INFLOOR HEATING SYSTEMS

Residential Design & Installation Guide

We Make Radiant Simple

America's Authority on Radiant Heating Systems and Designs for over 30 years

Table of Contents

Table of Contents

Introduction

Welcome to the world of Infloor Heating Systems. We specialize in designing and providing the best radiant heating systems and solutions available. We are an industry pioneer with over 30 years of experience and extensive knowledge about radiant heating methods, applications, and designs. Our heating solutions combine superior performance, comfort, and energy-efficiency. We make radiant simple!

We created this comprehensive design and installation guide to help provide all the information you need to select, design, install, and start-up an Infloor Heating System. Infloor residential system components may be used for space heating or warm floor applications. Each different type of application has a very specific design criteria. An Infloor representative is also available to answer questions and provide additional support.

History of Radiant Heating

The concept of "radiant floor heating" or under-floor heating has been used for centuries. It can be traced back to the Romans who used a hypocaust, which was a system that heated homes with hot air under the floors. Under-floor radiant heating also has a long history throughout Asia.

Heating by radiant energy is observed every day; the warmth of the sunshine being the most common example. It is similar to the heat you feel when you stand by a window on a sunny cold day. Your face feels warm, but the sun didn't need to heat the air outside to make you feel that way.

Under-floor heating serves up heat from below. The result is a more even overall heat that warms everything in the room, including surfaces, furnishings, and, most importantly, you. The systems depend largely on radiant heat transfer; the delivery of heat directly from a warm surface to the people and objects around it.

How it Works

Any residential, commercial, or industrial building can take advantage of all the benefits radiant floor heating has to offer. These projects can be new construction, remodel, small additions, retro-fit, industrial, and snowmelt applications. We offer electric cable and hydronic radiant heating systems.

Electric cable systems provide heat through cables installed over the subfloor in a bed of thin-set mortar. It is available in 120V and 240V. Ceramic or stone tile are popular floor covering choices. It can also be installed under laminate and other floating floors, such as engineered hardwood.

Hypocaust under the floor in a Roman villa in Vieux-la-Romaine, near Caen, France.

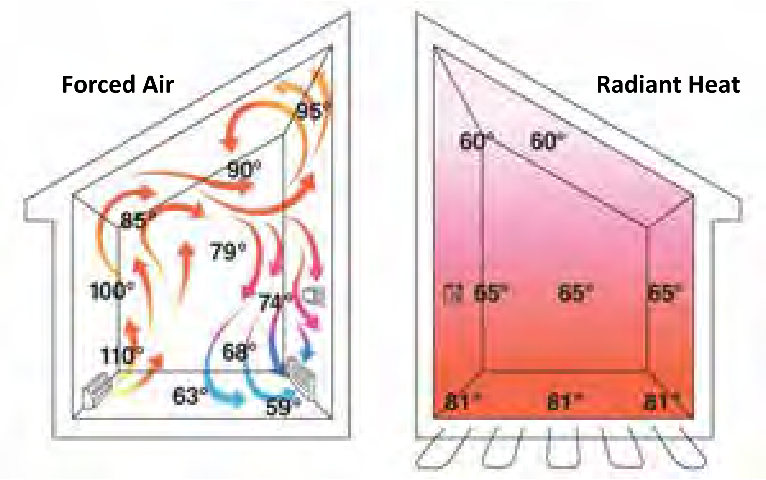
Introduction

Infloor residential hydronic heating system.

Hydronic systems are usually designed to heat an entire house, building, or outdoor space. A propylene glycol or water solution is heated to between 90 and 150 degrees Fahrenheit by a boiler and circulated through tubing in the floors. The tubing can be installed in several ways: embedded in a concrete slab, installed over an existing slab in gypcrete, stapled underneath the subflooring, or fitted inside the channels of specially designed subfloor panels. Any kind of finished flooring, including hardwood, vinyl, or carpeting, can be installed on top of it.

Whether you're building a new home or business, or remodeling your present one, isn't comfort one of the most important qualities you desire? Radiant heating has always been the most comfortable, energy-efficient choice for heating any area. Let's look at some of the ways Infloor radiant heating can improve your life.

Advantages of an Infloor Heating System
Infloor Heating Systems is proud to offer radiant heating solutions designed to improve your everyday living and comfort. There are many benefits to Infloor radiant heating. It is energy-efficient, reducing gas and electric bills, eliminates duct work and duct heat losses, creates a quieter home, is a healthier way of living for those with allergies, and provides greater energy management with zoning. It is a superior heating method that easily adapts to even further 'green living' sustainability with solar and geothermal options available for increased savings.



Nearly everyone now agrees that a radiant floor is the world's most comfortable heating system that makes floors wonderfully warm. Hydronic radiant floor systems save energy and lower fuel bills because radiant heat feels comfortable at lower air temperatures, enabling you to lower the thermostat. In addition, it is more efficient than other systems because it uses relatively low water temperatures to heat your home. In effect, the entire floor is a radiator, so it doesn't have to be as hot as conventional radiators. Boilers can heat water to lower temperatures more efficiently than they can heat water to higher temperatures.

Applications

Infloor Heating Systems offers a premium line of radiant heating products and components you can count on. We offer entire radiant heating systems, including the design. Our superior solutions offer design flexibility, ease of installation, reliable components, and the trusted support of Infloor representatives and technicians, making us the ideal choice for any home or office, in any part of the country.

Electric Cable

Infloor Electric Cable is available in Standard and Heavy-duty versions, and easy to install, giving you an economical way to include radiant heating into any project. Electric cables in the floor provides a constant, even heat that can be designed to fit any sized room or outdoor area, and can be utilized as primary space heating or as simple floor warming. Warming unusual shapes in a floor plan, including 45° angles, can be easily accomplished. The pre-engineered heating units are ready to use and available in many sizes.

Each unit is ready to be installed by simply laying the cable on the floor in loops of a specified distance. No extra building materials are needed. The unique patented cable is designed to provide the ultimate safety for both dry and wet environments. Every element is thoroughly tested during production to ensure a quality, long lasting product you can count on for years to come. Additionally, we offer complete controls for electric radiant systems, new or existing.

Hydronic Heating Systems

We offer four installation options for hydronic heating: Infloorboard, Concrete, Therma-floor, and Radiant Trak. Each of these installation methods offer unique advantages and features.

Infloorboard

Infloorboard is our premier thermal mass product for hydronic radiant heating applications with existing concrete slabs or where gypcrete (Therma-Floor) cannot be used. The low-profile, lightweight 3-panel system was designed with the installer and end-user in mind, with more efficiency and responsiveness, and is compatible with standard construction practices. It is ideal for new construction and remodeling alike.

Concrete

Embedding a radiant heating system into a concrete slab is one of the most effective ways to install it and most energy-efficient, being that concrete is a great thermal mass. This is the best choice for new construction and areas receiving new slabs.

Therma-Floor (Gypcrete)

One of our most common and effective installation applications is Therma-Floor, commonly known as a gypcrete. The gypsum underlayment is designed to pour over tubing, encasing the tubes in crack resistant, noncombustible gypsum, acting as the thermal mass. Therma-Floor systems can be used in many different situations, because it can be installed on top of subfloors and concrete slabs, whether existing or new.

Applications

Its special formula resists breakdown up to 150°F (66°C). And because it's poured only 1-1/4" to 1-1/2" (32 mm to 35 mm) thick, the heating system is more responsive and more comfortable. As a “green” building material, Therma-Floor is an ideal solution for sustainable building projects.


Electric Cable


Therma-Floor

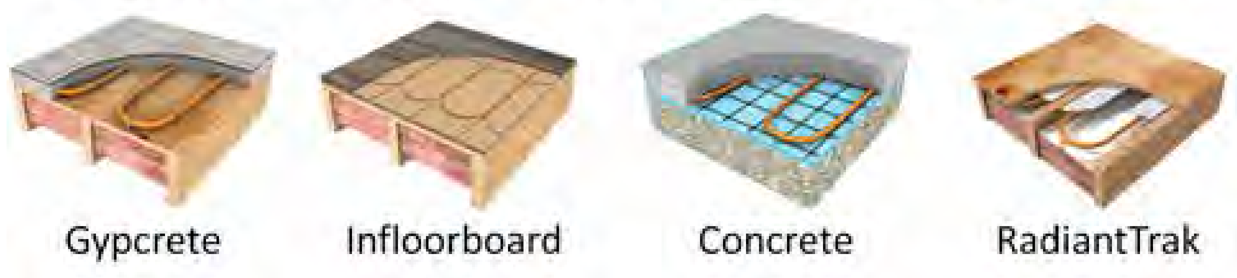
Radiant Trak

Radiant Trak is the ultimate product for under-floor radiant heating applications, providing an alternative installation to slab, gypcrete, or Infloorboard. This type of installation is most commonly found in retrofit applications.

It works by attaching high-quality aluminum plates between the joist spaces on the underside of the subfloor, which tubing snaps into, providing a heat transfer between the plates and the subfloor, warming the entire area. Radiant Trak is perfect for older homes or remodel projects, and can be utilized for floor warming or primary space heating.


Radiant Trak

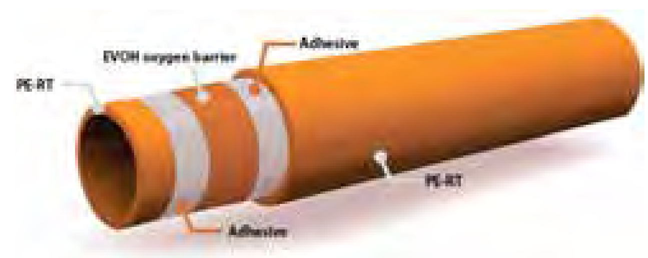

Infloorboard



Components

Infloor Heating Systems offers various options when selecting a radiant heating system. Infloor's Residential/Light Commercial Systems include copper manifolds, brass manifolds, mixing valves and related controls, zoning controls with domestic hot water priority, pre-piped and wired control panels, hydraulic separators, pumping stations, emission plates, and Infloorboard. Infloor offers all the related components for a complete system with the exception of the heat source. Infloor has provided general diagrams to include several heat plant options. Manufacturer's specifications of the heat source should be followed.

BPEX'S CROSS-LINKING CREATES BONDS BETWEEN INDIVIDUAL MOLECULAR STRANDS, GREATLY ENHANCING THE TUBE'S TEMPERATURE AND CHEMICAL RESISTANCE.



PERT TUBING IS CONSTRUCTED OF FIVE LAYERS WITH THE OXYGEN BARRIER ON THE INSIDE.

Tubing

Infloor tubing is available in 3 configurations: non-barrier tubing from cross-linked polyethylene (PEX), oxygen barrier tubing from cross-linked polyethylene (BPEX), and polyethylene raised temperature (InfloorPERT). These tubes provide excellent performance in radiant applications and provide the system designer with the greatest options for component selection to best fit the application.

Infloor PEX tubing is rated for 100 psi (689 kPa) at 180°F (82°C), and PERT tubing rating is 80 psi at 180°F (82°C). These conditions far exceed those normally found in radiant heating applications where system operating pressures are usually 12 to 20 psi (82 to 138 kPa) with maximum temperatures usually reaching 150°F (65°C). When oxygen diffusion barriers are required, Infloor BPEX tubing meets the German DIN 4726 ion of less than 0.1 gram of oxygen per cubic meter per day, while PERT tubing is less than 0.10/m3/day at 104°F (40°C) water temperature. Chemical compatibility varies with the various tubing.

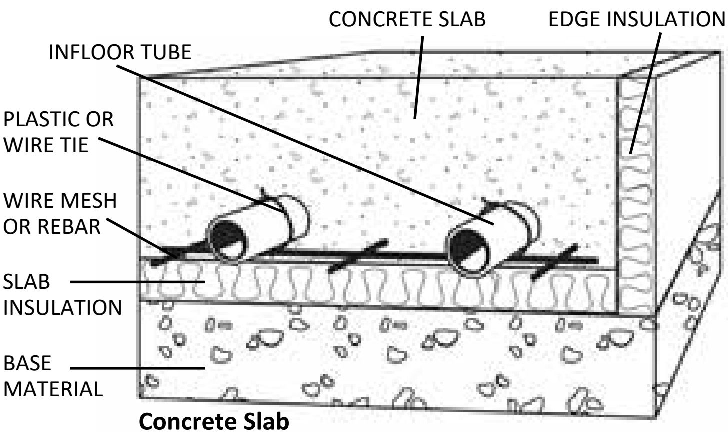
Infloor tubing may be installed in the concrete slab, on top of a sub floor and embedded in Therma-floor, a light weight gypsum cement that provides excellent thermal mass while adding sound control

Type	Part #	Size L	I.D.	O.D.	Press.	Temp.	ASTM	DIN	Length	Weight
BPEX	25000	3/8" (10mm)	3/8" (10mm)	1/2" (13mm)	100 psi (689 kPA)	180°F (82°C)	F-876	4726	600' (180m)	27 lbs.
	25010	1/2" (13mm)	1/2" (13mm)	5/8" (16mm)	100 psi (689 kPA)	180°F (82°C)	F-876	4726	900' (270m)	50 lbs.
PERT	25200	3/8" (10mm)	3/8" (10mm)	1/2" (13mm)	80 psi (552 kPA)	180°F (82°C)	F2623	4726	600' (182.9m)	25 lbs.
	25202	1/2" (13mm)	1/2" (13mm)	5/8" (16mm)	80 psi (552 kPA)	180°F (82°ºC)	F2623	4726	1,000' (304.8m)	54 lbs.

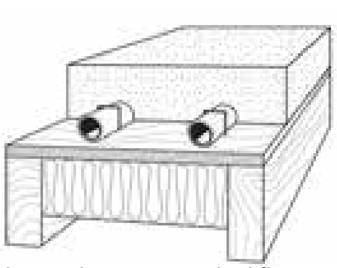
Components

and fire protection to the floor assembly, on top of an existing slab with a layer of insulation between the slab and the gypsum cement encased tubing, attached to a wood sub floor by using Infloorboard, and Warmboard applications requires our PERT products. Retrofit applications staple up with emission plates may be used, however close attention needs to be paid actual room heat loss and supplemental heat may still be required in colder climates.

