamps supplied by other companies are specifically excluded from any Watts Radiant warranty coverage.

There are three main ways to field construct a manifold.

1. CustomCut Manifolds:

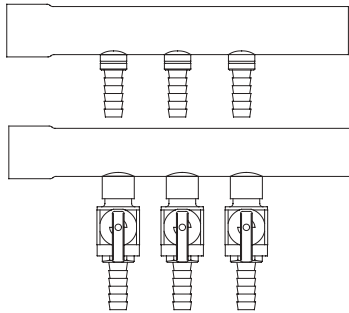
Manifold sticks from the factory designed to be used with any Onix barb. Installers can purchase prefabricated CustomCuts or base branch manifolds and field solder various combinations of barbs and mini-ball valves as the job demands.



Appendix

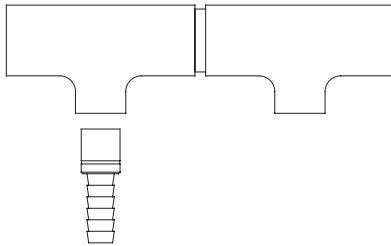
2. Swedged Manifolds:

Pre-assembled manifold sections that sweat together as needed.



3. 1" x 1/2" x 1" Reduced T-Fittings

can be soldered together forming a complete manifold. Onix Barbs are then soldered into the 1/2" fittings.

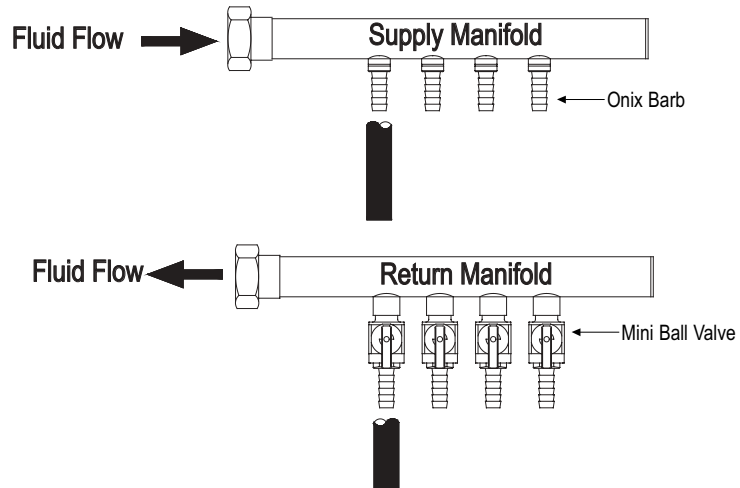


For each of the assembly options, the smallest trunk size used must be at least 1".

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

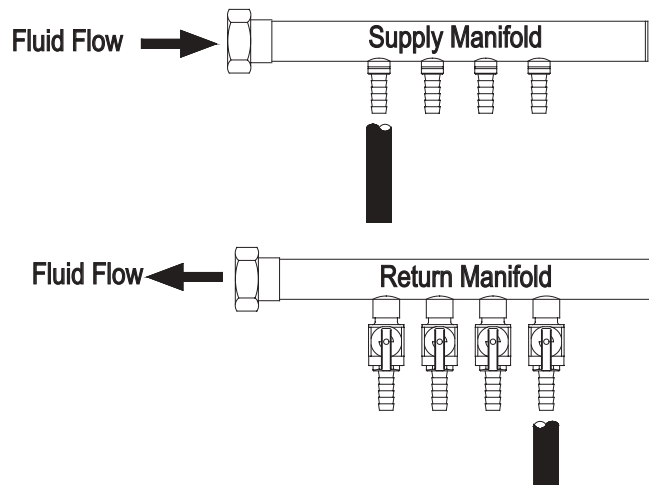
Max Flow (gpm)	Base Trunk Size
12	1"
20	1-1/4"
32	1-1/2"
60	2"

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.



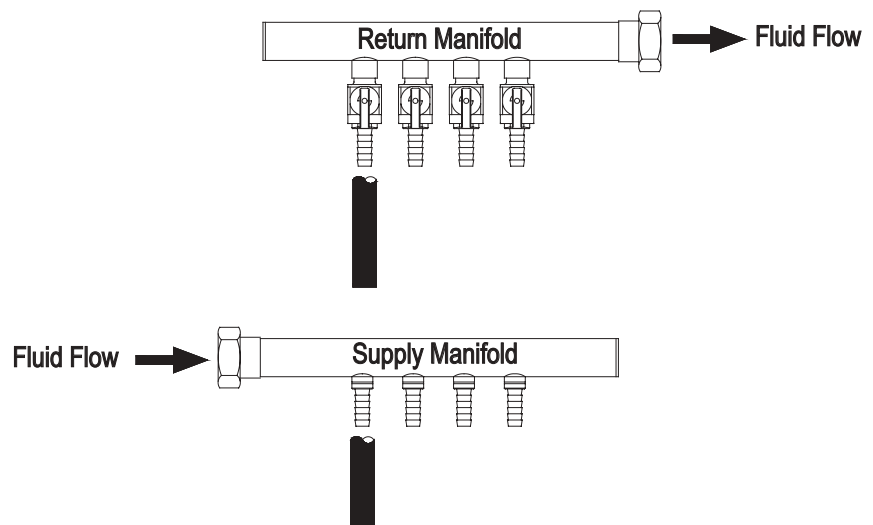
Direct Piping Option.

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.



Reverse Return Option B.

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

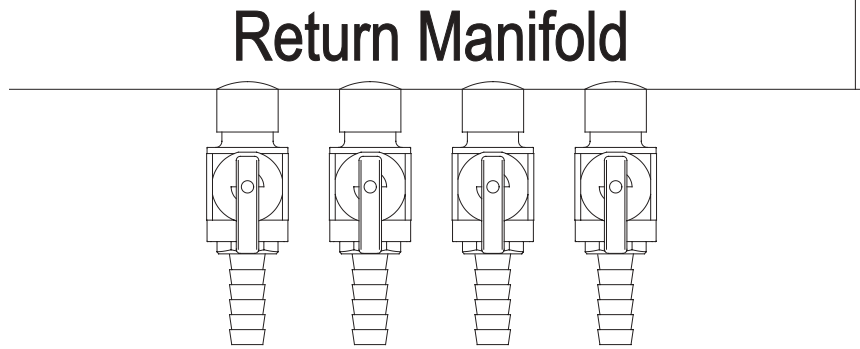
Appendix

Manifold Set Up

There are two ways fluid can flow through a manifold pair: 1) Direct and 2) Reverse Return. Both are dictated by how the Onix 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%.

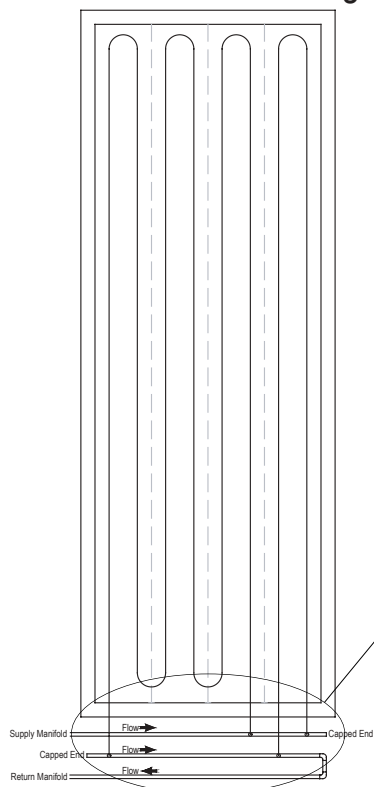
If a Long Manifold is installed, it is imperative to set the manifold up in a Reverse Return fashion. This is essential when the manifold spans the length of the zone.

Supply and return manifolds are installed along the length of the zone, perpendicular to the floor joists. To make Onix connections simpler, we recommend running a third copper line

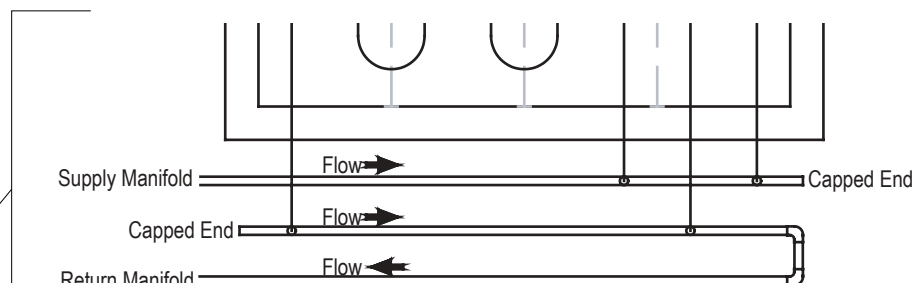
so the supply manifold is being supplied hot water at one end of the manifold array. The return manifold should then be discharging cooler water at the opposite end of the manifold array, as illustrated.

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 bays - drilling holes through the joists as necessary. However, never use both approaches in the same zone unless

Frame Floor: Long Manifold



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.



Appendix

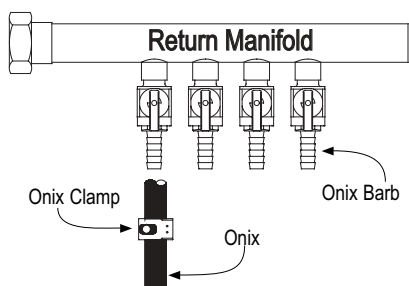
circuit balancing valves are installed to balance the flow.

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 Onix connections are easily accessible for future balancing, air purging, or maintenance.

Onix 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.

Onix Clamps

Onix requires special mechanical clamps, designed for higher temperature and burst pressure ratings. Watts Radiant provides two clamp options:

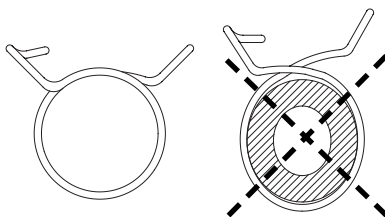
1. TorqueTite clamps are heavy-duty screw-type, wide-band, stainless steel clamps. An in.-lb. torque wrench is required to install them. Each clamp should be tightened according to the proper torque



setting for the size of clamp being used. Torque settings are listed on the instruction sheet that comes with the clamps.

Do not over tighten the TorqueTite clamp. Over-tightening may cause long-term damage to the Onix tubing and/or to the clamp itself.

2. SelfTite Clamps are chrome-vanadium, constant tension clamps. Watts Radiant recommends using the SqueezeTite pliers to properly open and install these clamps.