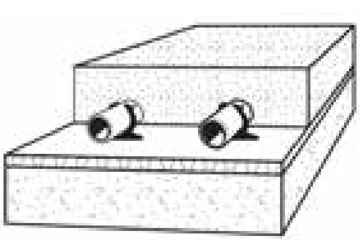
When selecting tubing, it is important to compare pressure and temperature ratings as well as the wall thickness for heat transfer and durability. The application environment or method of installation, the need for barrier or non-barrier tubing, flexibility and weight are additional considerations. Whether the installation method requires PEX tubing or PERT tubing for proper installation. Infloor has all of these products available to meet all the types of installation practices found in radiant today.



Concrete Slab

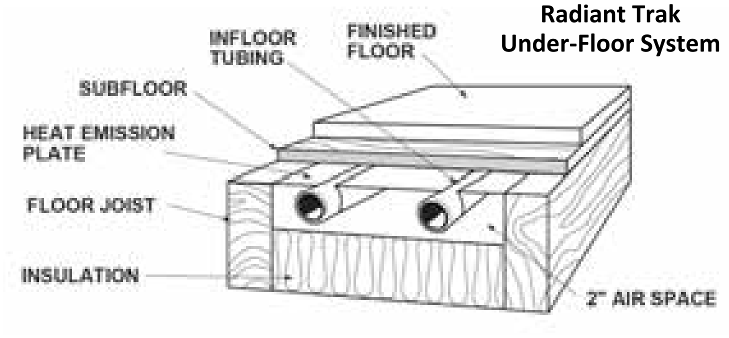


Therma-Floor Over Wood Subfloor



Therma-Floor Over Concrete

Radiant Trak Under-Floor System

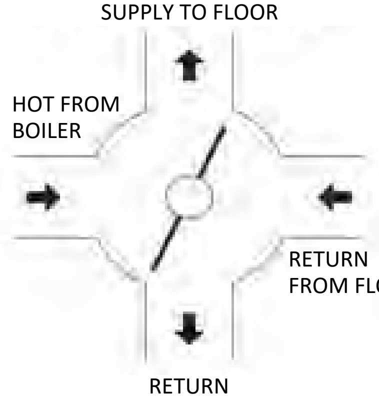


UNDER FLOOR APPLICATIONS MAY BE USED IN RETROFIT APPLICATIONS BUT REQUIRE CLOSE ATTENTION TO DESIGN AND INSTALLATION PARAMETERS FOR PROPER SYSTEM PERFORMANCE.

4-Way Mixing Valves

These valves provide tempering of water to the radiant zones. While there are variations in the use of these components, their main purpose is to provide the proper temperature to the radiant zone when the water temperature from the heat source is higher than the required water temperature for the radiant zone.

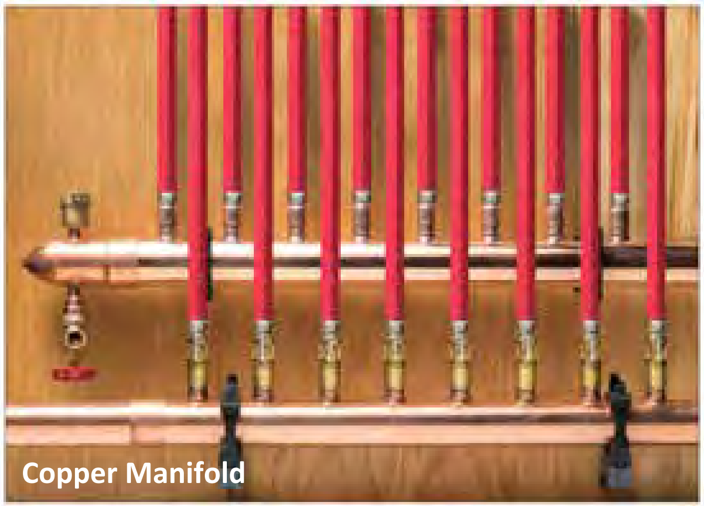
Multiple valves may be used in a system that requires multiple water temperatures. These valves may be controlled by a set point control that will modulate the valve, or can be controlled by an actuator motor that has indoor/outdoor reset control which will base the delivery water temperature to the floor on actual outdoor temperature.



Components

Copper Manifolds

Copper Manifolds provide a low cost manifold option for use with Infloor Heating Systems. These manifolds are offered in many configurations. These manifolds consist of 1" (25 mm) mains with 1/2" (13 mm) outlets, and are available in valved and non-valved configurations of up to 14 outlets. The valved version include 1/2" (13 mm) brass full port ball valve with stainless steel ball, for positive shut off on the outlets. (1-1/4", 1-1/2", and 2" mains with 3/4" outlets with and without valves are available as custom order items.)



Copper Manifold

The manifolds are standard 1" (25 mm) copper pipe size and may be joined using a standard 1" copper coupling to increase the number of outlets per manifold assembly. A 1" (25 mm) copper cap is used to seal the end of the manifold, or a purge 90 with vent end piece (#28400) may be used instead for easier purging. The tube outlets are brazed to the mains to allow for soldering of adjoining manifolds and fittings. Ball Valves are soldered to the branches.

Copper Manifold Tubing Connections

Fittings are PEX crimp. These fittings are available in 1/2" (13 mm) male copper sweat x either 3/8" (10 mm) or 1/2" (13 mm) crimp. PEX crimp tool or Oetiker crimp system must be used with PEX crimp fittings. Solder fittings to the outlets on the manifolds before attempting to attach the tubing, or order the manifold pre-assembled.

Fittings are PEX crimp. These fittings are available in ½" (13 mm) male copper sweat x either 3/8" (10 mm) or ½" (13 mm) crimp. PEX crimp tool or Oetiker crimp system must be used with PEX crimp fittings. Solder fittings to the outlets on the manifolds before attempting to attach tubing.

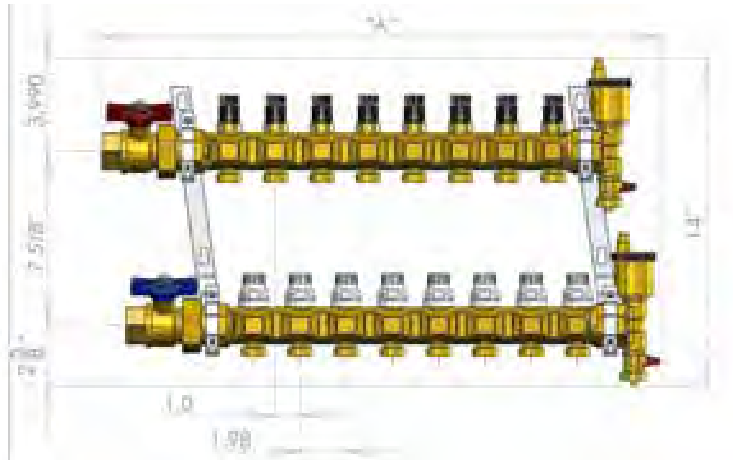
Brass Manifolds

For residential and commercial heating systems Infloor Brass manifolds provide complete control over each loop and will precisely regulate the flow and allow for individual loop control as well as isolation, air elimination, and purging capabilities.

These manifolds consist of a supply and return manifold with mounting brackets completely assembled. Supply manifold complete with micrometric balancing valves with flow curve

Components

indicator. Return manifold complete with shut-off valves that can utilize thermal actuators. A pair of shut off valves one on the supply manifold and one on the return manifold with color coded handles for supply and return. End fitting assembly, which consist of a drain valve fitting and an automatic air vent. The supply and return manifolds have a main trunk size that will accommodate either 1" or 1-1/4" fittings. These manifolds are available in loop configurations from 3 loops to 13 loops completely assembled ready to install.



Brass Manifold

Infloor brass manifolds are brass body, EDPM Seals, 1" threaded female connections, 3/4" male outlet connections for tubing. Compatible with water, water/propylene glycol solutions with a maximum glycol concentration of 50%. Maximum working pressure 150 psi. Temperature range from 41°F to 180°F.

Brass Manifold Tubing Connections

Fittings are designed to adapt to both PEX and PERT for a variety of sizes. Select the fitting size to match the size of PEX or PERT that is being installed. Slide Nut over tubing, then slide the olive over the tubing and then slide the adapter fitting into the end of the tubing. Tighten down fitting onto manifold 3/4" ports for final connection. This adapter offers a high resistance to pull out due to the special configuration of this fitting.

Did You Know?

Brass and copper manifolds can be used together in the same project to reduce labor and costs.

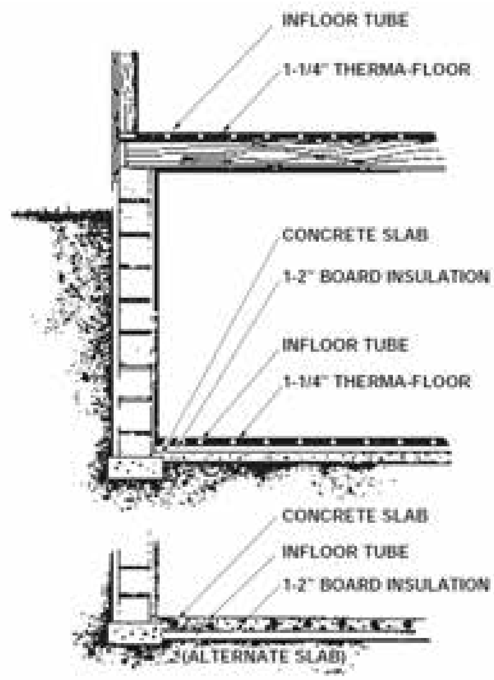
Our high quality brass manifolds come completely assembled, in the USA, on a mounting bracket making installation quicker and easier, and includes a 2-year limited warranty. The supply (red) and return (blue) handles are color coded for easy identification.

Site Preparation

Site Preparation

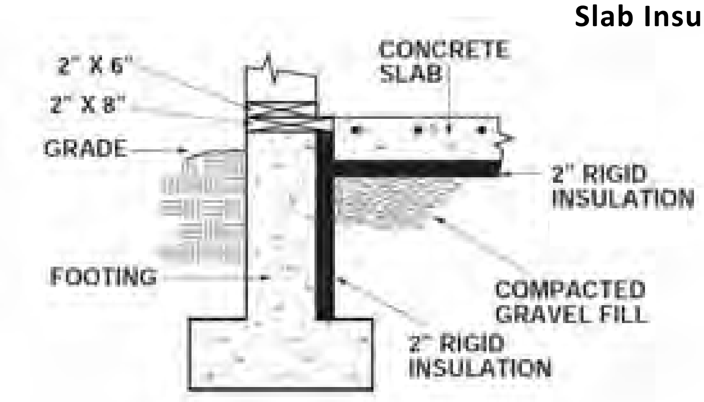
A properly prepared site is essential for optimum radiant system performance. The key to a good installation is a well-planned out installation. Radiant systems that are installed on sites that are not well drained, sit on bedrock, or clay subsoil can conduct considerable heat away from the system and limit the system performance. It is essential that slab edge insulation of 1" (R-5) to 2" (R-10) be installed in all radiant systems, and that under-slab insulation be installed up to the edge, and under the entire slab. This will provide better system control and response time will be greatly enhanced. Using insulation will reduce the overall mass of earth under the slab that will need to be heated to respond to changes in temperature. Use 2" foundation approved insulation board (R-10) with a minimum density of 2 pounds per cubic foot (32 kg/m3).

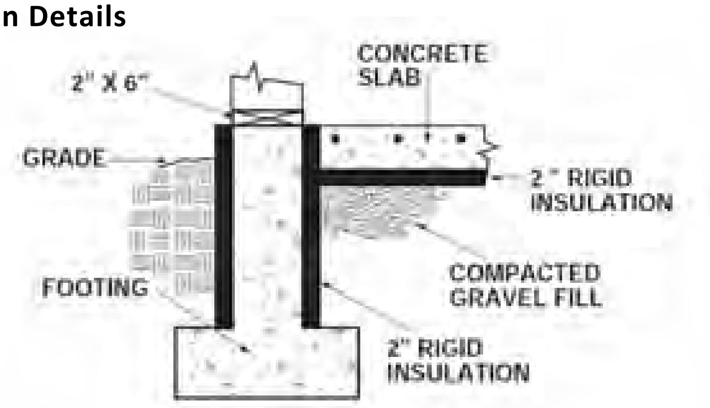
Below-Grade Slab Insulation Details

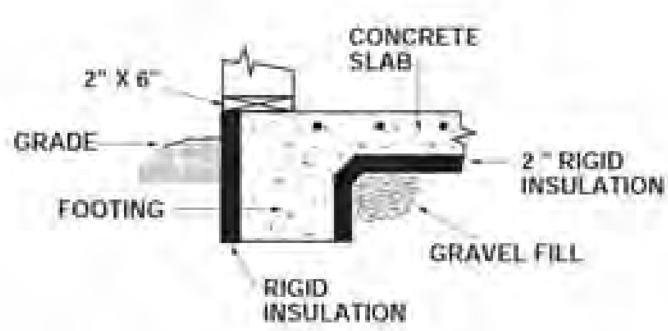


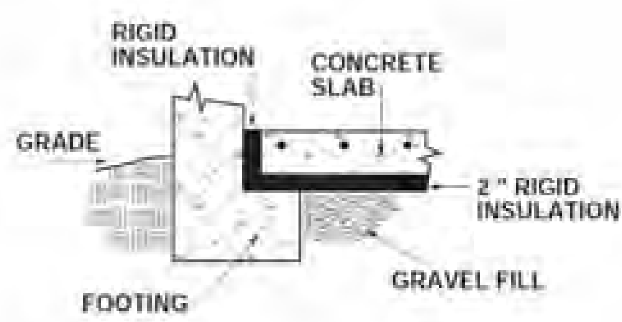
SLAB-EDGE AND PERIMETER INSULATION ARE CRITICAL FOR PROPER RADIANT HEATING PERFORMANCE. ELIMINATION OF THIS INSULATION WILL PRODUCE UNSATISFACTORY RESULTS. ESPECIALLY WHEN HIGH WATER TABLES ARE PRESENT OR HIGH R-VALUE FLOOR COVERINGS ARE USED.

Slab Insulation Details





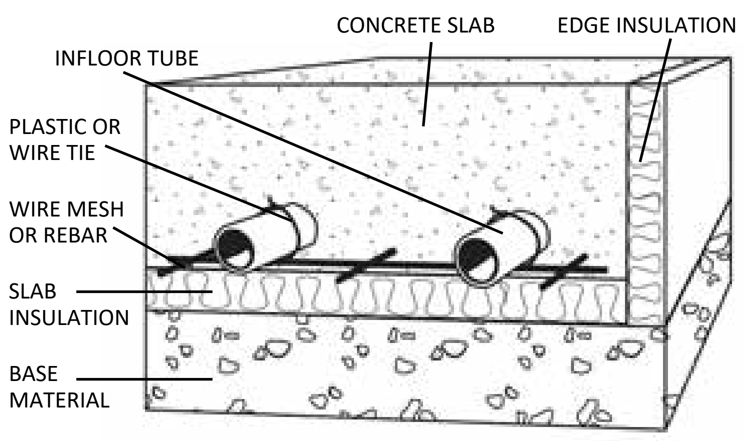




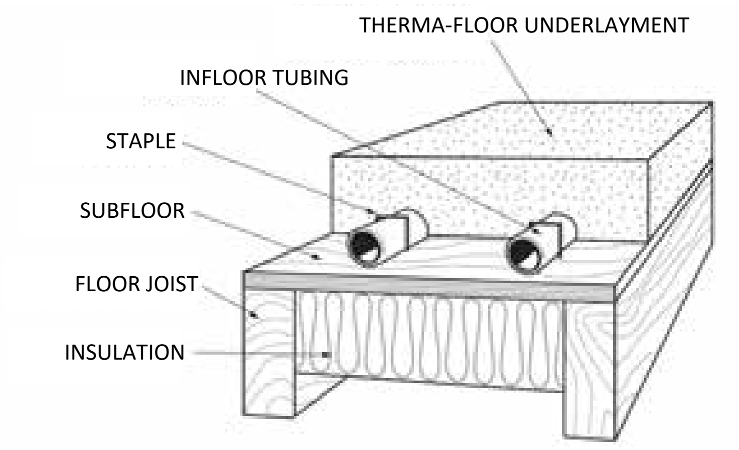
Site Preparation

Concrete Slabs
All plumbing and electrical work inside the slab area should be completed and inspected prior to installation of the radiant system. All trenches should be backfilled and slab area should be raked and compacted prior to installation of the under-slab insulation. Vapor barrier a minimum of 6 mil polyethylene should be used if using foundation-approved insulation such as polystyrene. Insulation should run underneath the entire slab and tie horizontally into slab edge insulation. All seams in insulation should be taped. Next, lay 6" x 6" reinforcing mesh over all the insulation in which radiant will be installed. Adjoining sections of the reinforcing mesh should overlap by 6" to 9" and be securely fastened together. The wire mesh is for securing tubing in place and use as a grid guideline for tubing attachment. All sharp edges of wire mesh should face away from tubing.

Layout with spray paint on top of the insulation all, rooms, walls, non-heated areas, stairways, toilets and tubs and showers. Then refer to the heating system detailed report and loop layout for proper spacing and loop length of the radiant heating system.



Concrete Slab



Wood Subfloor with Therma-Floor (Gypcrete)
The floor must be clean, structurally sound and contaminant free. Repair any weak or delaminated areas. Remove stud wall base plates in doorways and other areas to accommodate tubing layout.

Account for the change in floor elevation caused by the addition of a Therma-floor system, normally 1-1/2". By using a double sill plate, the floor height is adjusted and window and door elevations remain the same. Be sure to adjust stair risers and floor drains to match finished floor height. Planning of finished floor goods will help to determine height restrictions.

Layout grid on the floor using a tape measure and a lumber crayon, measure in 6" from all walls and place a mark. This mark will be the closest the tubing will need to be to the walls. Determine from the heating system detailed report and loop layout the tubing spacing for that particular area, normally 6" or 9". Then layout your grid in the room either 6" on center grid or a 9" on center grid. This grid will assist as a guideline for installing the tubing.

Site Preparation

Wood Subfloor with Infloorboard

The subfloor must be clean, structurally sound and contaminant free. Repair any weak or delaminated areas. Remove stud wall base plates in doorways and other areas to accommodate tubing layout.

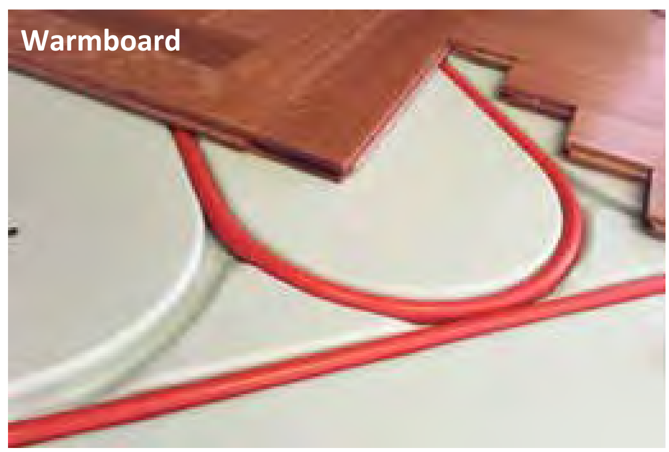
Non-structural Infloorboard is designed specifically for subfloor applications. Infloorboard is constructed of a dense composite board with an aluminum that spreads the heat evenly and quickly from the hydronic tubing. Infloorboard is a low profile product, which is only 5/8" thick. This makes it an excellent choice for new construction or retrofit applications. Infloorboard in manufactured from MDF (medium density fiber board).

Infloorboard is typically glued and screwed or stapled to the wood subfloor. Tubing spacing is 8" on center and will accommodate 3/8" BPEX or InfloorPERT tubing. Infloorboard responds quickly, with almost no overheating since there is no "thermal lag" to overcome. Infloorboard is great for small retro fit applications as well as complete homes. Infloorboard has its own complete installation guide.

Infloorboard III installed in a bathroom as part of a whole-house application.

Warmboard

Warmboard combines a structural subfloor and a thermodynamically sophisticated radiant panel into one simple component of your radiant heating system. Warmboard begins with a stiff, strong, 1-1/8" thick, 4' X 8' sheet of tongue and groove, weather-resistant plywood. A modular pattern of channels is cut into the top surface. A thick sheet of aluminum is stamped to match the channel pattern and is permanently bonded to each panel.



As Warmboard panels are installed, they automatically create a uniform pattern for tubing, making installation of 1/2" InfloorPERT tubing more streamlined. Less tubing means lower cost more efficient installations. Fast response is one of the most important characteristics of this type of radiant heating system. The amount of heat required by a home or an individual room changes over time and the changes can be fairly rapid. Cloud cover can clear in just a few minutes causing rapid changes in the warmth provided by the sun. The outside temperature can change significantly in just one hour due to normal daily variations.

Infloor Heating System components are recommended with this type of system.

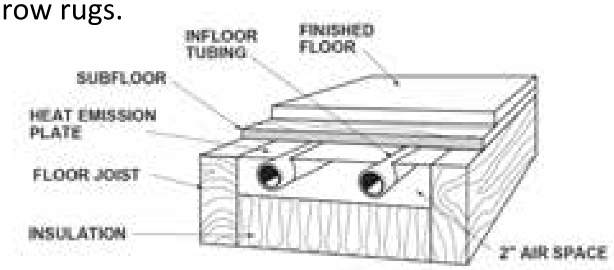
Site Preparation

Wood Subfloor with Staple Up with Emission Plates (Radiant Trak)

This type of system is often used as a retrofit application or in new construction homes where the floor height cannot be changed to accommodate gypsum type product or Infloorboard. A radiant designer should design this type of system, in many cases these types of systems still require supplemental heat. Infloor does not recommend this type of installation without the use of emission plates.

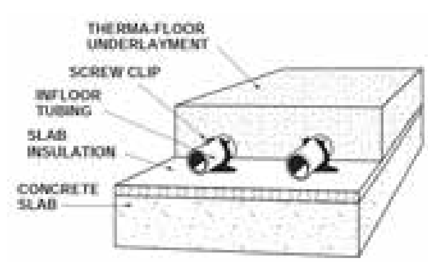
Area must be clean of any nails or staples protruding from subfloor. Infloor emission plates (#39501) for 1/2" tubing. Plates are 4" wide x 4' long predrilled for acceptance of screws. Screw emission plates up to subfloor using screws that will not penetrate other side of subfloor. Plates should be placed 8" on center the entire length of the joist bay leaving approximately 12" at each end of the bay. Plates can be placed with ½" to 1" gap between the emission plates. Infloor side groove plate, grooves should be facing each other for ease of installation.

These systems require higher water temperatures than any of the other radiant type systems mentioned. Insulation must be placed under this system, using reflective insulation is recommended. Insulation under this system must be four times greater than the insulation R-value of the subfloor, floor covering plus any additional throw rugs.



Precast Concrete Subfloors

The subfloor must be clean and contaminant free. In cold climates it is highly recommended that a minimum of 1" of foundation-approved polystyrene insulation be placed on top of the existing slab to enhance the response time and reduce the amount of downward loss to the existing slab. Mechanically fasten 6" x 6" wire welded mesh to the insulation / concrete subfloor using concrete screws. Fasten the wire mesh tightly to floor to prevent the floating of tubing.



Attach the tubing to the wire mesh using Infloor wire ties (#26001) or plastic ties (#26005). When 1" or thicker insulation is installed over the existing concrete subfloor, Infloor screw clips (#26015) may be used. The screw clip will secure Infloor 3/8" (10mm) and 1/2" (13mm) tubing. Infloor also offers the insulation tacker tool (#26085), which allows for installation of plastic staples (#26081) into the insulation for tube attachment.

System Design

Heat Loss

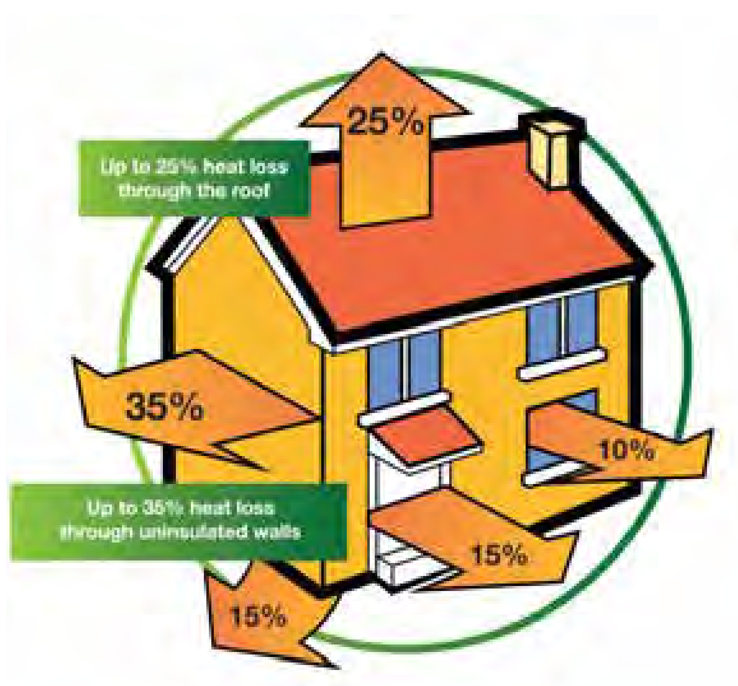
The Infloor LoopCAD Radiant Design Software performs all the necessary calculations for designing an Infloor Heating System, or you can use any industry-standard heat loss calculation guide. Pay special attention to areas with potential for high heat loss. When properly insulated, downward heat loss is not significant in slab-on-grade applications. However, it is critical the slab edge be insulated to prevent excessive heat losses. In general, good insulating techniques are a major factor contributing to the success of any radiant heating system. A significant reduction in heat loss may be expected with a radiant heating system due to the decreased effect of air infiltration losses. Since radiant heating systems warm objects and not the air, the infiltration losses are minimized. Usually 0.5 Air changes per Hour (ACH) to a height of 8 to 10 feet (3 m) is sufficient for calculating infiltration heat loss.

To determine the amount of heat required to provide comfort in a room or a house, it is necessary to calculate the amount of heat lost (in Btu per hour) when winter conditions outdoors are at the Outside Design Temperature (ODT). ODT is the normal coldest temperature reached 97.5% of the time for that area (to convert Btu/h to W, multiply by 0.293).

Heat is transmitted through all surfaces that will be warm on the inside and cold on the outside. This includes walls, ceilings, floors, windows and doors. If a room on the other side of a wall or ceiling is to have normal heating, that wall is not considered "cold."

In addition to the outward transmission losses, the infiltration of cold air must be added. However, this effect is minimized by radiant heating systems. Transmission plus infiltration equals the Total Heat Loss, which must be replaced by the heating equipment.

The amount of heat lost is directly related to the Temperature Difference (TD) between the desired Indoor Design Temperature (IDT) and the Outside Design Temperature (ODT). It is usually desirable to maintain 70°F (21°C) inside the room when the outside temperature is at its normal low point. The ODT for each major city is determined by long-range weather readings, and is fixed by the engineering profession. Subtracting ODT from the usual 70 °F (21 °C) gives the Temperature Difference for that locality.



System Design

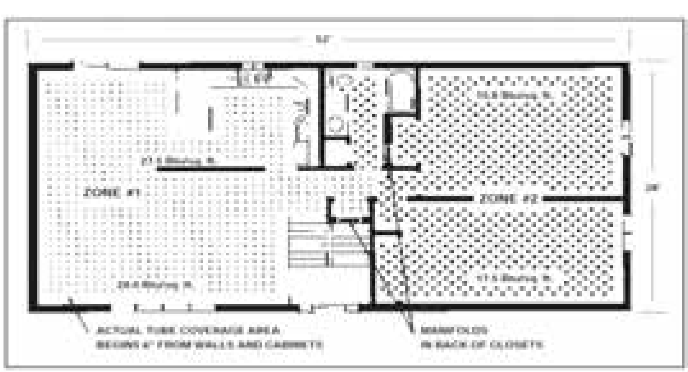
Required Floor Output

The heat lost from an area must be replaced by heat from the floor. The Total Heat Loss divided by the Adjusted Gross Floor Area (do not include cabinet areas or other areas that do not generate heat) will produce the Required Floor Output in Btu/(h*ft_2). (To convert to W/m 2, multiply by 3.15.)