Onix SelfTite Clamps. It is important not to allow the clamp to flatten while being held open. Flattened clamps will not fit properly over the Onix and barb assembly.

Cautions

- Do not solder near, or overheat, any Onix connections. Extreme temperatures associated with soldering may seriously damage the Onix and will void warranty.
- All Onix and brass fitting surfaces must be clean and dry before making the connection.
- Whenever possible, avoid making connections or splices in inaccessible locations.
- Repairing Onix 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 Onix tube must be removed. Use an alcohol swab or pad to remove the residue(s), then allow the tube to dry prior to connection.

Field Repairs

Jobsite damage does occur from time to time. To prevent the need to replace a complete circuit of Onix, Watts Radiant provided a repair kit. Each kit contains with two barb-by-barb splices and four Onix Clamps.

WARNING:

Use Field Repair Kits only for the repair of Onix damaged in the field. Read complete instructions before beginning repairs. Do not splice together multiple lengths of Onix. 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



TorqueTite Repair Kit includes two barb-by-barb splices and four clamps.



SelfTite Repair Kits include two barb-by-barb splices and four clamps.

Appendix

leaks. Watts Radiant's Onix and fittings are engineered to work together. *Watts Radiant extends no warranty expressed or implied to any failure or damage of any kind resulting from use of materials not supplied by Watts Radiant (see Onix warranty for specifics).*

1. Cut the Onix.

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

2. Select the Correct Brass Splice.

Use only Watts Radiant brass splices and clamps to repair Onix.

NOTE: Our research shows that Watts Radiant brass fittings make the best connections to Onix. Off-the-shelf brass fittings are made to different dimensions and tolerances. Do not use them.

3. Choose the Correct Clamp.

Make sure to use the correctly-sized stainless TorqueTite or SelfTite clamp for making Onix connections. Identify the clamps by the size markings on the clamps. Use:

TorqueTite Clamps
17–19 mm for 3/8" Onix,
21–23 mm for 1/2" Onix,
25–27 mm for 5/8" Onix,
29–31 mm for 3/4" Onix, and
37–40 mm for 1" Onix.

SelfTite Clamps
19 mm for 3/8" Onix,
22 mm for 1/2" Onix,
25 mm for 5/8" Onix, and
29 mm for 3/4" Onix,

Slide one clamp about three inches onto the length of the Onix.

4. Make the Connection.

Slide both lengths of Onix onto the brass splice. Slide the clamps back over the barbed area on both sides. The clamp should be applied to the middle of the barbed area.

If using TorqueTite clamps, tighten the clamp using only an in.-lb.

torque wrench according to the torque settings shown on the instruction sheet that comes with the clamps.

Do not use a screw gun or wrench to tighten TorqueTite clamps. Safety glasses must be worn if using SelfTite Clamps.

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

Pressure Test

After the Onix 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.

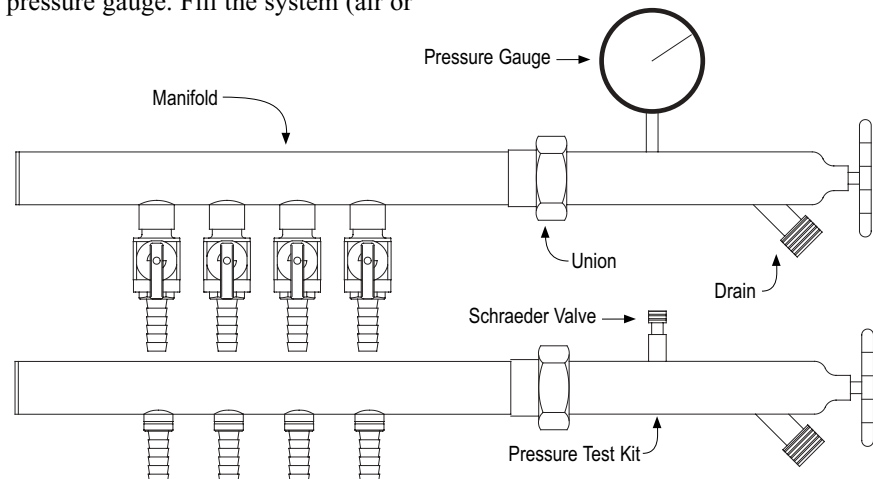
One half of the Watts Radiant test kit has a Schraeder valve (air valve) on side A. The other half, side B, has a pressure gauge. Fill the system (air or

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.

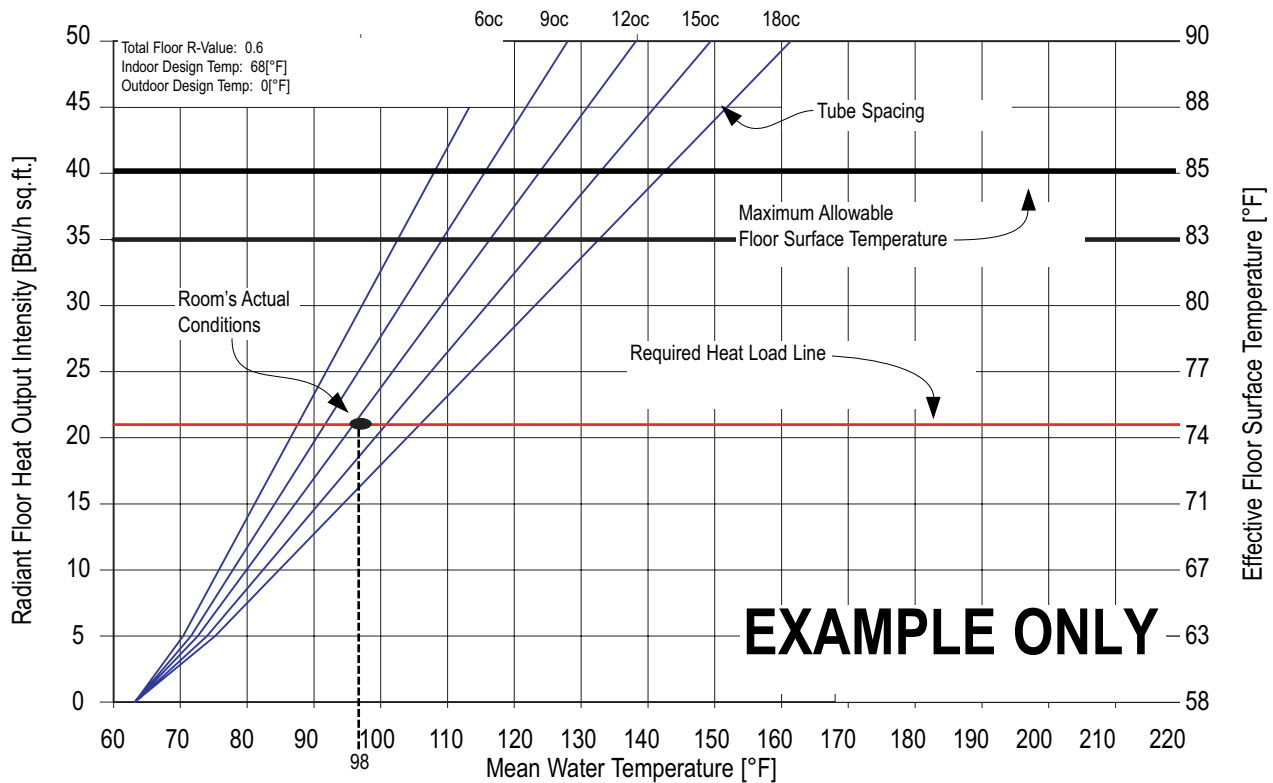
The cool night air will usually cause less than a ten psi drop in pressure as the water or air contracts from the cold. If there is more of a pressure drop, or if there are other reasons to believe there is a leak, spray a soapy solution on all connections and inspect for leaks. If there are still concerns about leaks, increase the test pressure to 100 psi and inspect each of the circuits. A leak should be visible.

NOTE: During pressure testing the ends of each circuit where they connect to the manifolds may bubble for ten or fifteen minutes each time the system is pressurized. This is due in part to the pressure expanding the inner channel, driving small amounts of trapped air out of the braiding between the tube and cover. This is normal and is not a concern, as long as the system pressure does not drop.



Appendix

Watts Radiant Nomograph © for Breakfast / Kitchen Area Slab Application 3/8" Onix



Typical Nomograph

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 Onix 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°F,

the project is at an altitude of 2000 ft. and 3/8" Onix is being installed.

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

The right vertical axis displays the average floor surface temperature. The actual floor surface temperature will vary ±1°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/h/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.

Appendix

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

Each diagonal line shows the heat output of a different Onix spacing, under the same design parameters. Changes in the Onix size, 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 Onix spacings, ranging from 6" to 18" on center. 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 whenever the horizontal line associated with the heating intensity intersects the diagonal line associated with a particular hose 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/h/sq.ft. and we choose an Onix spacing of 12" on center. The mean water temperature where these two lines intersect is about 92°F, or 102°F supply temperature (based on a 20°F temperature drop). If a 6" on center 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 Onix spacing necessary to meet the load still may not satisfy the customer. For example, an 18" o.c. 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 Onix, for plain water, ethylene and propylene glycol. Information regarding the heat required by the circuit (Q_s), pressure drop in the hose (ft.-hd./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°F—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/h. Four, 200' circuits of 3/8" Onix 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/h/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" Onix.
4. Drop a line vertically to read the pressure drop per foot of hose (0.03 ft.-hd./ft.)
5. Find the total length of the hose 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 0.03 ft.-hd./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 energy transfer hose. 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 practice to maintain water velocities above 1 ft./sec and below 5 ft./sec. For instance, 3/8" Onix in 200' lengths should be designed to transfer at least 3,000 BTU/h, and 5/8" Onix in 200' lengths should ordinarily be designed to transfer at least 9,000 BTU/h.

Flow rate per circuit at 20°F ΔT can be found by continuing horizontally from the heat required (Q_s) per circuit (on the left side of the chart) and

Appendix

reading the flow rate on the right side of the chart.

In the above example, the flow rate for each circuit is approximately 0.43 gpm at a ΔT of 20°F. The total flow rate to deliver 16,000 BTU/h is 4 (circuits) $\times$ 0.43 = 1.72 gpm.