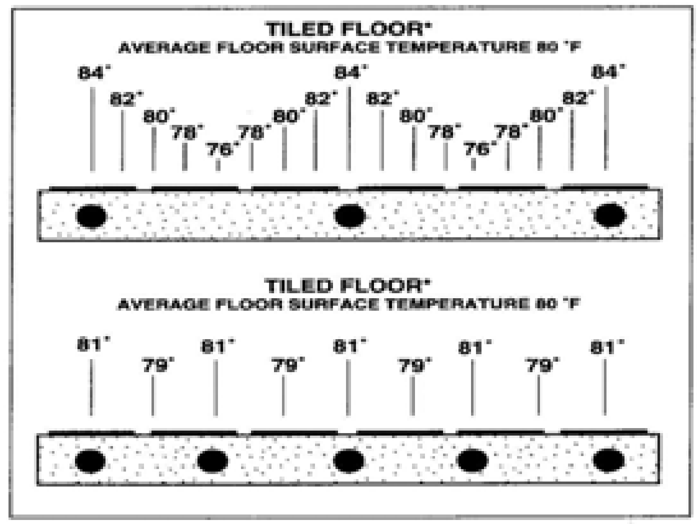
Floor Coverings

Floor coverings have a pronounced effect on the performance of radiant floors due to their insulating qualities. A floor covering with high insulating properties (carpet and pad, for example) needs a hotter Supply Water Temperature to achieve the Required Floor Output. The table below lists the R-values of various floor coverings and carpet pad underlayments.

While it may be most desirable to have a uniform surface temperature across the entire floor, it is not economically possible to embed tubing in every inch of floor space. As tubes are spaced further apart, the floor surface temperature varies depending on the distance between the tubes. When tubes are spaced too far apart, warm and cold spots may be felt across the floor. This is not only less comfortable, but also impedes the ability of the floor to transfer heat and may result in unwanted temperature swings in the room. Wide tube spacing also requires higher water temperatures to effectively heat the room.



TEMPERATURE DISTRIBUTION DUE TO WIDE TUBE SPACING



*AT APPROXIMATELY 18 BTU/H*FT² OUTPUT

R-VALUES OF VARIOUS FLOOR COVERINGS

Floor Covering	R-Value
1/2" Oak Parquet and Pad	0.7
3/8" Hardwood	0.5
48 oz. Waffled Sponge Rubber	0.8
5/8" Oak Wood	0.6
Asphalt Tile	0.1
Bare Concrete - No Covering	0
1/2" Bonded Urethane	2.1
Heavy Carpet	0.8
Heavy Carpet with Heavy Pad	1.9
Heavy Carpet with Light Pad	1.6
Heavy Carpet with Rubber Pad	1.2
Light Carpet	0.6
Light Carpet with Heavy Pad	1.7
Light Carpet with Light Pad	1.4
Light Carpet with Rubber Pad	1
Linoleum	0.1
Marble Floor and Mudset	0.2
3/8" Prime Urethane Underlayment	1.6
Rubber Pad	0.6
Rubber Tile	0.1

All R-values shown in hrft_2 °F/btu*

System Design

Actual Floor Output and Delivery Water Temperature

The Infloor distribution water temperature is limited by the application chosen for the design. Generally 85°F (29°C) is accepted as the maximum surface temperature for comfort where there is prolonged foot contact with the floor. Perimeter areas outside normal traffic areas can operate with higher surface temperatures.

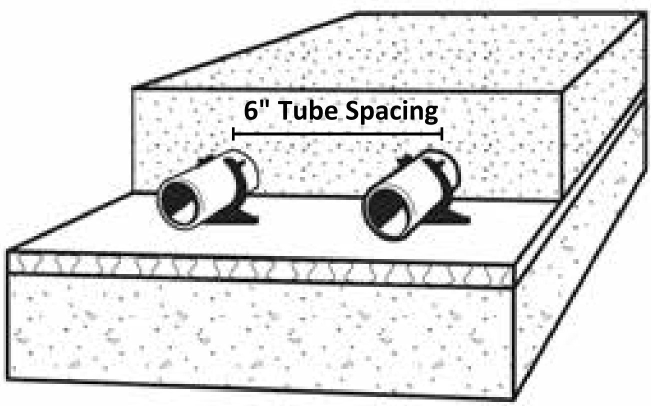
With these limits in mind, use the Output Chart to find the required Floor Surface Design Temperature and Delivery Water Temperature. These numbers are based on a 70°F (21°C) inside design temperature. The Floor Surface Temperature is increased or decreased 1°F (0.5°C) for every degree the Indoor Design Temperature is above or below 70°F (21°C).

Supplemental heat, if needed, may be used to make up the difference between the Required Floor Output and the Actual Floor Output.

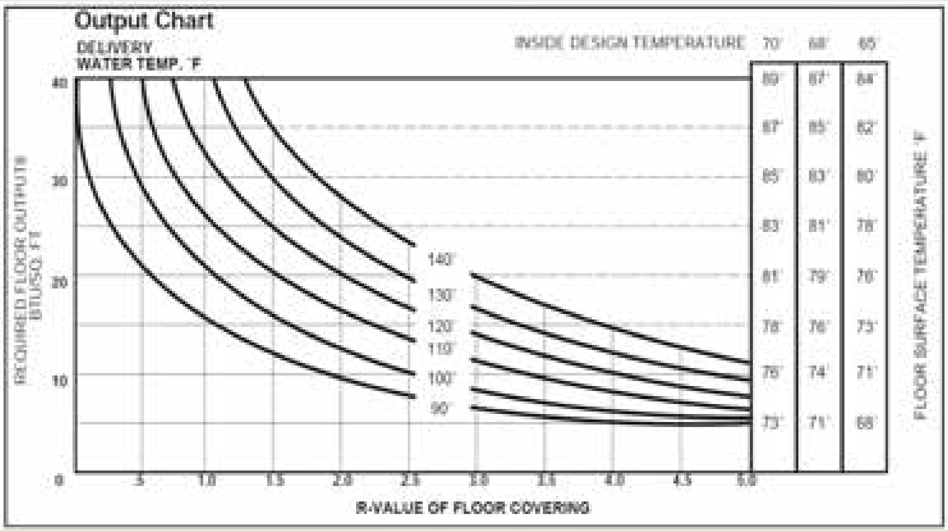
Varying floor outputs can be averaged in a room to achieve a higher overall Btu per square foot output. High-output tile floors under windows may be used to compensate for low-output carpeted floor areas. (When designing for floor warming only, plan a floor output of 20 Btu/(h*ft_2) [63 W/m 2].)

RECOMMENDED 6" (150 MM) SPACING FOR 3/8" (10 MM) TUBE, OR 9" (230 MM) SPACING FOR 1/2" (13 MM) TUBE. DEPENDING ON THE HEAT LOSS ANALYSIS, WIDER OR NARROWER SPACING MAY BE USED.

Therma-Floor (Gypcrete) Over Concrete



1. Find the Required Floor Output on the left side of the chart and extend a line to the right to read the Floor Surface Temperature.
2. Locate your selected floor covering R-value on the bottom of the chart (R-value from R-value Table). Extend a line up to your first line.
3. Read the Delivery Water Temperature at the intersection of the two lines.
4. If the lines intersect beyond the 140° line, do one or more of the following:
   a. Select a floor covering with a lower R-value
   b. Reduce the heat loss of the area to lower the Required Output
   c. Figure supplemental heating:
      -Extend a line up from your Floor Covering R-value until it intersects the 140° line.
      -From that point, extend the line to the left to the actual output of the floor.
      -Subtract the actual output from your required output to find the amount of supplemental heat needed



System Design

Tube Spacing and Total Tube Required

The Tube Spacing and Total Tube Required varies due to the Required Floor Output and the size of the tubing being used. Larger diameter tubing can deliver the same Btu at wider spacing than smaller diameter tubes.

Locate the tube size and the spacing under the Floor Output column. Find the spacing factor for the spacing used. Multiply the Tube Coverage Area (Adjusted Gross Floor Area minus the 6" (150 mm) around all perimeter walls) by the Spacing Factor. That number is the Total Tube Required.

Number and Length of Tube Circuits

If you are not using the Infloor LoopCAD Radiant Design Software, the recommended length of any given circuit depends on the tube and manifold system used.

Determine the total number of circuits by dividing the Total Tube Required by the maximum length allowed. Round up fractional numbers to the next highest whole number. Divide the Total Tube Required by the Number of Circuits to obtain the Actual Circuit Length. To simplify balancing, make all the circuits on a given manifold the same length.

The actual layout of tubing on a plan is usually unnecessary. The designer need only identify the controls and manifold locations, number and length of circuits and tube spacing. The layout can be done in the field quickly and accurately or is easily accomplished using the Infloor LoopCAD Radiant Design Software.

Note: These design factors are dependent upon each other. Do not use these values as a basis for a system design. All numbers are averages only. A heat loss analysis is required for an actual system design.

TUBE SPACING

	FLOOR OUTPUT		
Tube Size	10-20 Btu/(h*ft$_2$) (31.5-63 W/m$_2$)	20-30 Btu/(h*ft$_2$) (62-94.5 W/m$_2$)	30-40 Btu/(h*ft$_2$) (94.5-126 W/m$_2$)
3/8" (10 mm)	9" (230 mm)	6" (150 mm)	4" (100 mm)
1/2" (13 mm)	12" (300 mm)	9" (230 mm)	6" (150 mm)
3/4" (19 mm)	15" (380 mm)	12" (300 mm)	9" (230 mm)

SPACING	FACTOR
4" (100 mm)	3.0 (9.8)
6" (150 mm)	2.0 (6.6)
9" (230 mm)	1.3 (4.2)
12" (300 mm)	1.0 (3.2)
15" (380 mm)	0.8 (2.6)

RECOMMENDED TUBE LENGTH FOR RESIDENTIAL MANIFOLDS

3/8" tube – 200 ft. (10 mm / 60 m)
1/2" tube – 300 ft. (13 mm / 90 m)
5/8" tube – 400 ft. (16 mm / 120 m)
3/4" tube – 500 ft. (19 mm / 150 m)

SYSTEM DESIGN GUIDELINES

Design Factor	Residential	Light Commercial
Room Temp.	65-72°F (18-22°C)	60-72°F (15-22°C)
Water Temp.	95-140°F (35-60°C)	90-140°F (32-60°C)
Surface Temp.	75-85°F (23-29°C)	75-85°F (23-29°C)
Heat Output	15-30 Btu/(h•ft$_2$) (47-95 W/m$_2$)	10-30 Btu/(h•ft$_2$) (47-95 W/m$_2$)
Temp. Drop	15-20°F (8-11°C)	15-20°F (8-11°C)
Flow/Loop	≈0.3 gpm (≈0.02 L/s)	≈0.7 gpm (≈0.04 L/s)
Pressure Drop	2-5 ft. H_20 (6-18 kPa)	3-10 ft. H_20 (9-30 kPa)
Loop Length	200 ft (60 m)	300 ft. (90 m)
Tube Size	3/8" (10 mm)	1/2" (13 mm)
Tube Centers	4-9" (100-230 mm)	6-12" (150-300 mm)

System Design

Water Flows
To calculate the total water flow for the heating system, divide the Total Heat Loss by 10,000. (A water flow rate of 1 gallon per minute produces approximately 10,000 Btu/hr with a 20°F (-7°C) temperature drop between the supply and return manifolds.) Then divide the System Water Flow by the Number of Tube Circuits to determine the flow rate for the individual tubes. (If a water/glycol solution is used, divide the Total Heat Loss by the heat capacity of the propylene glycol concentration desired.)

If more than one manifold assembly is needed, determine the water flow rate for that assembly using the same procedure, but substitute the Total Heat Loss by the heat loss of the zone being served. Repeat this procedure for each manifold, then add the water flows of each zone to determine the System Water Flow.

SYSTEM FLUID HEAT CAPACITY IN BTU
(H • GPM) [K W/(L• S)]

Glycol Solution	Freeze Temp.	Fluid Temperature Drop		
		20°F	30°F	40°F
0%	32°F (0°C)	10,000 (46.4 kW)	15,000 (69.6 kW)	20,000 (92.8 kW)
10%	23°F (-5°C)	9,900 (46.0 kW)	14,850 (69.0 kW)	19,800 (91.9 kW)
20%	15°F (-9°C)	9,600 (45.5 kW)	14,400 (66.9 kW)	19,200 (89.1 kW)
30%	2°F (-16°C)	9,300 (43.2 kW)	13,950 (64.8 kW)	18,600 (86.4 kW)
40%	-14°F (-25°C)	9,000 (41.8 kW)	13,500 (62.7 kW)	18,000 (83.6 kW)
50%	-37°F (-38°C)	8,700 (40.4 kW)	13,050 (60.6 kW)	17,400 (80.8 kW)

Circuit Head Pressure
Circuit Head Pressure is affected by the water flow rate, diameter of tube, addition of additives such as propylene glycol, and delivery water temperature. The appendix contains Pressure Drop Charts for the Infloor tubing (PEX/PERT) with plain water and a 50% glycol solution.

Do not add the individual head pressures from each zone. Each zone is plumbed in parallel and the circulator pump only needs to produce the System Water Flow at the highest head pressure in any given zone on that parallel circuit. One circulating pump may be used to supply all the radiant zones, or a circulating pump may be dedicated to each radiant zone. When using multiple circulators, calculate only the flow rate and head pressure for the zone being serviced and select a circulator capable of meeting the zone requirements. (A primary circulator pump must be capable of providing the Total System Flow and overcome the head loss in the primary distribution piping.)

HEAD LOSS CHART FOR WATER AT 140˚F
(FT H2 0 PER 100 FEET OF TUBE)

BPEX	3/8"	1/2"	3/4"
GPM	**Ft. H_2O**	**Ft. H_2O**	**Ft. H_2O**
0.1	0.29	0.07	0.01
0.5	4.78	1.12	0.22
1	16.06	3.77	0.73
2	54.02	12.67	2.45
3		25.75	4.99

(Ft H 20 ÷ 2.31= psi)
(Ft H 20 x 2.99 = kPa)

NOTE : SEE APPENDIX (PAGE 40) FOR DETAILED CHARTS.

System Design

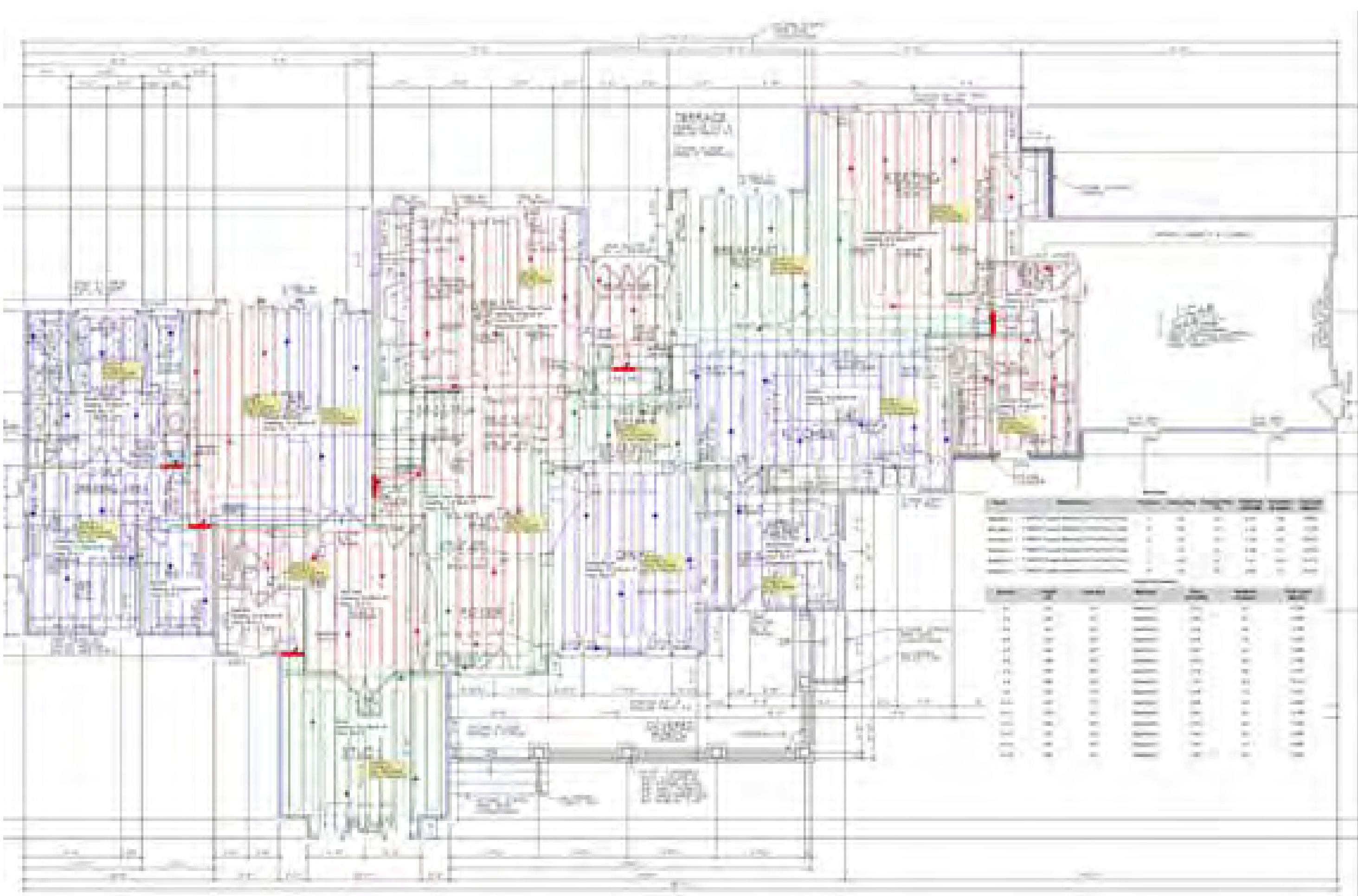
LoopCAD OEM Design Program

We are happy to offer an original LoopCAD project design blueprint, specific to your project, with every Infloor Heating System we provide. We do this because we know that proper planning and installation of our heating systems is paramount to obtaining maximum satisfaction and results that include the correct system function, a long life span, and most importantly, the customer's positive experience.

LoopCAD gives installers the loop layout with exact tube spacing, placement, and length, taking objects such as cabinets into consideration, the manifold placement, zoning, and routing of supply and return lines, with a complete list of materials needed for the radiant heating system. Proper planning, preparation, and organization prior to installation can greatly reduce labor hours and overall costs as well.

Some of the features you can enjoy with LoopCAD:

- Floorplan Drawing
- Automated Circuit Drawing
- Heat Loss Calculations
- Cooling Load Calculations
- Hydronic Calculations
- Snowmelt Design
- 3D CAD Views
- OEM Compatibility
- ACCA®-Approved Manual J®



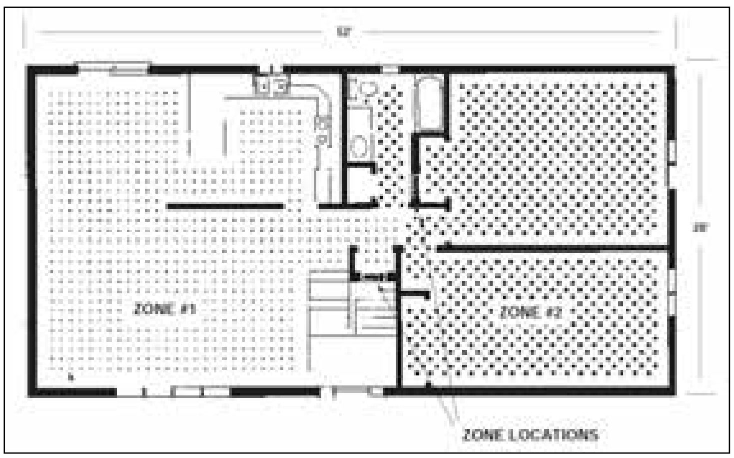
Installation

Manifold Installation

Determine how zoning is to be done. Locate manifolds as centrally as possible within the zone. Manifolds may be installed in a split configuration to provide better access to the areas within the zone and to prevent congestion of tubing in front of the manifolds.

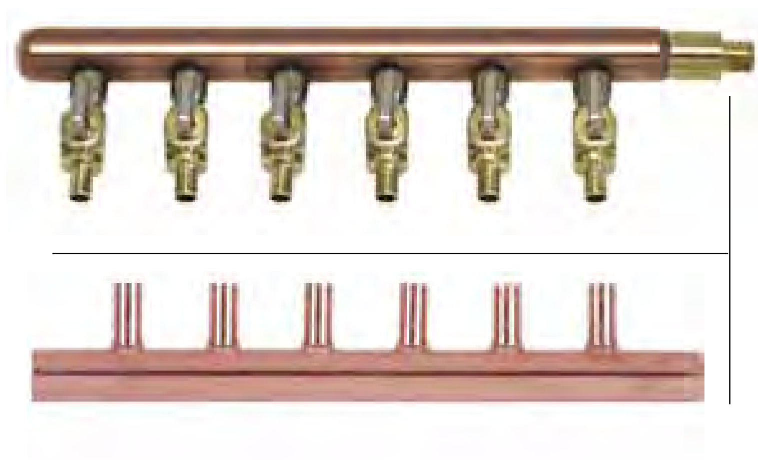
3-loop manifold is 7-3/4" (197 mm) long. Allow additional 8" (150 mm) for system piping. Cut out sill plate if the manifold is installed in the wall cavity to allow tubing to enter. Manifold covers will need to be created if installed within the wall cavity. Manifold cabinets are available.

FLOOR PLAN WITH MANIFOLD LOCATIONS



RECOMMENDED: NO MORE THAN 8 CIRCUITS PER MANIFOLD TO PREVENT CROWDING OF TUBE AND HIGH FLOOR TEMPERATURE AT MANIFOLD LOCATION AND TO ENSURE MORE EFFECTIVE USE OF TUBE TAILS.

COPPER MANIFOLDS



Cooper Manifolds

Prepare location for the manifold. These manifolds may be installed in a wall cavity of a 2" x 6" wall, with mounting brackets (#28360) or surface mounted. Locate the lowest manifold about 24" above the finished floor height (minimum). This height is needed to reduce the possibility of side load stress on the tubing. Manifolds should be located in areas that will be hidden from normal sight, such as closets. Infloor does not recommend installing manifolds in areas that will not be accessible in the future. Plan the width of the manifold location to accept the manifold assembly.

Each manifold outlet is space 2-1/2" on center. The 2-loop manifold is 5-1/4" (134 mm) long and the

WALL CAVITY WIDTH

Number of Circuits	Width
4	16 1/2" (420 mm)
5	19" (500 mm)
6	21 1/2" (550 mm)
7	24 1⁄4" (620 mm)
8	26 3/4" (680 mm)
9	29 1/4" (745 mm)
10	32" (815 mm)

Installation

Copper Manifold Tubing Connection

To connect tubing, begin with a clean square cut. When using crimp fittings, slide crimp ring over the tubing and then push the tubing onto the fitting until it bottoms. Place crimp ring approximately 1/8" (3 mm) from the end of the tube and secure crimp ring with crimp tool. Make a good square crimp to assure a leak-free installation. Do not re-crimp. Use go/no go tool to determine if crimped all the way. To connect tubing using Oetiker cinch clamp repeat the same process as listed above.

Brass Manifolds

Prepare location for the manifold. These manifolds may be installed in a wall cavity of a 2" x 6" wall. Locate the lowest manifold about 18" above the finished floor height (minimum) unless using a manifold mounting cabinet. This height is needed to reduce the possibility of side load stress on the tubing. If using a manifold mounting cabinet mount the cabinet 10" to 12" above finished floor level. Manifolds should be located in areas that will be hidden from normal sight, such as closets. Infloor does not recommend installing manifolds in areas that will not be accessible in the future. Plan the width of the manifold location to accept the manifold assembly.

Brass Manifold Cabinet & Tubing Connections

Manifold cabinets are a painted steel cabinet with locking door and can be ordered for complete protection of the manifolds and to provide a clean environment for the connection of tubing with the PEX or PERT fittings. To connect tubing to a brass manifold, begin with a clean, square cut. Slide nut over tubing, then slide the olive over the tubing and then slide adapter fitting into the end of the tubing. Tighten down fitting onto manifold 3/4" ports for final connection using a Manifold Wrench (part #22095). This adapter has high resistance to pull out due to the special configuration of this fittings.

WALL CAVITY WIDTH

Number of Circuits	Width
3	15-3/16"
4	17-1/8"
5	19"
6	21"
7	23"
8	25"
9	28-1/8"
10	30-1/8"
11	32-1/16"
12	34-1/16"
13	36"

MANIFOLD CABINET

Number of Circuits	Height x Width x Depth
3	18" x 16" x 5-1/2"
6	18" x 24" x 5-1/2"
10	18" x 32" x 5-1/2"
13	18" x 40" x 5-1/2"
17	18" x 48" x 5-1/2"

MANIFOLD CABINET

Installation

Tube Layouts

COUNTERFLOW SPIRAL - This tube layout pattern provides the most even distribution of heat. The supply and return lines run next to each other, creating an average temperature between the tubes.

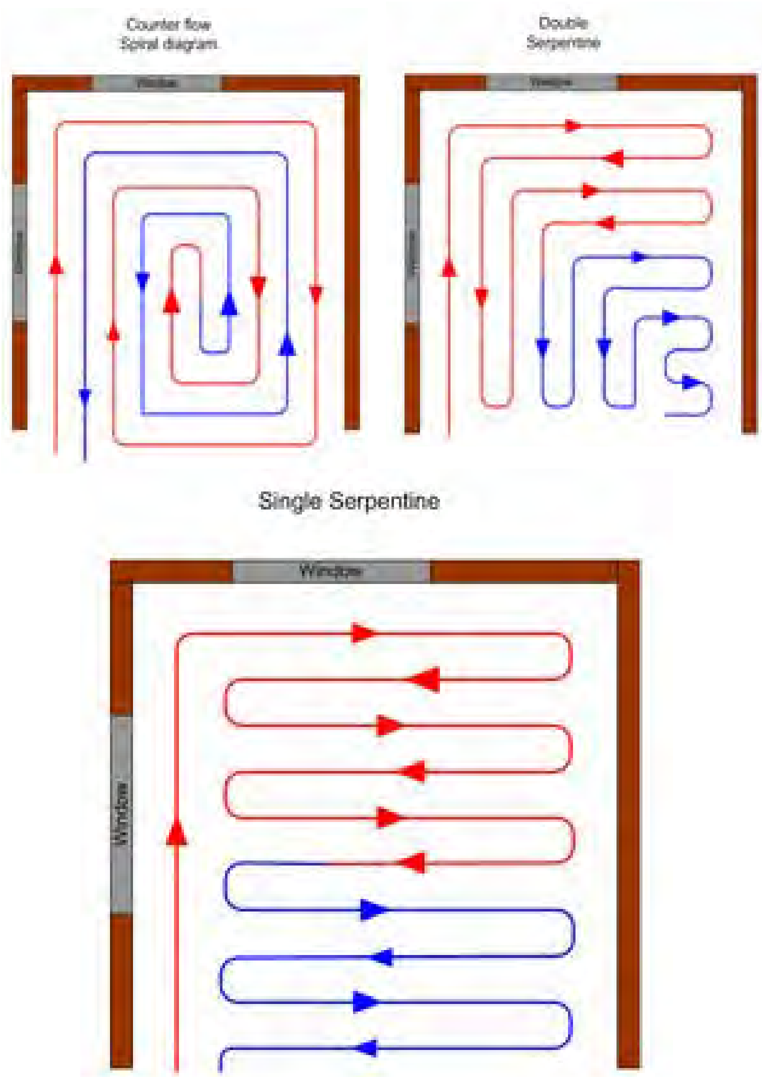
DOUBLE SERPENTINE - This pattern is used when there is significant heat loss along two adjacent exterior walls. The water temperature decreases as it flows inward, toward the area of lower heat loss.