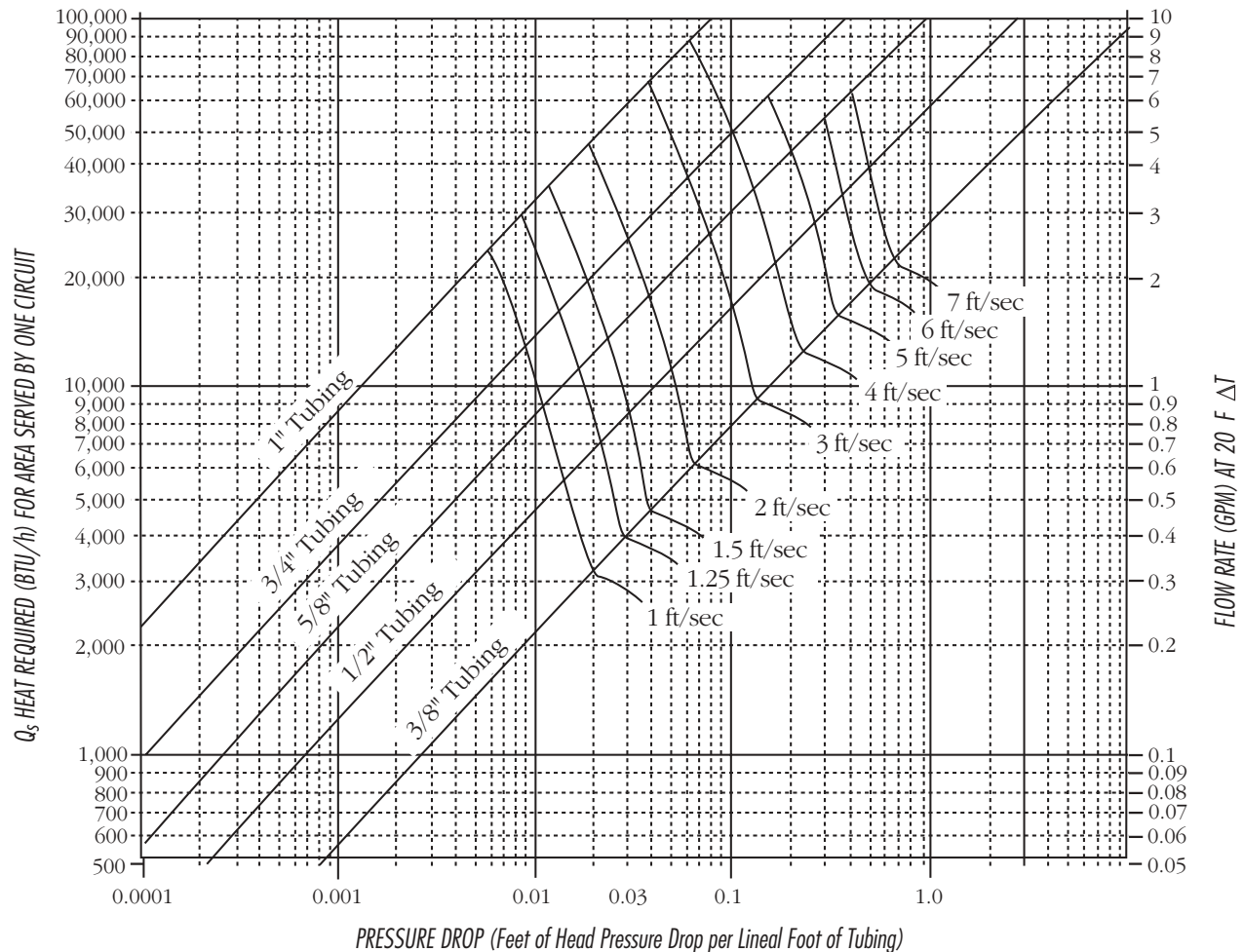
Note that if the flow rates are to be manually calculated, the required supply temperature can make a significant difference in the resulting calculations. All three of the following charts are

for fluids at a temperature of 120°F. Systems with anti-freeze 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 AUTOMOTIVE ANTIFREEZE IN ANY HYDRONIC SYSTEM.

Watts Radiant™ PRESSURE DROP CHART FOR Onix™ Pure Water

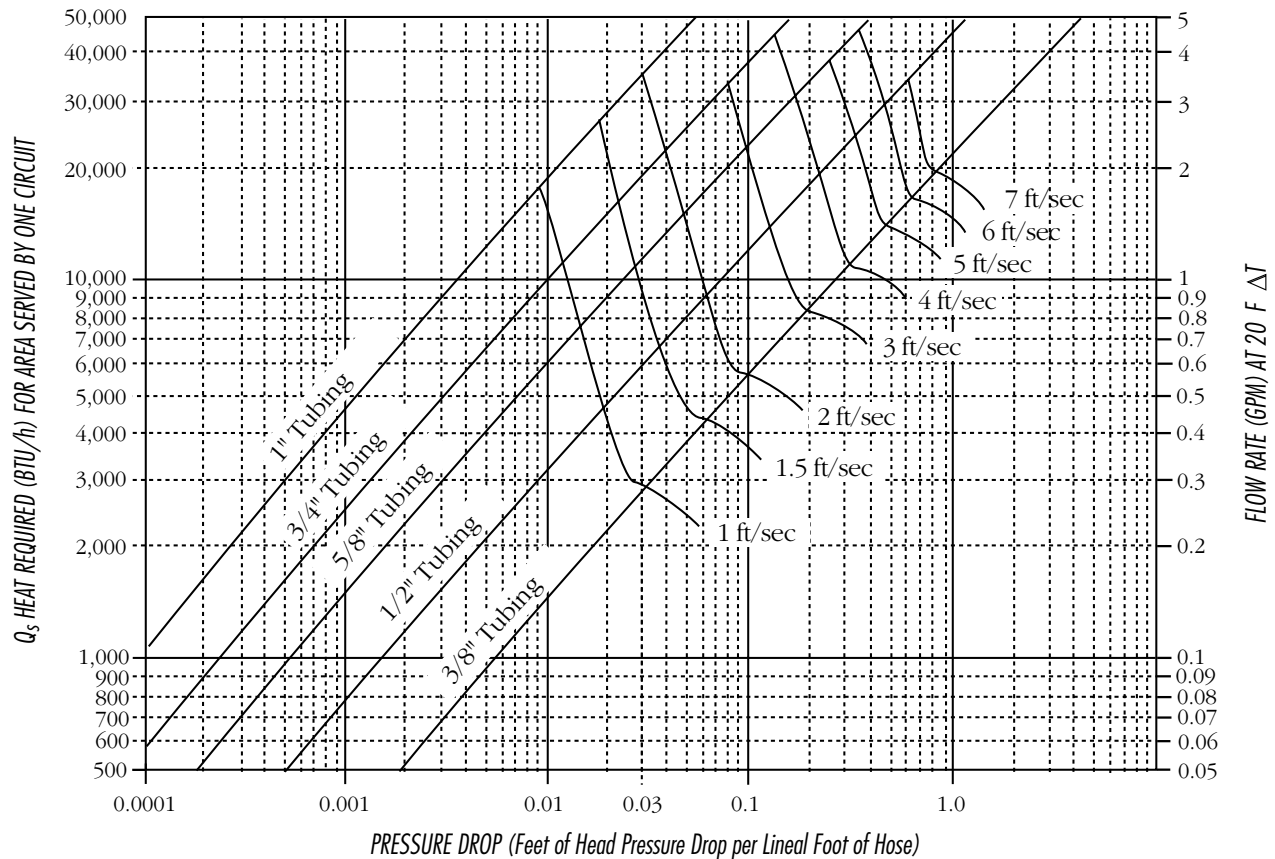


- Notes:
1. The heat required is the energy the boiler must deliver for the calculated heat output of a circuit. If only the net heat output of the circuit is known, multiply by 1.1 to get Q_s , assuming the back and edges are insulated or space below is heated.
 2. If the ΔT is different from 20°F, the value of Q_s must be multiplied by $20/\Delta T$.
 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.

Typical pressure drop chart for water systems.

Appendix

Watts Radiant™ PRESSURE DROP CHART FOR Onix™ 50% Propylene Glycol/50% Water

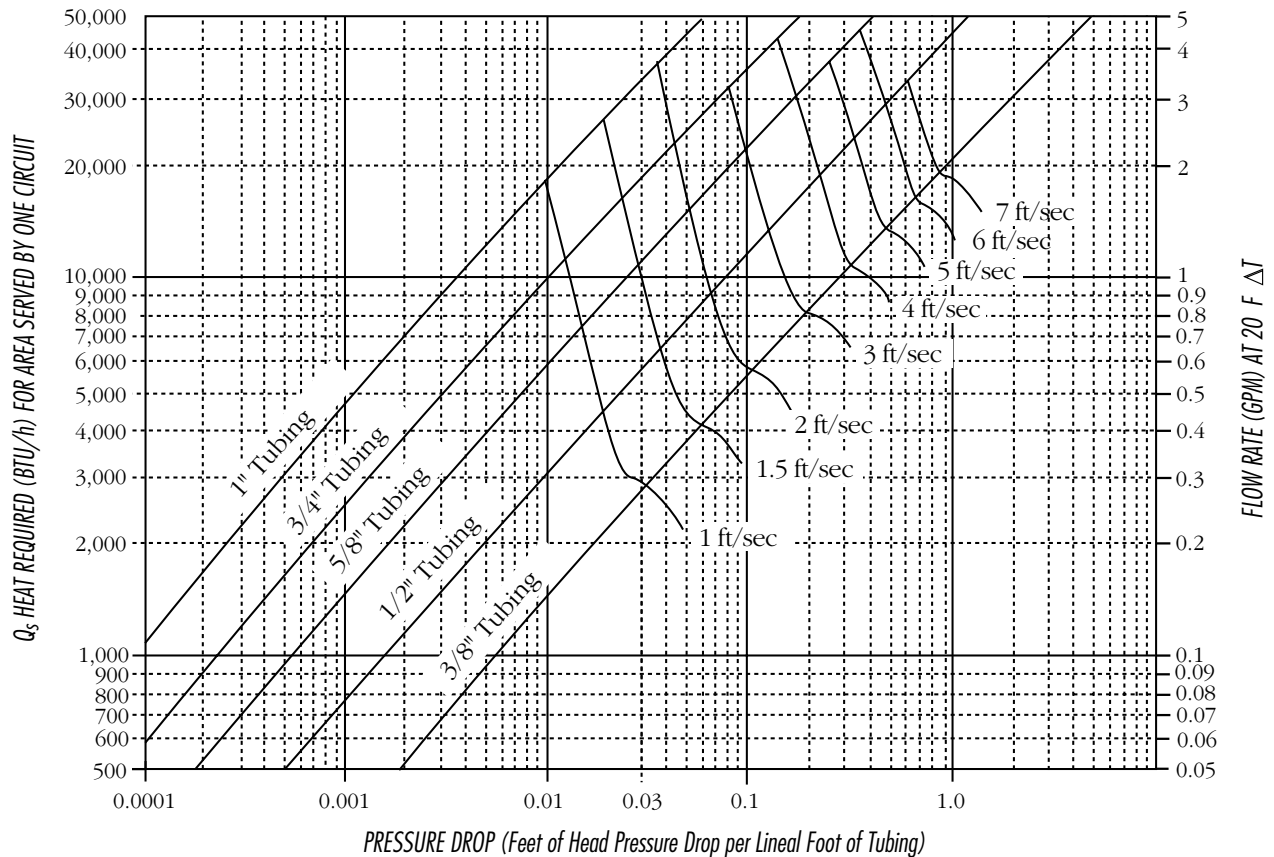


- Notes:
1. The heat required is the energy the boiler must deliver for the calculated heat output of a circuit. If only the net heat output of the circuit is known, multiply by 1.1 to get Q_s , assuming the back and edges are insulated or space below is heated.
 2. If the ΔT is different from 20°F, the value of Q_s must be multiplied by $20/\Delta T$.
 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.

Appendix

Watts Radiant™ PRESSURE DROP CHART FOR Onix™ 50% Ethylene Glycol/50% Water



- 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 Q_s must be multiplied by $20/\Delta T$.
 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.

Appendix

Onix No-Sweat™

Watts Radiant's Onix 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 Onix to baseboard, fan coils or manifolds. It is important to prevent Onix from exceeding its minimum allowable bend radius. If this radius

Baseboards, Fan Coils and Manifolds Connections

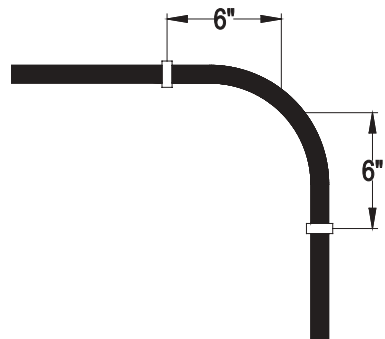
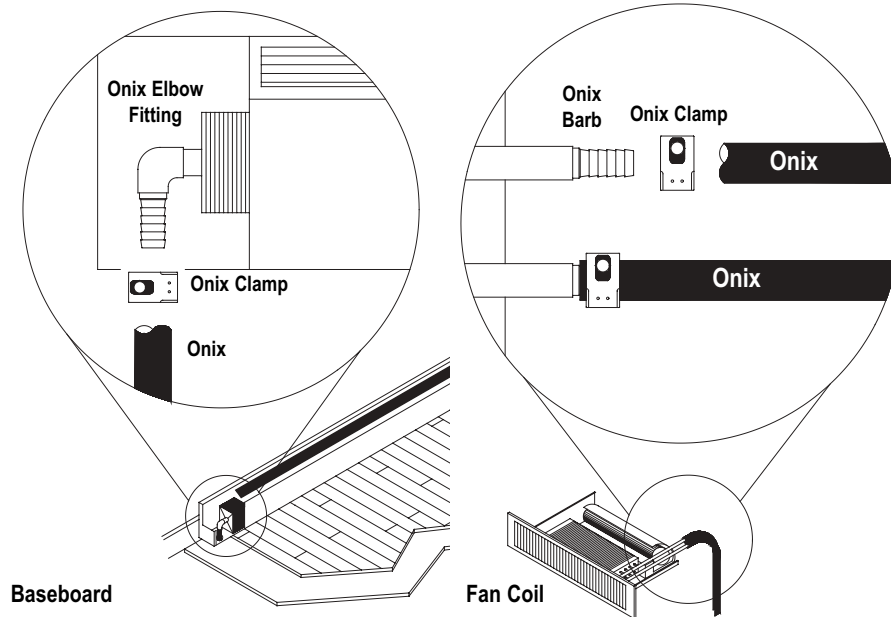
can not be maintained, a copper elbow should be hard piped to the unit prior to the installation of the Onix Barb fitting.

CONNECTION DETAILS

1. Choose the correct Onix size for the design flow rate (see below).
2. Choose the corresponding Onix Barb or Elbow and clamp (TorqueTite or SelfTite).

3. Solder the Onix Barb, or Onix Elbow, onto the baseboard, fan coil unit, or manifold. If an elbow is required, install this prior to installing the barb.
4. Slide the clamp over the Onix and then the Onix over the entire barb.
- 5a. TorqueTite clamp: Tighten using an in.-lb. torque wrench to proper torque settings for each clamp size. Torque settings are stated for each clamp size on the instructions that accompany the clamps.
- 5b. SelfTite clamp: open with a pair of SqueezeTite pliers, making sure not to over expand the clamp.

Follow additional installation instructions included with the Onix fittings and clamps.



Ordering numbers for Onix barbs, elbows, and clamps.

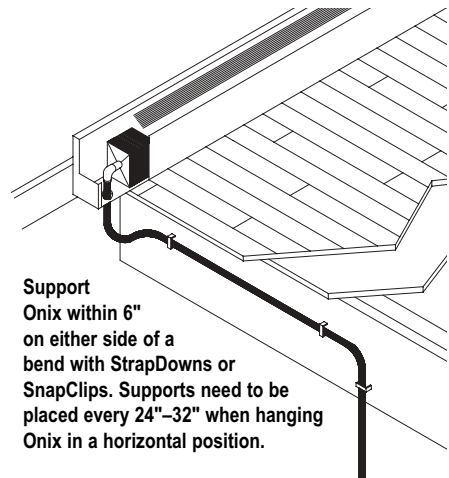
Tubing Size (I.D.)	Onix Barbs	Onix Elbows	TorqueTites	SelfTites
1/2" Onix	81000663	81000116	81002916	81000526
5/8" Onix	81000667	81000120	81002919	81000529
3/4" Onix	81000671	81000118	81002922	81000532
1" Onix	81000675	N/A	81002925	N/A

Estimated maximum output (BTU/ft.) by pipe size for baseboard systems.

Temperature	System Piping Size		
	3/4"	1"	1-1/4"
160°F	520	560	610
170°F	600	650	700
180°F	680	730	790

Estimated maximum output (BTU) at three flow rates for fan coil systems.

Temperature	Rate of Flow		
	1 gpm	3 gpm	5 gpm
160°F	6500	7100	7300
170°F	7400	8000	8200
180°F	8000	8600	8950



Support Onix within 6" on either side of a bend with StrapDowns or SnapClips. Supports need to be placed every 24"-32" when hanging Onix in a horizontal position.

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 eventually lead to premature failure of the boiler.

In addition to condensation, boilers must operate at a maximum temperature rise, typically 20° to 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.

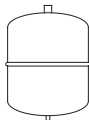
There are several books solely dedicated to this piping practice which offer a very detailed explanation. For this manual, we will assume the following conditions:

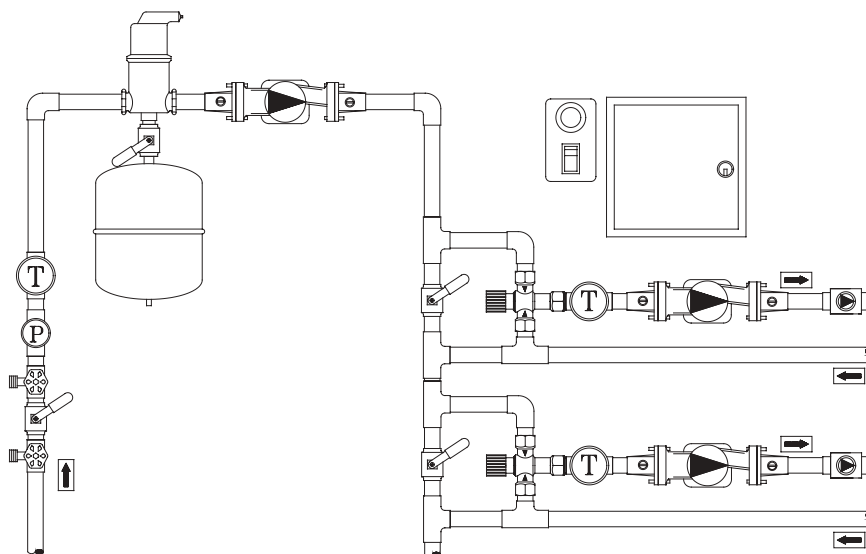
1. The Air Remover, Expansion Tank and automatic fill assembly are located at roughly the same location.
2. The primary pump is positioned after the expansion tank in a pumping away position.
3. The primary pipe size is sized based on the boiler load and flow requirements.

How to Size a Circulator

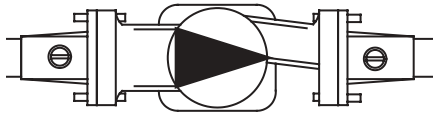
Circulators, or pumps, are sized based on the required load and piping loss for a given zone. The heat load dic-

Legend

	Expansion Tank
	FuseTron and RelayBox
	Air Remover
	Circulator
	Isolation Flanges
	Mix Valve
	PRV Valve (AutoFill)
	Backflow Preventer
	Control
	Sensor
	Pressure and Temperature Gauges
	Ball Valve
	Boiler Drain
	Gravity Check Valve
	Spring Check Valve
	Zone Valve



Appendix



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

Pure Water:

$$\text{BTU} = \text{gpm} \times 500 \times \Delta T$$

50% Glycol-50% Water:

$$\text{BTU} = \text{gpm} \times 455 \times \Delta T$$

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

$$1 \text{ gpm} = 10,000 \text{ BTU/h}$$

So, a system requiring 100,000 BTU/h 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 Onix 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 Onix 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/h to be delivered to a zone with 5'—200' circuits of 3/8" Onix. The manifold is located 20' from the mechanical room.

Step 1: Determine the zone flow rate.

The flow rate for the zone is
 $20,000/10,000 = 2 \text{ gpm}$.

Step 2: Determine the circuit flow rate.

The flow rate through each circuit is
 $2 \text{ gpm}/5 \text{ circuits} = 0.40 \text{ gpm/circuit}$

Step 3: Determine the zone pressure drop

Using the pressure drop chart for water, the pressure drop per foot of tubing is 0.031 ft.-hd./ft. tubing. This gives a zone pressure drop of $0.031 \times 200 = 6.20 \text{ ft.-hd.}$

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. $0.02 \times 40'$ (supply and return distance) = 0.80 ft.-hd.