SINGLE SERPENTINE - This pattern is used when most heat loss occurs along one wall. The water temperature decreases as it flows through the tube. Use this layout when hotter water needs to be concentrated in areas of high heat loss. An example is an exterior wall with an overhead door.

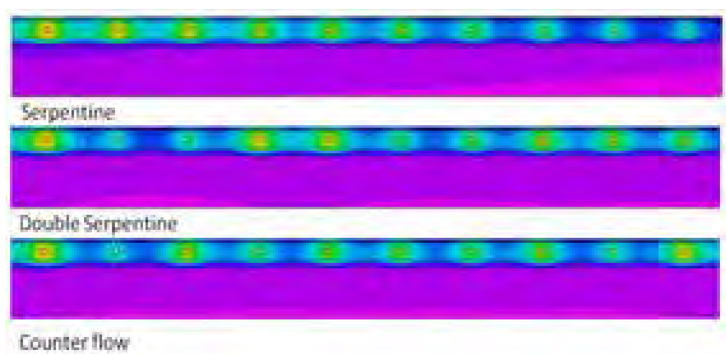
Tubing Installation

To make installation easier, Infloor tube has foot markings so it can be installed without actually measuring its length. All tubing should be 6" (150 mm) away from walls and cabinets. Do not place tubes in areas where equipment will be bolted to the floor. Do not make bends tighter than 6" (150 mm) for 3/8" (10 mm) tube; or 9" (230 mm) for 1/2" (13 mm) tube. Protect any tubes passing through expansion joints or control joints by running tubing to the bottom of the slab and place a "sleeve" of pipe insulation or larger diameter tubing around the Infloor tubes at the expansion joint. Also use a protective sleeve when tubes exit the slab. For installation over wood subfloors or precast planks, group tubes together when passing through doorways and cover with a nail guard.

TUBE LAYOUT PATTERNS



INFRARED HEATING PATTERNS

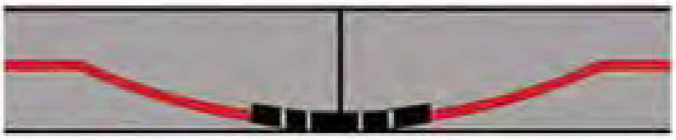


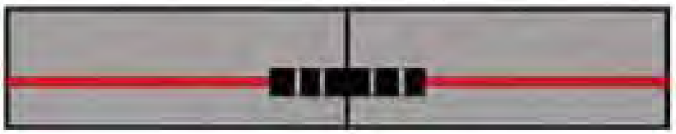
Installation

Sleeving Detail

"SLEEVE TUBING AT EXPANSION JOINTS" - ROUTE TUBING TO THE BOTTOM OF SLAB AND SLEEVE THROUGH EXPANSION JOINTS

DO NOT ALLOW TUBING TO CROSS OVER ITSELF AS





THIS MAY PROVIDE INSUFFICIENT THERMAL MASS COVERAGE AND MAY CREATE CRACKS IN THE CONCRETE SLAB.

Calculations

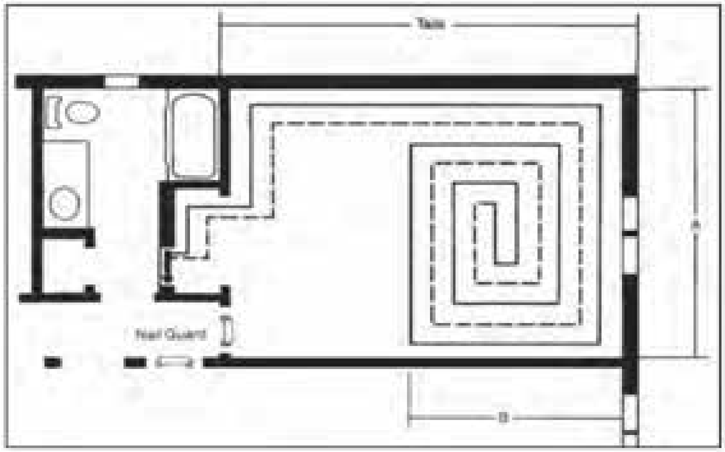
These calculations apply for all tube layout patterns. If you are not using the Infloor LoopCAD computer program to calculate circuit length, use the recommended length as shown below. Start at one end of the manifold and plan to work from one extreme side of the space toward the other with each successive circuit.

Determine the amount of tube needed to get from the manifold to the far corner of the zone and back. This length of tube is called the "tails." Subtract the tails from the over-all circuit length. The result is the amount of tube available for the tube pattern.

RECOMMENDED:
200' (60 M) FOR 3/8" (10 MM) TUBE
300' (90 M) FOR 1/2" (13 MM) TUBE

Calculate the tube coverage by dividing the remaining tube by the spacing factor. This determines the square feet to be covered by the circuit. Measure the width of the zone (Dimension A) and subtract 1 foot (for the 6-inch setback from each wall). Then subtract 2 times the tube spacing (the distance taken by the tails). This adjusted width is the dimension available after the tails are run.

Divide the adjusted width into the number of square feet the circuit will cover. This is Dimension B of the tube pattern. Measure from the outside wall (or adjacent circuit) layout floor plan with Counterflow Spiral.



Installation

SAMPLE LAYOUT CALCULATION

CALCULATING TUBE COVERAGE DESIGN	194 FT. (59 M)
CIRCUIT LENGTH	
MINUS COMBINED TAILS	48 FT. (15 M)
TUBING FOR SPIRAL	146 FT. (44 M)
DIVIDED BY	
SPACING FACTOR	2 (6.6)
TUBE COVERAGE	73 SQ. FT. (6.7 M_2)
CALCULATING DIMENSIONS FOR SPIRAL DIMENSION A	12 FT. (3.6 M)
MINUS DISTANCE FROM WALL TO TUBE 2 X 6 INCHES	1 FT. (0.3 M)
MINUS TUBE SPACING	1 FT. (0.3 M)
2 X 6 INCHES	
ADJUSTED WIDTH	10 FT. (3.0 M)
DIVIDED INTO	
TUBE COVERAGE	73 FT. (6.7 M_2)
DIMENSION B	7.3 FT. (2.2 M)

Start by cutting the end of the tube clean and square using an Infloor plastic tubing cutter (#26035). Fasten the tube down about 4' (1m) from the manifold. In concrete construction, use plastic ties (#26005), or Infloor wire ties (#26001) to fasten the tubing directly to the reinforcing mesh. Over wood subfloors, use an Infloor staple gun (#26093) and wide-crown staples (#26096) to fasten the tube directly to the subfloor. Over pre-cast concrete, tie tubes to wire mesh or snap tubes into Octa rails (#26072) attached to the subfloor.

Unroll the tube, fastening it down every 12" to 18". When installing a Counterflow Spiral follow the outside dimensions of the coverage area and spiral towards the center while maintaining the double-tube spacing between tubes. Once in the center, reverse and spiral out between the tubes of the original spiral.

When laying tube in a serpentine pattern, begin at the farthest point of the tube area and place the supply portion of the loop at the outside walls. "Snake" the tubing across the tube area maintaining the desired spacing. This pattern allows the hottest water to be delivered to the outside wall.

As each circuit is run, write the number of loop and supply or return on the tubing with a black marker and the length and identify which area each tube circuit services.

Do not exceed a bend radius of 6 times the outside diameter of the tubing as this can cause excessive restriction to fluid flow.

Tube Pressure Test

Once all the tube is installed and connected, secure the tubes in front of the manifolds. Then pressure-test the system to 60 psi or local codes. If the system won't hold pressure, find and repair the leak. Tubing must be pressure tested with documentation or proof of pressure test, such as digital picture or regular picture with date and time prior to installation of concrete or gypcrete. If it is necessary to protect the system from freezing, use propylene glycol.

(NOTE: Never use automotive antifreeze.)

Installation

Splice Instructions

To repair tubing damaged after installation, use a repair splice. Make a clean, square cut on the tubing. If necessary, remove the damaged section and replace with a new section of tubing. Use a crimp coupling. Once all connections have been made, pressure test the system to check the splice. If the splice will be buried in a thermal mass, wrap the splice with tape or insulation to prevent direct contact with the concrete or patching material. Patch the area around the splice with a suitable patching compound. Mark on the prints where the splice has been placed. Infloor recommends only using a crimp coupling in concrete or gypsum applications.

CRIMP COUPLING

Size	Part #
3/8" COUPLING	(#24010)
3/8" CRIMP RING	(#24000)
1/2" COUPLING	(#24012)
1/2" CRIMP RING	(#24001)

Control Options

Control Strategy

The type of heat source is very critical in determining the type of control strategy to use. Every heat source has different operating efficiencies and will vary in cost depending upon the model. Higher efficiency equipment costs are higher initially, but operate at a much lower cost. Traditional equipment such as cast iron boilers typically cost less, but operational cost is higher.

Infloor Heating Systems can operate very effectively using cast-iron boilers, high-efficiency modulating condensing boilers, water heaters, ground source heat pumps, wood or coal fired boilers, solar thermal systems and virtually any component that can produce sufficient hot water. However, each of these heat sources require a different control strategy.

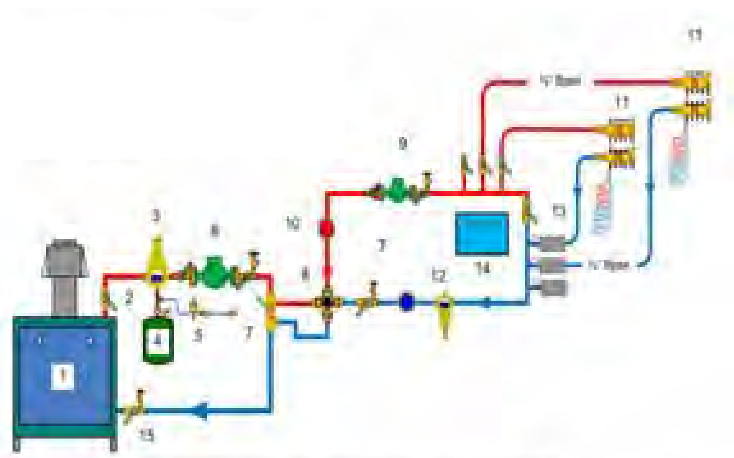
Cast Iron Boilers

Cast-iron boilers typically operate at much higher temperatures than normally required for radiant heating. This is a requirement of the boiler's operating conditions to prevent condensation of flue gases and potential reduced service life. However, these boilers can effectively be used when the water to the radiant system is tempered. The use of Infloor 4-Way Mixing Valves, variable speed injection pumps, or 3-Way Thermostatic Mixing Valves are used to accomplish this. The mixing valves may be manually set, or connected to automatic modulating controls which change the supply water temperature in relation to changes in the outdoor temperature. So, as it gets colder outside, the water being supplied to the radiant floor gets hotter. These valves mix the hot boiler water with cooler return water from the radiant floor to provide the proper temperature water for delivery to the floor. All valves should be piped in by using closely spaced tees.

Mixing valves are primarily used to modulate the water temperatures required by the different installation methods used in the system. However, sub-zones may be further modulated by using a 3-way thermostatic mixing valve.

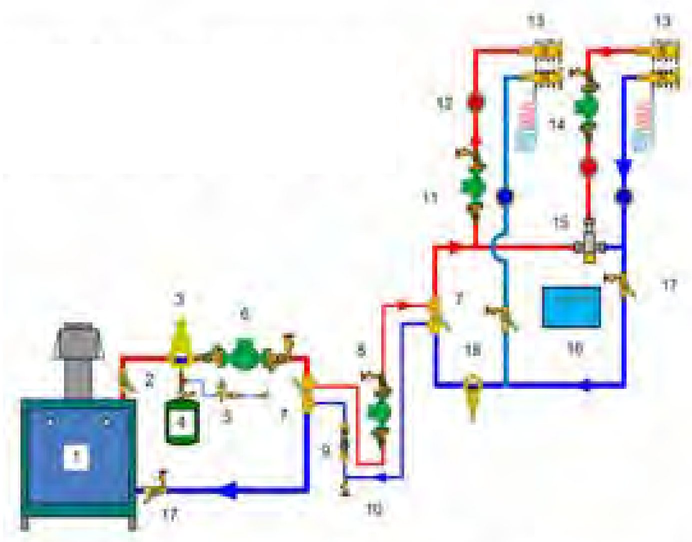
Injection pumps are controlled by a reset controller that varies the speed of the pump which provides necessary hot water to the secondary loop to maintain the desired delivery water temperature. The reset control adjusts the secondary loop water temperature in relation to changes in the outdoor temperature. Boiler return temperature sensing control is also available.

CAST IRON BOILER WITH 4-WAY MIXING VALVE, SINGLE TEMPERATURE WITH ZONE VALVES



Control Options

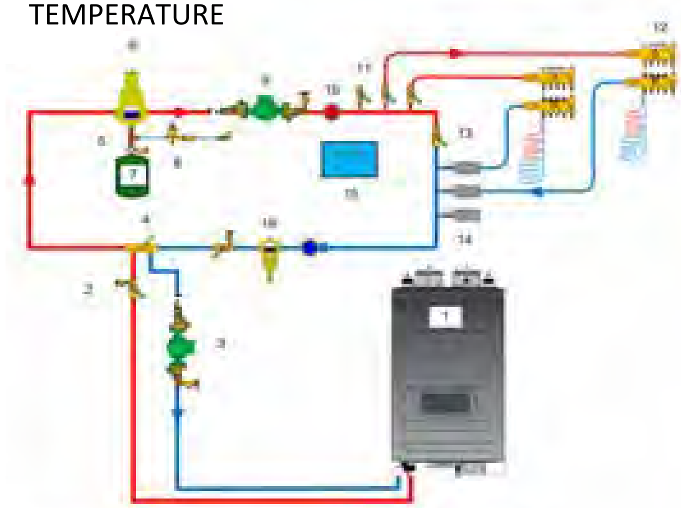
CAST IRON BOILER WITH INJECTION PUMP, 2 TEMPERATURE WITH 3-WAY THERMOSTATIC MIXING VALVE



High-Efficiency Condensing Boilers

These boilers contain low mass and non-corrosive materials so it is possible for them to operate at temperatures within the range of radiant floor requirements. Since the modulating condensing boiler can be set to deliver the proper water temperature, mixing valves are not required unless a multiple temperature system is needed. These boilers can be operated with on demand controls, such as a thermostat, most come with outdoor reset controls, which turn on the boiler according to changes in the outdoor temperature. Since these boilers are low mass, they require proper flow to operate effectively. Some require high head pumps for proper flow rates.