Step 5: Determine complete pump spec.

The required pump load is 2 gpm at $(6.20 + 0.80)$ or 7.0 ft.-hd.

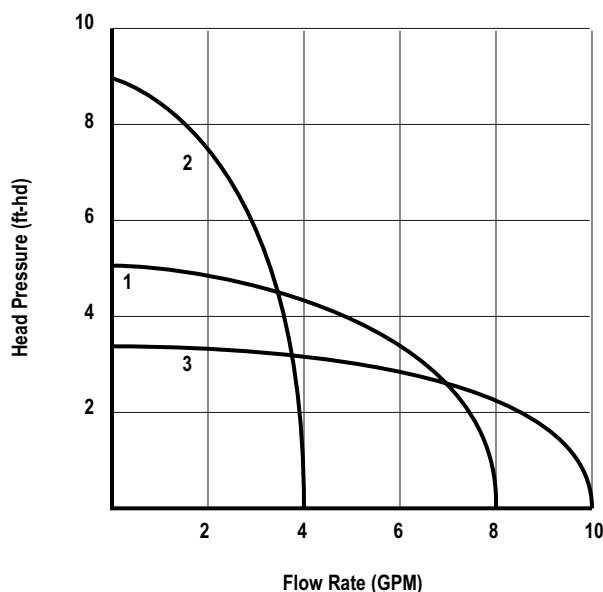
The actual pump required for this zone is selected using the given manufacturer's guidelines. This is usually done with the use of a pump curve chart. The chart is set up showing the pumps capacity at various pressure drops. Choose the pump that best reflects the needs of the system.

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.



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

Appendix

$$PV = T$$

(Pressure x 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 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 step-by-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, supply-return 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.

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).

	Pipe Length	×	Volume/Foot*	=	Fluid Volume
Radiant Piping	_____		_____		_____
Supply/Return Piping	_____		_____		_____
Boiler Volume (see boiler manual)	_____		_____		_____
Total Volume (TV):					_____

Total System Volume Includes:

Boiler (see manufacturer's specifications)
Fancoils
Radiant Supply/Return Lines

Optional Buffer Tank
Radiators
Additional Hydronic Components

$$\text{Tank Size} = \frac{\text{Expansion Volume (EV)}}{\text{Acceptance Factor (AF)}}$$

$$\text{Fill Pressure} = (\text{No. of floors} \times 3.87 + 7 \text{ psi}) + 14.7 = \underline{\hspace{2cm}}$$

$$\text{Expansion Volume (EV)} = \text{Total Volume (TV)} \times \text{Expansion Factor}$$

$$\text{EV} = \underline{\hspace{2cm}}$$

$$\text{AF} = \frac{(\text{Relief Pressure} + 14.7) - \text{Fill Pressure}}{(\text{Relief Pressure} + 14.7)} = \underline{\hspace{2cm}}$$

$$\text{Tank Size} = \frac{(\text{EV})}{(\text{AF})} = \underline{\hspace{2cm}}$$

* See system volume table on the following page.
See table of expansion factors on the following page.

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.

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.

Appendix

System volume chart.

Tubing I.D.	Onix-PEX Fluid Capacity	Type M Copper Fluid Capacity
3/8"	6.25 gal./1000 ft.	8.31 gal./1000 ft.
1/2"	10.25 gal./1000 ft.	13.2 gal./1000 ft.
5/8"	16.0 gal./1000 ft.	18.1 gal./1000 ft.
3/4"	25.0 gal./1000 ft.	27.0 gal./1000 ft.
1"	N/A	45.5 gal./1000 ft.
1-1/4"	N/A	68.2 gal./1000 ft.
1-1/2"	N/A	95.4 gal./1000 ft.

Expansion Factors.

Water		Glycol	
System Temperature (°F)	Expansion Factor	System Temperature (°F)	Expansion Factor
105	0.004	105	0.0048
110	0.005	110	0.006
115	0.007	115	0.0084
120	0.008	120	0.0096
125	0.010	125	0.012
130	0.012	130	0.0144
135	0.013	135	0.0156
140	0.015	140	0.018
145	0.017	145	0.0204
150	0.018	150	0.0216
155	0.020	155	0.024
160	0.022	160	0.0264
165	0.023	165	0.0276
170	0.025	170	0.030
175	0.026	175	0.0312
180	0.028	180	0.0336
185	0.030	185	0.036
190	0.032	190	0.0384
195	0.033	195	0.0396
200	0.035	200	0.042
205	0.037	205	0.0444
210	0.039	210	0.0468

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.

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 ft.-hd.) 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.

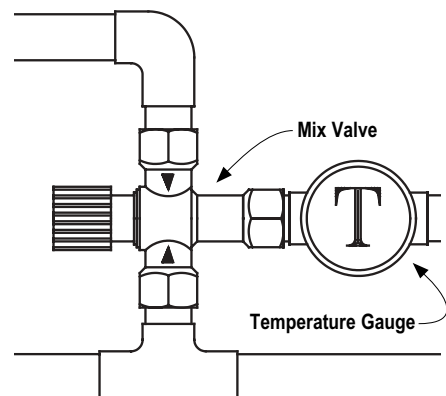
To determine the pressure drop through the mix valve at a given flow rate, use the following equation:

$$\left[\frac{\text{gpm}}{\text{Valve Cv rating}} \right]^2 \times \text{SG} = P$$

where SG is the specific gravity of the fluid (for water this is 1, for glycol this is 1.15), and 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:

$$\text{BTU/h} = \text{gpm} \times 500 \times \Delta T$$

50% Glycol-50% Water:

$$\text{BTU/h} = \text{gpm} \times 455 \times \Delta T$$

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

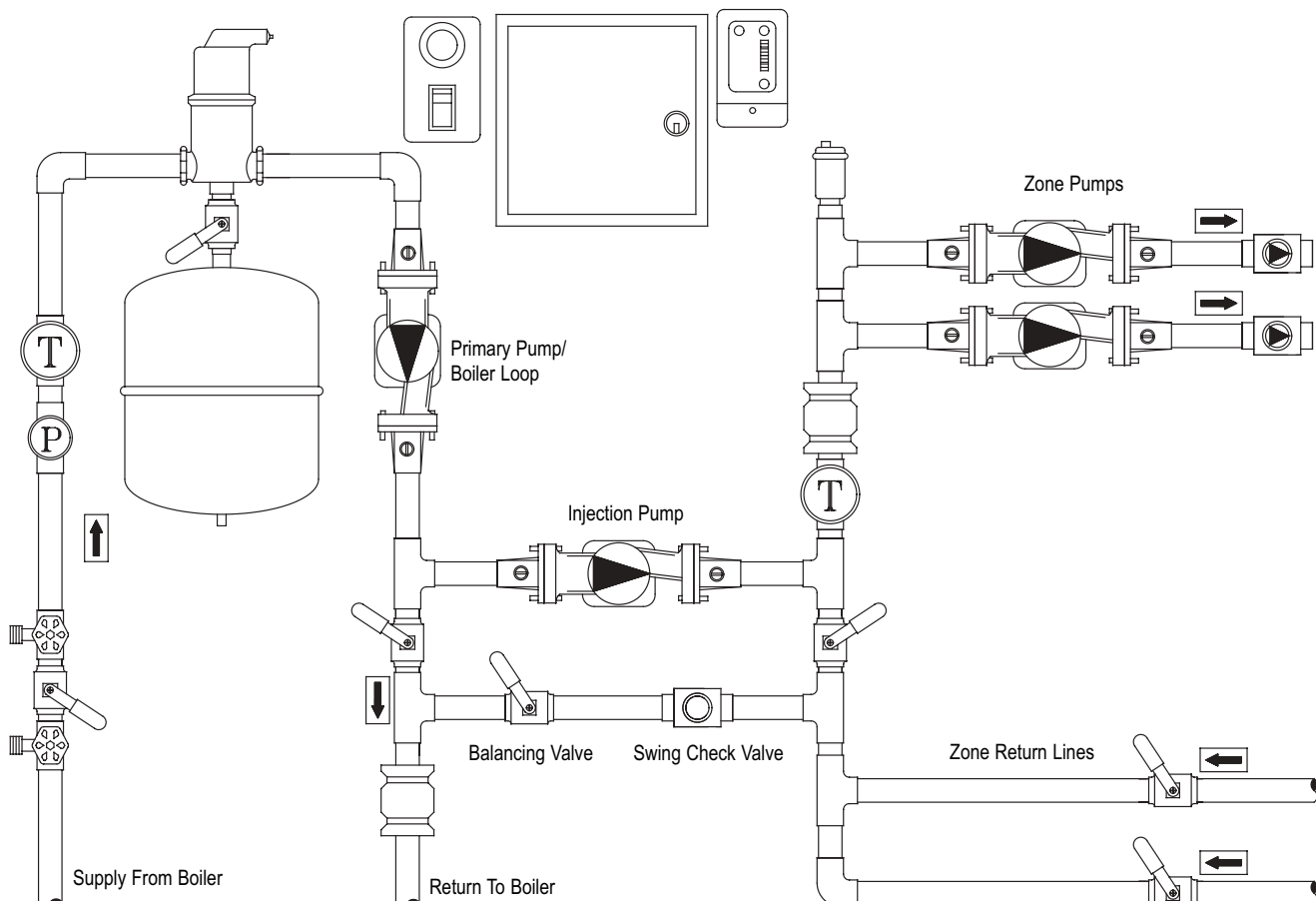
Each zone is designed around a 20°F ΔT . This is done for comfort and

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:

$$\text{BTUs} = 10 \times 500 \times 20 = 100,000$$



Appendix

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

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

$$\text{gpm} = 2.5$$

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.

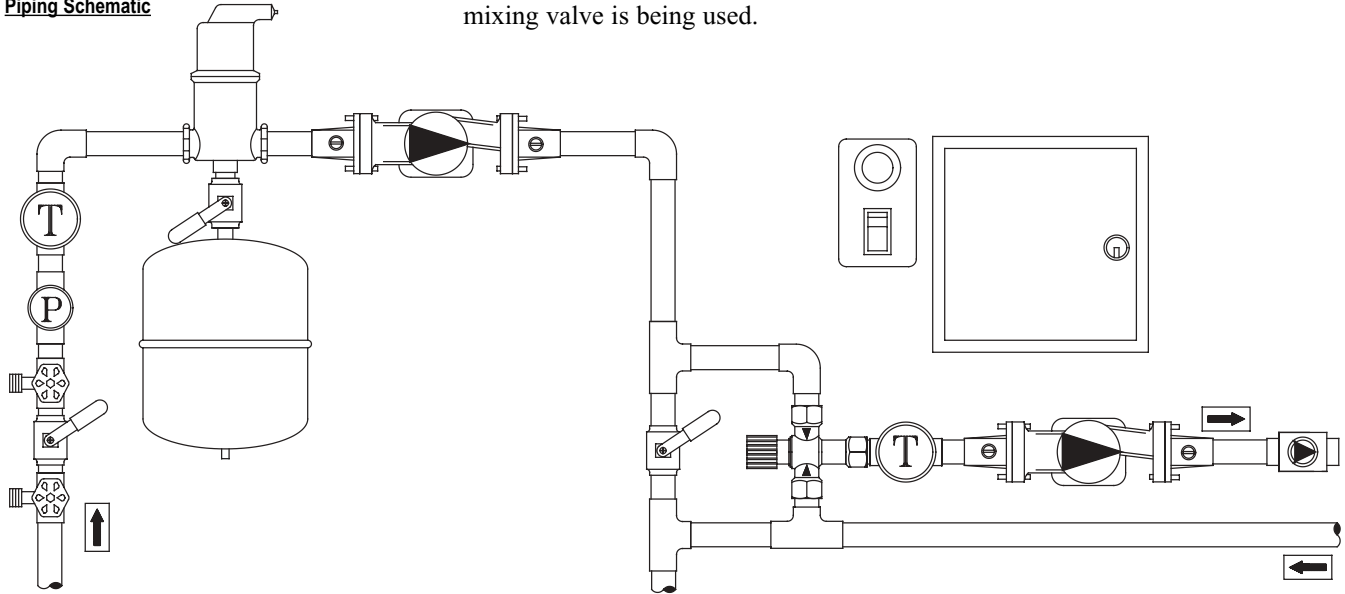
Appendix

Piping and Electrical Diagrams

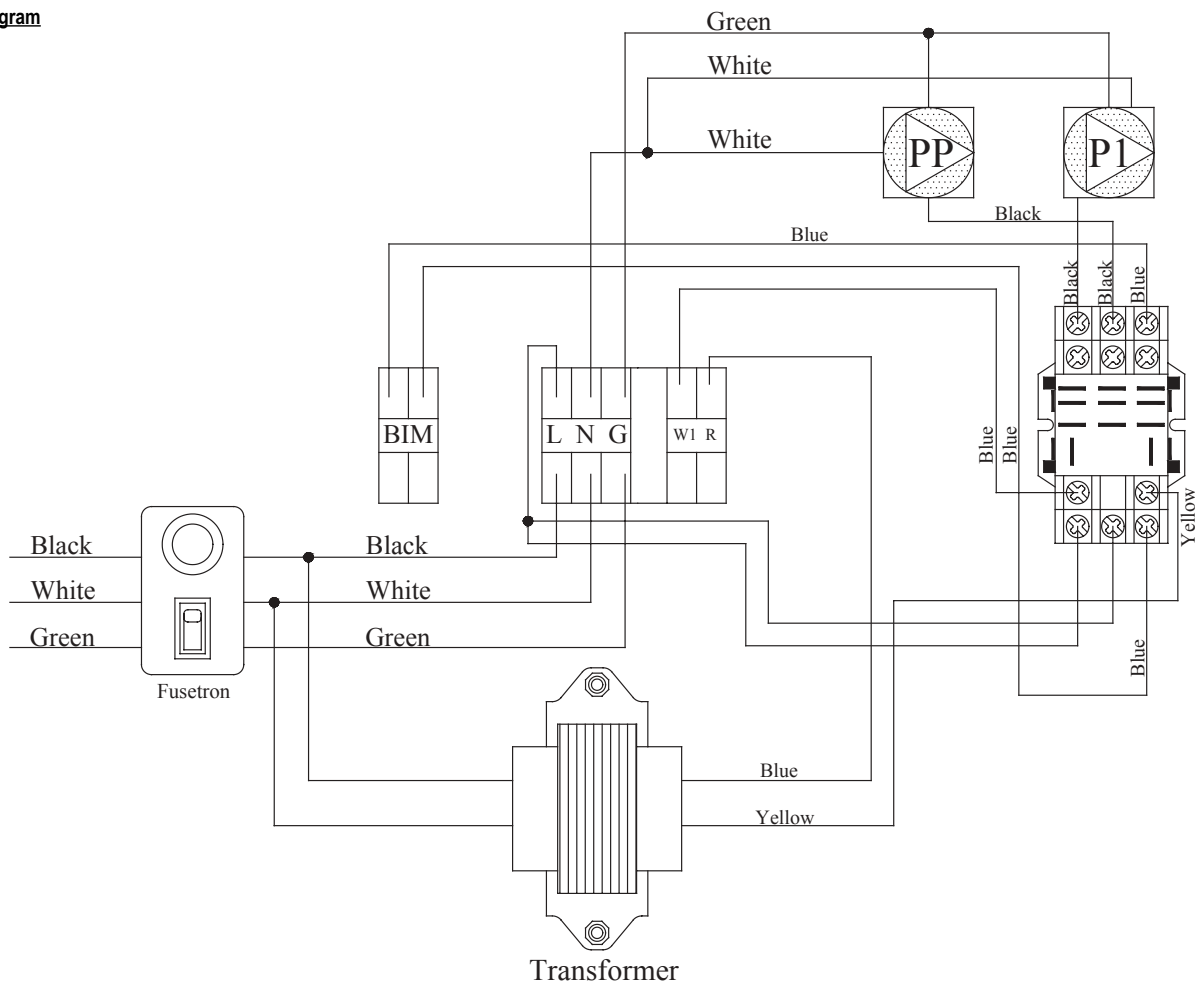
One zone off boiler

The schematic shown illustrates a single-zone system, where a non-electric mixing valve is being used.