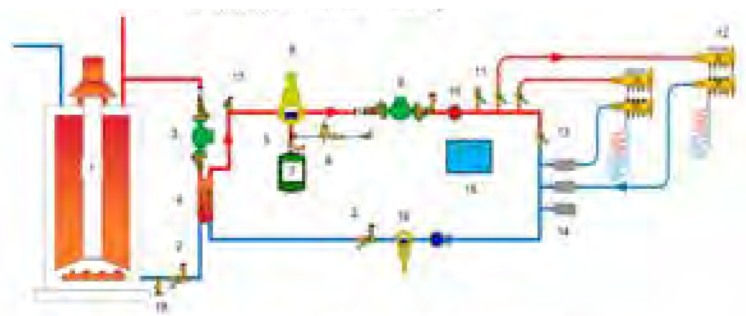
MODULATING CONDENSING BOILER, SINGLE TEMPERATURE



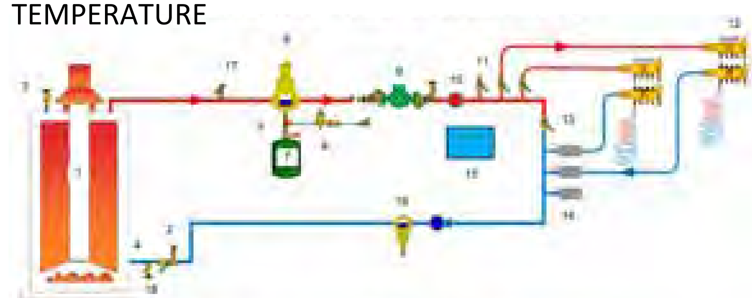
Water Heaters

Water heaters provide a low cost alternative to a heat source for radiant heating systems. They provide proper water temperatures without mixing valves, do not corrode, are efficient, and are available in natural gas, propane, and oil. Infloor does not recommend using electric models unless using an electric boiler. Generally, water heaters are sufficient for renovations and small heating zones only. High heating loads or projects using propylene glycol are usually not recommended for water heater applications.

WATER HEATER WITH BRAZED PLATE HEAT EXCHANGER, MULTI-ZONE, SINGLE TEMPERATURE



DEDICATED WATER HEATER, MULTI-ZONE, SINGLE TEMPERATURE



Control Options

Ground-Source Heat Pumps (Geothermal)
Ground-source heat pumps (GSHP) provide very efficient heat source option for radiant heating systems. GSHPs provide high operating efficiency, and when used with a radiant heating system, can provide high heat distribution efficiency. Care must be taken when using GSHPs because their temperature output is limited, usually to 120°F (50°C) or less. This temperature is normally sufficient for radiant heating systems except in zones that have high heat loss and/or highly insulated floor coverings. Also, a buffer water storage tank is required to prevent short-cycling.

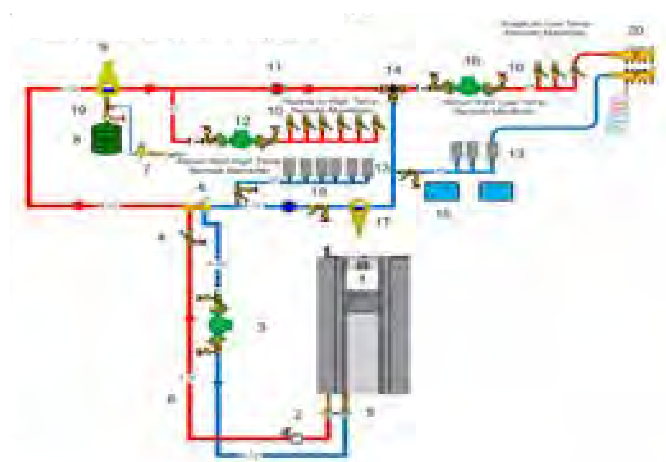
GEOTHERMAL, SINGLE TEMPERATURE, MULTI-ZONE SYSTEM

Wood/Coal Fired Boilers
These units require the use of Infloor 4-Way Mixing Valves for the radiant zones, and a buffer water storage tank for the boiler. Since these types of units can produce high water temperatures, the 4-way mixing valve controls the temperature to the radiant zones. The water tank acts as a heat sink to prevent over-temperature conditions in the boiler.

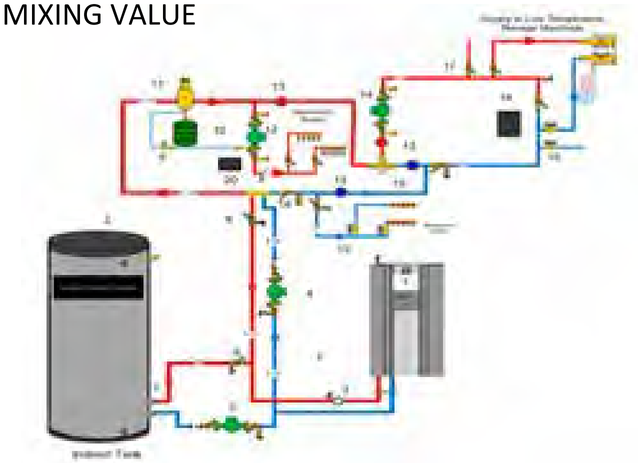
PRESSURIZED WOOD OR COAL BOILER, SINGLE TEMPERATURE WITH 4-WAY MIXING VALVE

Alternative Systems
Use of a mixing valve allows other heat transfer devices to be used in combination with a radiant heating system. These devices may be used when supplemental heat is needed, such as beneath large windows, or when heating non-radiant zones such as a work area or garage. Radiators, baseboard convectors and fan coils may be run directly off the boiler while the mixing valve tempers water to the radiant floor. All these devices should be piped using primary and secondary piping arrangements with the use of closely space tees or hydraulic separators.

MODULATING CONDENSING BOILER, HIGH/LOW TEMPERATURE WITH 3-WAY MIXING VALVE



MODULATING CONDENSING BOILER, HIGH/LOW TEMP. AND DHW WITH 3-WAY THERMOSTATIC MIXING VALUE



Control Options

Solar Gain

In zones with a large amount of solar gain, there is a tendency for the radiant mass to discharge its heat during the day and then be slow to respond when the sun sets. To help counter this problem, use an Infloor dual-sensing thermostat (#29001). Set the dual-sensing remote sensor to maintain a mass temperature lower than that required for heating. The air sensor will control the required zone temperature. This will prevent the mass from totally discharging its heat and reduce the time required to heat up again.

While this control strategy will not prevent temperature overshoot due to a sudden influx of solar energy, it will help to accelerate the recovery of the thermal mass and lessen the lag time.

Zoning

Zoning the radiant system may be a desired option. Valves may be used to provide room or area "sub-zoning." Zone valves are used to control the entire manifold assembly. This allows for zoning by room usage, floor coverings, floor levels, etc. Individual loop control can be achieved by using brass manifolds and thermal actuators. This is a common practice when reducing manifold locations and using larger manifolds. Radiant heating systems provide very stable temperature environments and over-zoning produces added expense with minimal energy savings.

When using zone valves, match the thermostat anticipator with the valve manufacturer's instructions. Then adjust for longer or shorter operation to achieve desired boiler cycling.

When using a boiler, make sure you read the boiler manufactures installation instructions to determine if a mixing device is required for the radiant application. Many boilers require primary / secondary piping in order to provide adequate flow through the boiler.

DUAL SENSING THERMOSTAT (#29001)

Wiring

Electric Control Box

An Infloor Control Box (30061-30064) provides easy system wiring. Included are isolation relays for controlling domestic hot water priority and secondary pump. This control also provides a domestic hot water (DHW) priority and an end switch for use in operating a boiler.

The Control Box will allow up to 4 to 6 zone valves to be operated by individual thermostats. The control box can also be configured to expand to another for up to 24 zones with a thermostat on each zone.

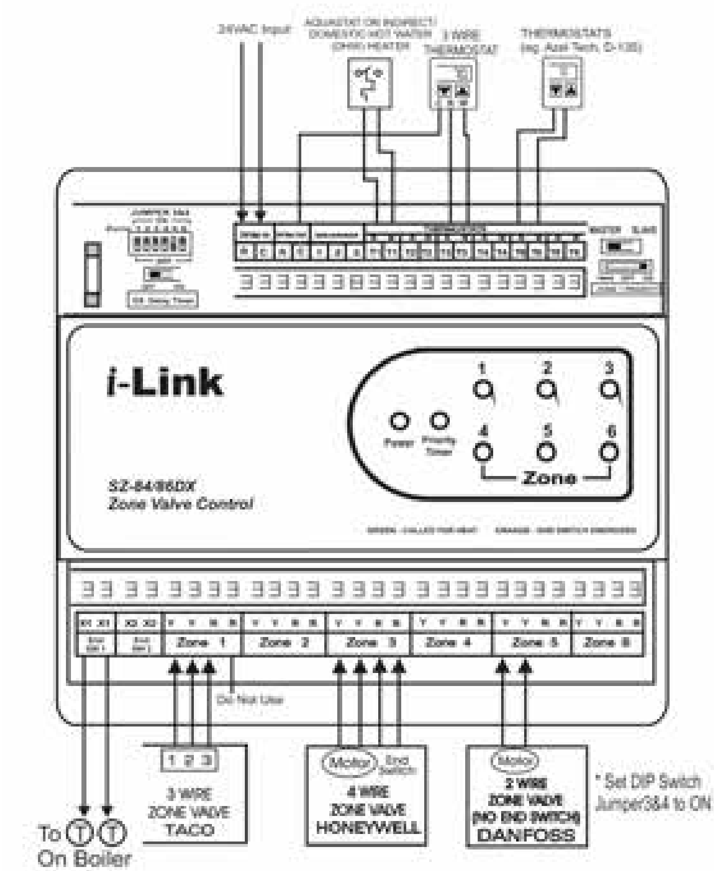
CONTROL BOX (#30062)

There are also terminals for adding a domestic hot water priority zone. The DHW terminals on the upper left corner of the circuit board connects to tank aquastat. A transformer is required for the operation of this control box.

Whenever there is a call from the DHW priority, the domestic hot water priority valve turns on and the secondary heating pump turns off. The end switch terminals will continue to operate the boiler. The control will return to space heating when the domestic water demand is satisfied.

LEDs provide a visual indication of the control status: Green - power on, amber and red Indicator lights per zone valve and thermostat. Zone valve end switches activate call for heat to boiler. 2, 3 and 4 wire zone valves which are power open spring return can be used with this control. If additional zones or pumps are needed another Control Box can be added.

WIRING DIAGRAM 30061-30062 CONTROL BOX WITH DOMESTIC HOT WATER PRIORITY



Wiring

Wiring Options

The Infloor Control Box may be used to control a variety of devices in a variety of configurations. Each zone terminal is 24 VAC powered, so any low-voltage zone device may be used with the control box. All power is provided by a 24 VAC transformer.

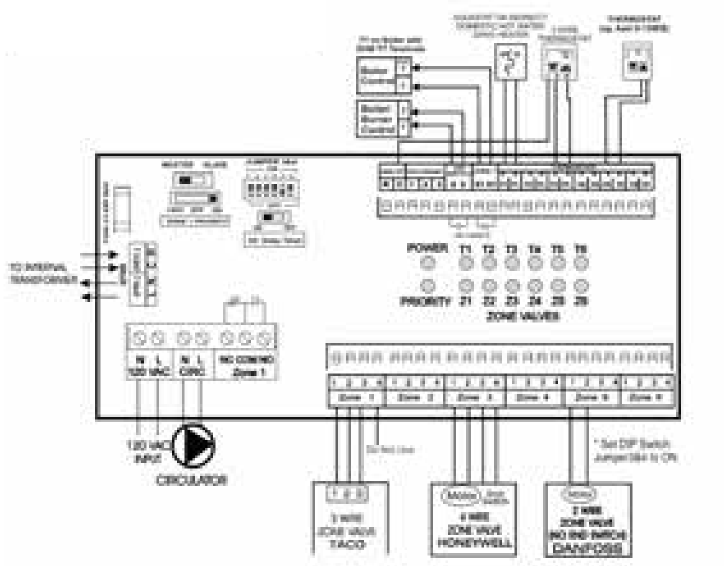
Standard 4-wire motorized zone valves are connected directly to the zone terminals. Infloor thermostats (#29019 or #29001) are connected to the thermostat terminals. The control box has an end switch to activate the boiler. Also included are terminals for a domestic water priority aquastat and terminals for domestic hot water priority valve. In systems using multiple heating elements, such as baseboard heaters or fan coils, the control box may be used to interface all components.

Alternative thermostat: a dual-sensing thermostat (#29001) may be used. However, the wiring diagram is different since the dual-sensing thermostat needs power to operate and provides a dry contact for zone operation.

See diagram to the left and in appendix. (Use 18-4 gauge wire to connect the thermostat to the transformer and to the zone valves.)