Piping Schematic

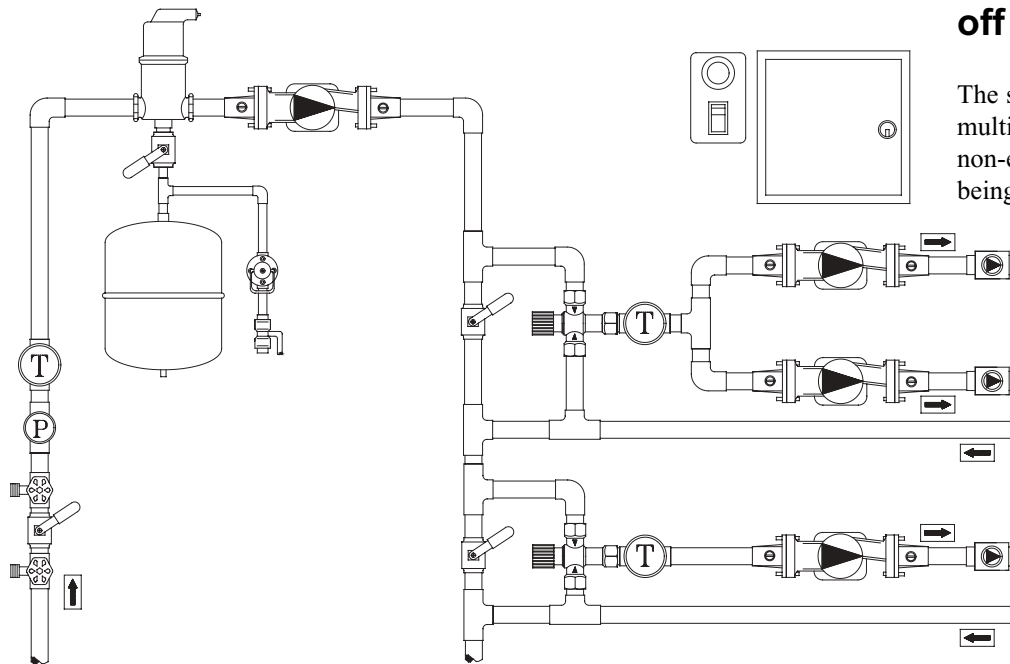


Electrical Diagram



Appendix

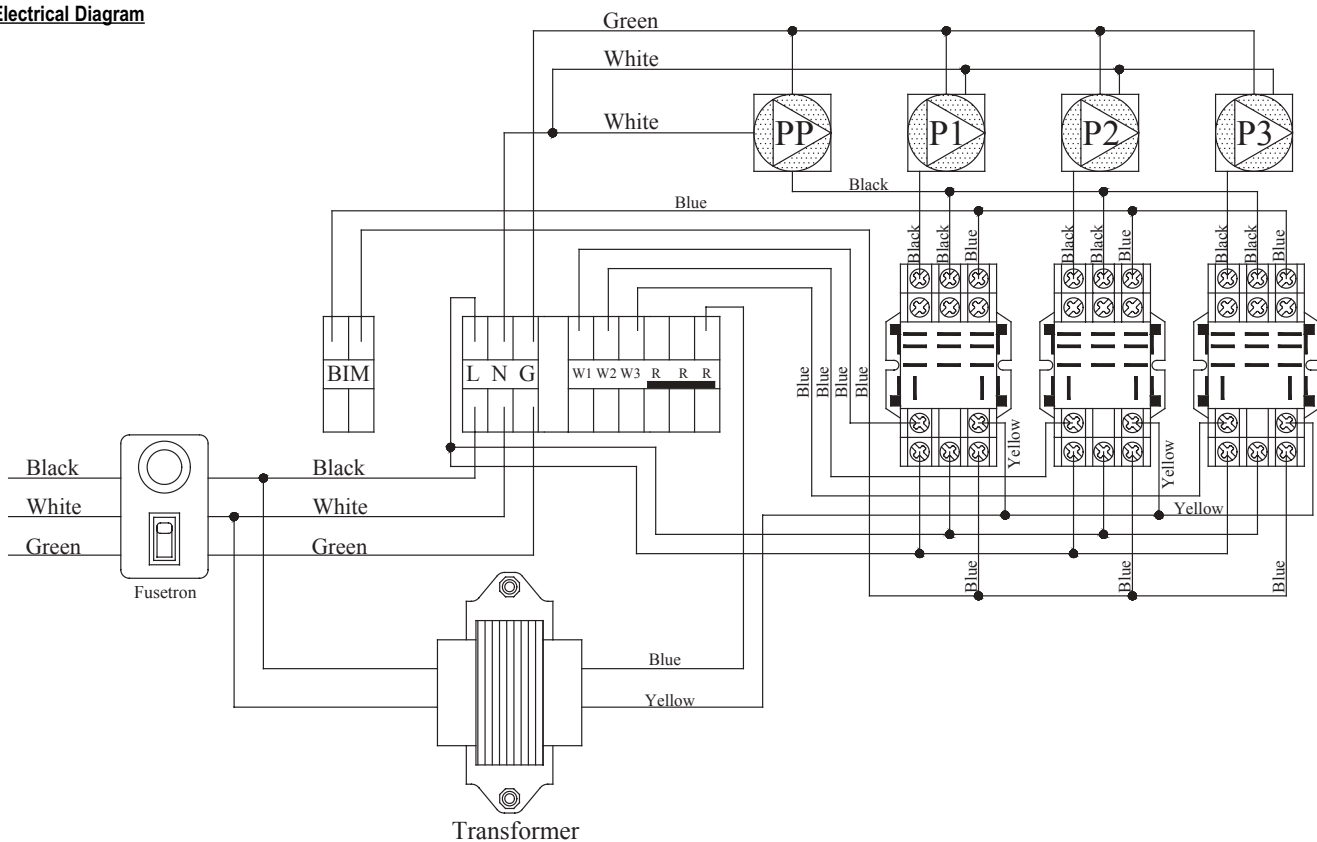
Piping Schematic



Multiple zones off boiler

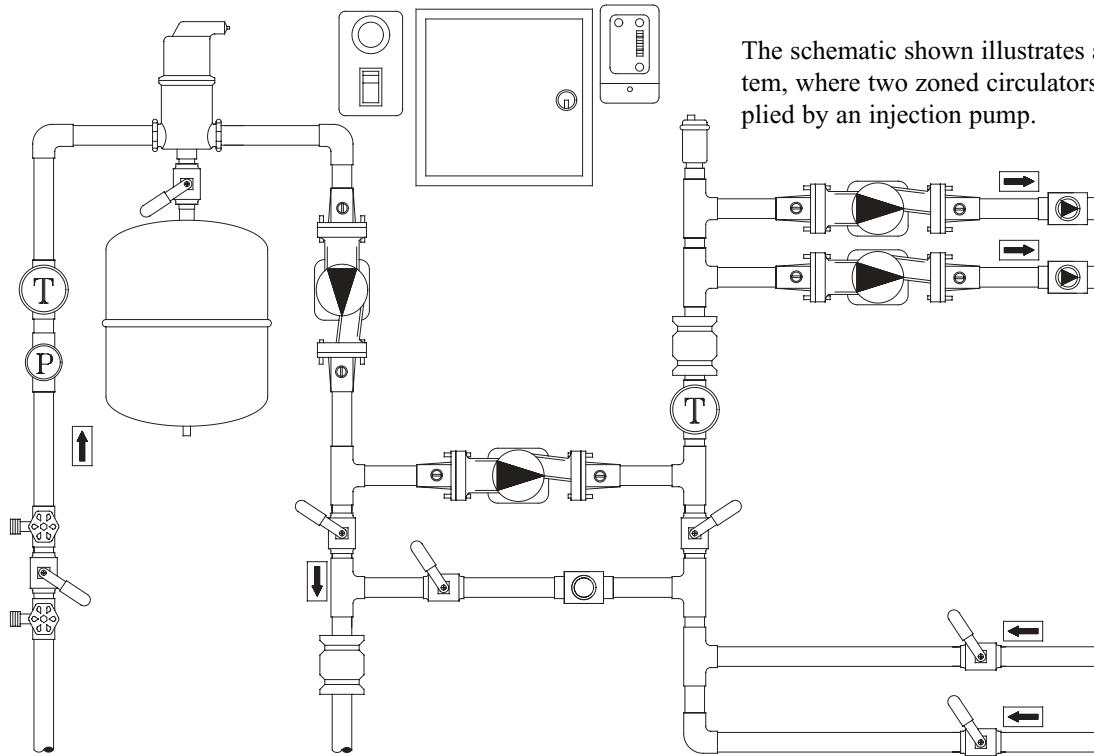
The schematic shown illustrates a multi-zone system, where two non-electric mixing valves are being used.

Electrical Diagram



Appendix

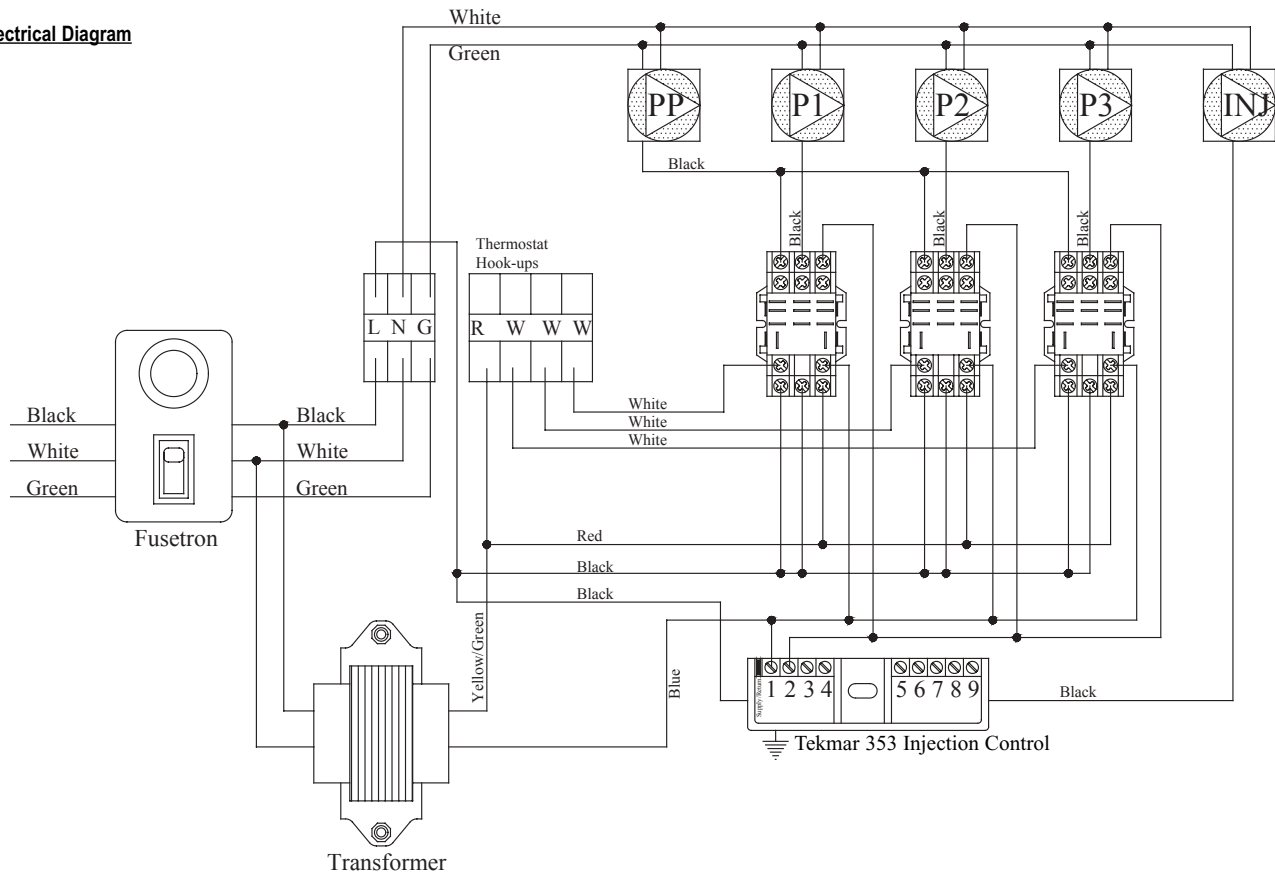
Piping Schematic



Multiple zones off boiler with injection pump mixing

The schematic shown illustrates a multi-zone system, where two zoned circulators are being supplied by an injection pump.

Electrical Diagram



Notes

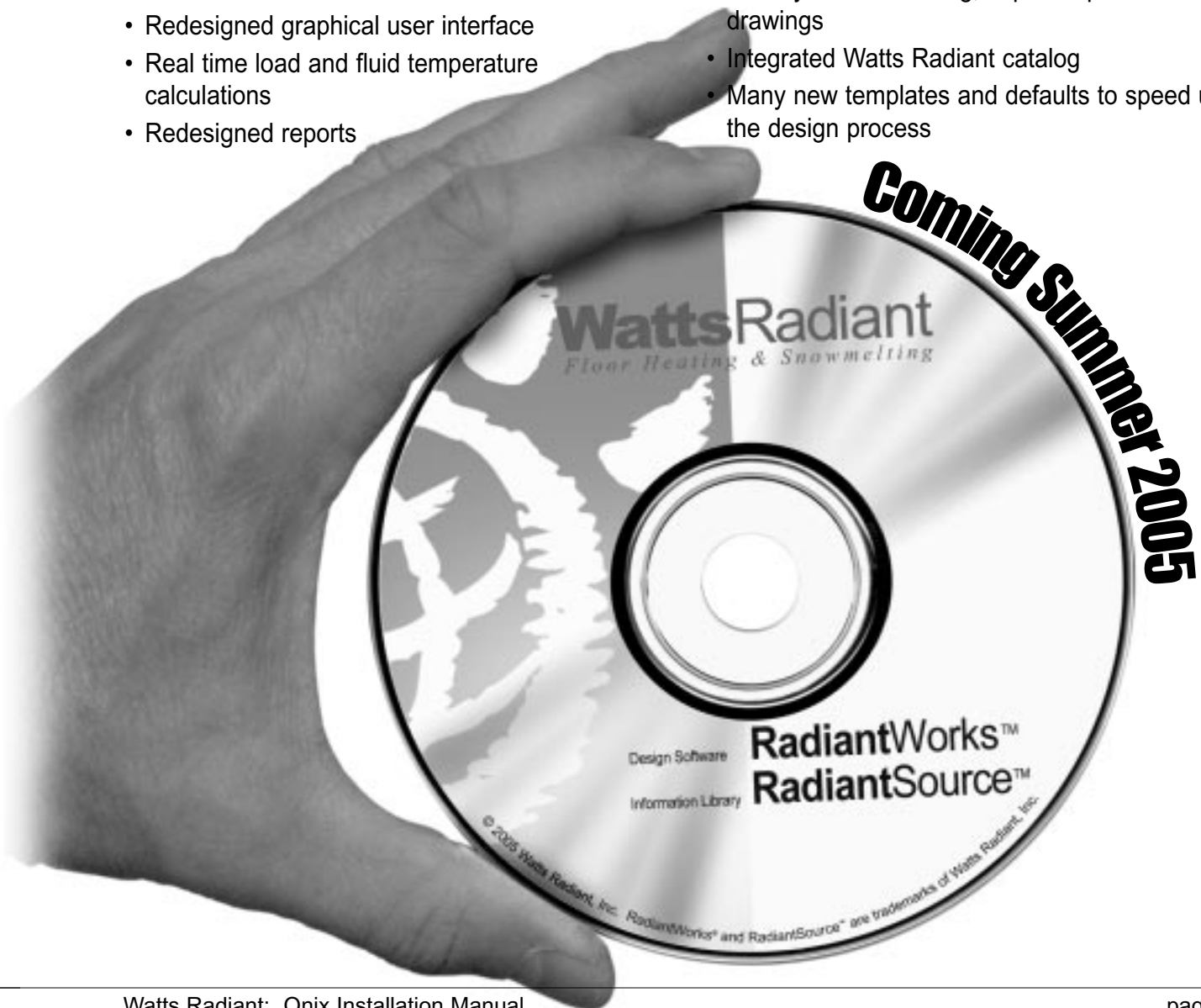
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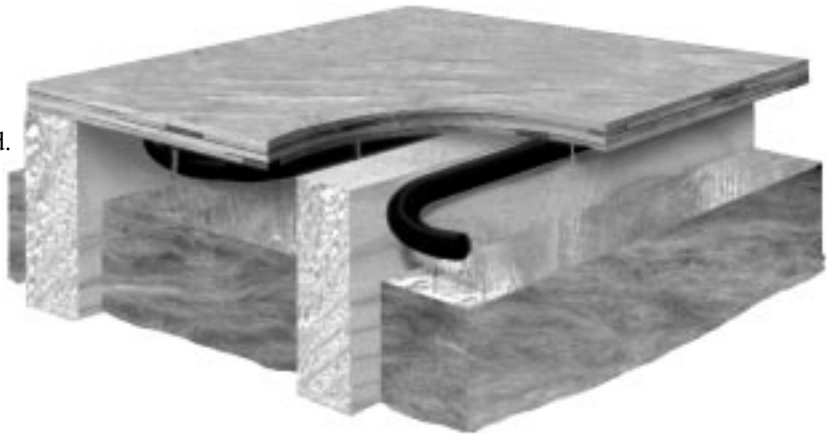
Common Radiant Floor &

Staple-Up™

This is one of our most popular installation methods. Staple Onix underneath the wood subfloor every 4" to 6" so that the Onix maintains continuous contact with the wood.

Install a foil-faced fiberglass insulation (foil facing up), leaving a 2" air gap between the foil and the underside of the subfloor.

It is important to always insulate the exterior band joists in this application.



Sandwich Over Frame Floor

with fiberglass insulation

This technique is generally used when hardwood flooring is being installed or when there is no access to install the Onix from below the subfloor.



Always use a foil-faced fiberglass (foil facing up), leaving a 2" air gap between the foil and the underside of the subfloor. It is very important to select the correct nailer thickness, so that the Onix maintains continuous contact with the underside of the upper floor or subfloor, but isn't crushed or deformed.

Alternatively, a concrete mix or gypsum-based mix can be used to fill this void.

Do not use staples or NailTites in this application. Use duct tape or contractor's adhesive if the Onix needs to be held in place.

Sandwich Over Frame Floor

with foamboard insulation

Use this technique when you don't have access under the existing floor or when the underside of the floor can't be used, such as beamed ceilings.



Install a high-temperature foil-faced foamboard insulation, such as Thermax® or equivalent, between the nailers. It is very important to carefully select the correct nailer and foamboard thickness, so that the Onix maintains continuous contact with the underside of the upper floor or subfloor, but isn't crushed or deformed.

Alternatively, a concrete mix or gypsum-based mix can be used to fill this void.

Do not use staples or NailTites in this application. Use duct tape or contractor's adhesive if the Onix needs to be held in place.

Sandwich over Slab

This is a popular option when converting a building with an existing slab, such as a garage or basement, to a radiant floor heating system.



Install a high-temperature foil-faced foamboard insulation, such as Thermax® or equivalent, between the nailers. It is very important to carefully select the correct nailer and foamboard thickness, so that the Onix maintains continuous contact with the underside of the upper floor or subfloor, but isn't crushed or deformed.

Do not use staples or NailTites in this application. Use duct tape or contractor's adhesive if the Onix needs to be held in place.

Thin Slab over Frame Floor

with fiberglass insulation

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



You must use a foil-faced insulation for this application, with the foil facing up. Allow a 2" minimum air space between the foil surface and the subfloor.

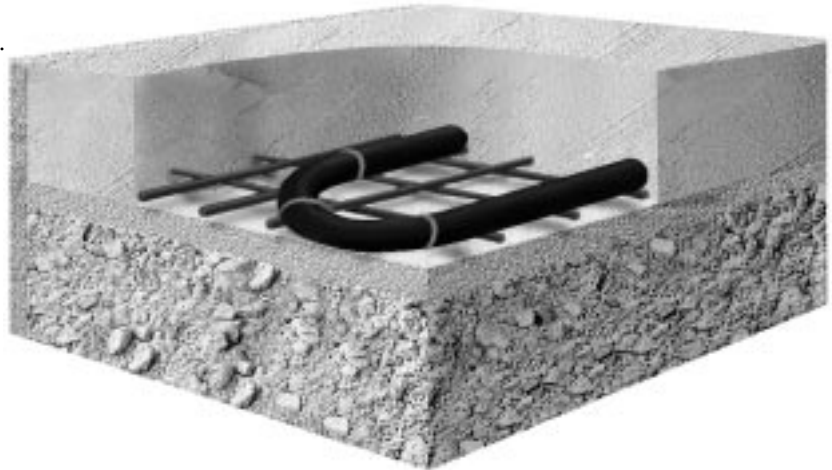
Snowmelting Applications

Slab on Grade

Warm up a concrete slab to provide space heat.

Install a minimum of 2" of concrete above the top of the Onix for residential and 3" for commercial floor heat applications. You may need a greater thickness over the Onix, 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 Onix can be tied to rewire or poultry netting depending on the structural needs of the project.

Typical Slab Snowmelt

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



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

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

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 Onix in place and then cover it with a minimum of 2" of portland concrete mix above the top of the Onix. 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.

Sprayed-on insulation also works well in this application.

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.



Onix is installed in a sand or crushed stone base, then secured with wire hooks every two feet along its length. A layer of sand is then placed over the Onix and compacted to provide a minimum of 1" coverage above the top of the Onix (more may be required depending on structural loading). The brick pavers are then installed on the compacted base material.

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

Onix with AlumaShield Compared with EVOH Barrier PEX

Tubing Properties

Flexibility	Onix flexible even in subfreezing temperatures	Barrier PEX larger bend radius, stiff below 40°F
Abrasion	highly abrasion resistant	susceptible to abrasion from metal, fasteners or sharp fill
Sunlight	not affected by exposure	damaged if exposed for more than a few weeks
Kinking	not damaged by kinking	must be replaced or repaired if kinked
Temperature	functional from -35°F to +180°F	easily damaged in cold
Flame resistance	highly flame resistant	burns easily
Stress cracking	not affected by stress cracking	damaged by physical impact and other stress

Barrier Properties

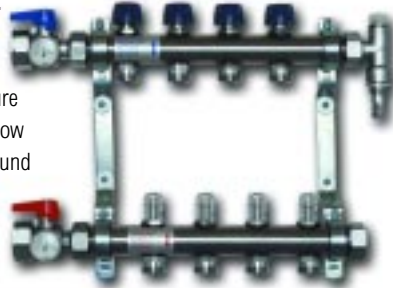
Moisture	AlumaShield™ not damaged by moisture	EVOH performance lessened by exposure to moisture
Heat	not damaged by heat	permanent performance loss by 160°F+ exposure
Sunlight	not damaged by UV radiation	damaged by more than a few weeks of sunlight

Available Sizes:

Onix is available in the following nominal I.D.: 3/8", 1/2", 5/8", 3/4", and 1".

Onix Manifolds:

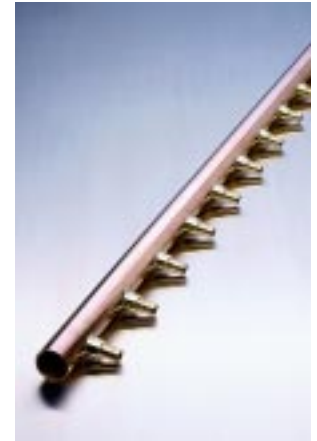
Watts Radiant offers a wide range of manifolds for Onix. Manifold accessories include unions, isolation valves, temperature gauges, vent-and-purge assemblies, and flow meters. Additional specifications can be found in the Watts Radiant Onix Submittal or the Watts Radiant full-line Product Catalog.



Stainless Steel Manifolds



Swedged Manifolds



CustomCut™ Manifolds

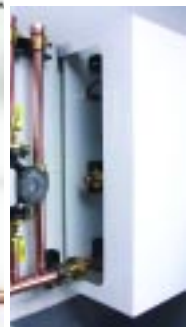
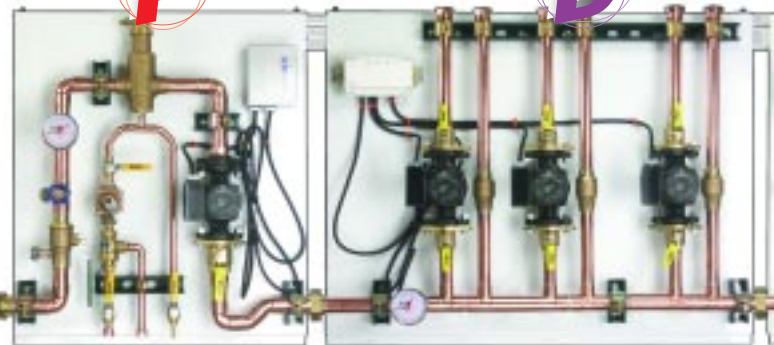
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Onix is tested to relevant portions of several ASTM standards, carries the BOCA certification mark as approved by BOCA research report number 95-47.1, and carries the UPC mark as approved by the International Association of Plumbing and Mechanical Officials. Watts Radiant is a charter member of the Radiant Panel Association.

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