#30064 WITH TRANSFORMER

MULTIPLE ZONE VALVE AND DUAL-SENSING THERMOSTAT



Wiring

Infloor Single Zone Switching Relay

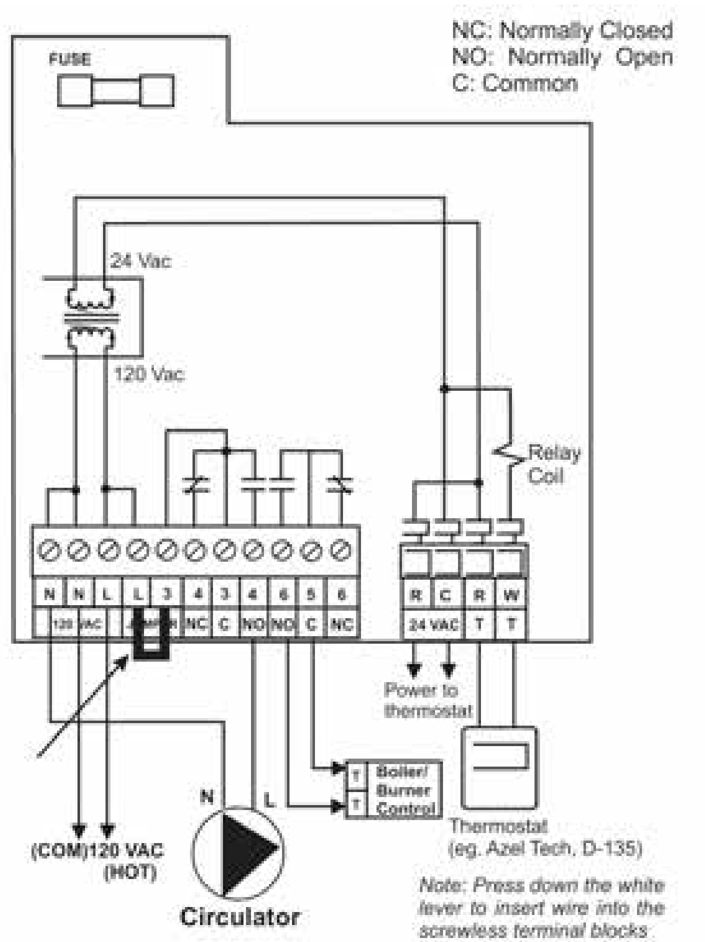
Use the Infloor single zone switching control (#31040) in simple systems when a circulator pump is used. The control is UL/CSA listed and allows a low-voltage thermostat to switch a line voltage circulator pump. The relay also contains an end switch for switching low-voltage components. Infloor thermostats (#29019) and (#29001) may be used with this control.

Thermostats

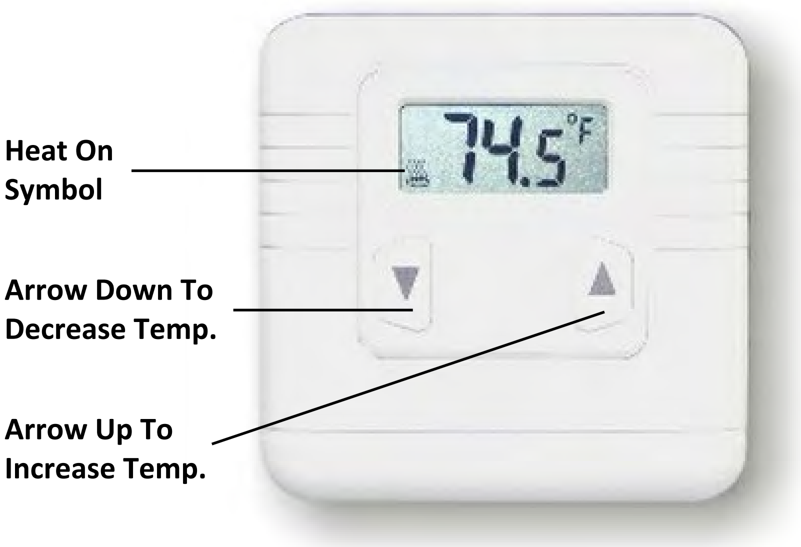
Heating System Applications

The Infloor air-sensing thermostats provides very precise control over room temperature. Using a temperature differential of less than 1°F allows the thermostat to react rapidly to changes in the indoor temperature. The thermostat may be mounted directly to the wall. Install the thermostat about 5 feet (1500 mm) above the floor, away from direct sunlight, fireplaces, and air conditioning ducts. Run 18-4 (heating only) or 18-6 (heating/cooling) gauge wire from the thermostat location directly to the mechanical room, to the Infloor Control Box.

INFLOOR SINGLE ZONE SWITCHING RELAY



24 VAC DIGITAL HEATING THERMOSTAT (#29019)



Wiring

Warm Floor Applications

When using the Infloor Remote Sensing Thermostat (#29001), install a sensor tube to the desired location for the thermostat about 5 feet (1500 mm) above the floor. Run the sensor tube (#29011) from the thermostat location to the floor extending 3 feet (1 m) away from the wall. This sensor tube will contain the thermostat's remote sensor. Use 18-4 gauge to connect the remote sensing thermostat to the control system.

Optional Thermostat - an optional control for a warm floor application is the Dual-Sensing Thermostat (#29001).

Wi-Fi Thermostats

Wi-Fi thermostats are the next generation of smart technology. Monitor and control your Wi-Fi connected thermostat anytime, from anywhere, on your smartphone, tablet, or computer.

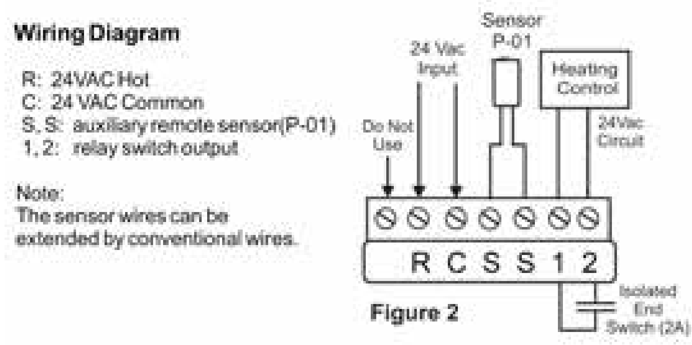
Most thermostats read the temperature in one place (usually the hallway), which can make other rooms uncomfortable. Wi-fi thermostats, such as the ecobee3, uses room sensors to deliver the preferred temperature to the rooms that matter.

Most models come with free energy reports providing users insights into how much they have saved based on run times.

We have different models to choose from with cool features such as simplified touch screen interface, high resolution color display, motion-sensing light up, and more. Contact us to learn more, for installation support, and place an order.

DUAL-SENSING THERMOSTAT (#29001)

DUAL SENSING THERMOSTAT WIRING



ECOBEE3 WI-FI THERMOSTAT WITH ROOM SENSORS

System Start-Up

Purging
Make sure the boiler, controls and other system electrical components are "off." After checking all connections, fill the system with water and pressurize to 20 psi (210 kPa). Bleed air from the manifold vents, air vents, and the primary loop air vent. Check the entire system for leaks.

It is important to remove all air from the system to assure proper operation. Air trapped in tubing or manifolds may prevent circulation of water through isolated tubes. Air trapped in circulator pumps could cause pump to fail. It is best to use available city water pressure to force the initial air out of the system. A purge valve should be installed in the system to assist in removal of air. An air eliminator installed in the system will remove residual air. It is suggested that a micro-bubble air eliminator be installed as these are the most efficient air eliminators available.

Use a pressure reducing fill valve with a manual shut off valve for adding water to the system. Occasionally, after initial start-up, system pressure will drop. Add water to the system until pressure stabilizes, then turn off the fill valve.

PURGE 90° END PIECE

IMPORTANT: The use of an automatic fill valve is recommended during initial fill of the system, however this valve should be shut off after initial fill. If system will not hold pressure find the source of the leak.

System Treatment
All hydronic heating systems benefit from a water treatment program. Infloor offers Formula 10 or Infloor Closed System Treatment to prolong the life of system components. Calculate the total volume of water in the system, including all the water in the tubing. See the chart for tube capacities. Add the proper dosage for the treatment used.

TUBE CAPACITY CHART

Tube Size	Gallon per foot (L/m) PEX/BPEX
3/8" (10 mm)	0.0050 (0.07)
1/2" (13 mm)	0.0092 (0.11)
3/4" (19 mm)	0.0184 (0.23)
1" (25 mm)	0.0304 (0.38)

Tubing Size & Type	Volume gal/ft
1/2” typ m copper	0.01319
3/4” typ m copper	0.02685
1” typ m copper	0.0454
1-1/4” typ m copper	0.06804
1-1/2” typ m copper	0.09505
2” typ m copper	0.1647

System Start-Up

Infloor System Treatment

Infloor System Treatment (#27000) is a non-chromate based treatment that must be maintained in proper concentration to prevent system corrosion. The concentration may be checked with a Sodium Nitrite Test Kit.

Initial treatment may require more or less system treatment depending upon water quality. Test concentration during initial application. Propylene glycol may be added if freeze protection is desired.

Check concentration after several weeks of system operation and adjust concentration level if necessary. Proper dosage is one gallon (3.79L) of Infloor System Treatment for every 50 gallons (190L) of water in the system. [One quart (0.9L) of Infloor System treatment for every 12.5 gallons (47L) of water].

Formula 10

Formula 10 (#27005) is a silicate-based system treatment capable of protecting all metals in the system with a single application. Proper dosage is one quart (0.9L) of Formula 10 for every 50 gallons (190L) of system water.

Note: Formula 10 may not be used with glycols or other chemicals.

Thermal Mass & Floor Coverings

Thermal Mass
A radiant floor system should be designed to use the lowest water temperature possible for heating. This means that the conductivity of the floor itself is very important. Any thermal resistance between the embedded tubing and the floor surface requires higher water temperatures. Therefore, a floor that spreads the heat uniformly with little resistance is the most desirable. Additionally, any flooring structure that stores some of the heat will help to even out short term heating demands. With this in mind, Therma-Floor for suspended or capped floors, and concrete for slab floors are ideally suited. Tubing embedded in either of these materials will work as an excellent heat exchanger.

Under-slab heat loss may severely affect system performance. Insulate under the entire slab when there are high water tables, when restrictive floor coverings are used, and when the area being heated has a high heat loss.

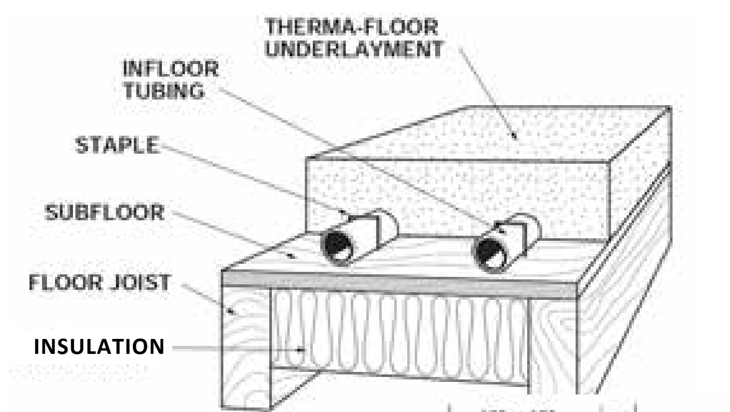

Therma-Floor

NOTE: THE MINIMUM DEPTH OF THERMA-FLOOR IS 3/4" (25 MM) OVER THE TOP OF THE TUBING.

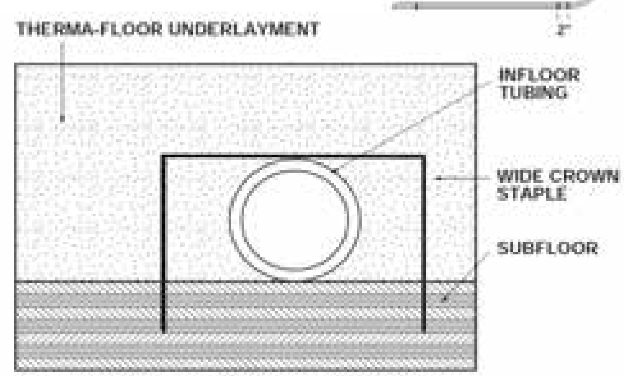
Suspended Floors
Infloor tubing is stapled to the subfloor using the Infloor staple gun (#26093) and wide crown staples (#26096). Staple the tubing every 12" to 18" and place five staples at each turn, two at the beginning and end of the turn and one in the middle of the turn. Do not allow the tubing to be severely indented by the staple.
Caution: In freezing weather, warm tubing before stapling to prevent damage to tubing.

Insulation must be placed under the floor, between the joists on all applications, to prevent downward heat transfer. A higher R-Value insulation is required under the floor if there is unheated space below, such as a crawl space or unheated garage.

WOOD SUB-FLOOR / THERMA-FLOOR DIAGRAM



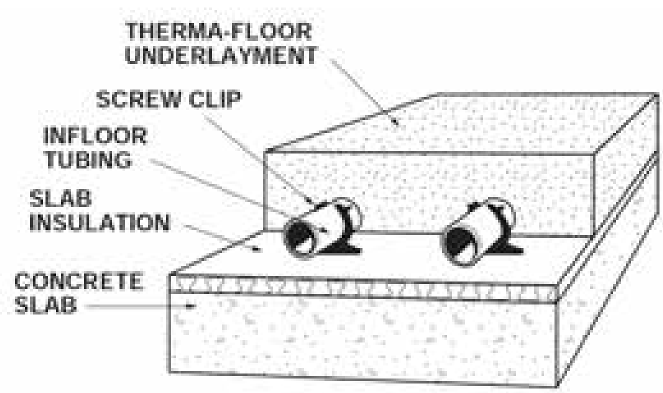
STAPLING DETAIL



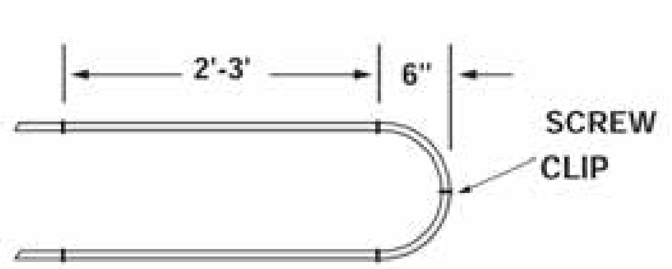
Thermal Mass & Floor Coverings

Existing Concrete Slab
In renovation projects, or where more precise system control is desired, the existing concrete slab may be capped. Secure high density insulation (1.8 to 2.0 pounds per cubic foot) [32 kg/m 3]) to the existing slab. When 1-inch (25 mm) insulation board is used, tubing may be fastened using Infloor screw clips (#26015) or plastic staples (#26083). Install a clip or staple every 1 foot to 18" and place three clips or staples at each turn, one at the beginning and end of the turn, and one in the middle of the turn.

CONCRETE SLAB / THERMA-FLOOR DIAGRAM



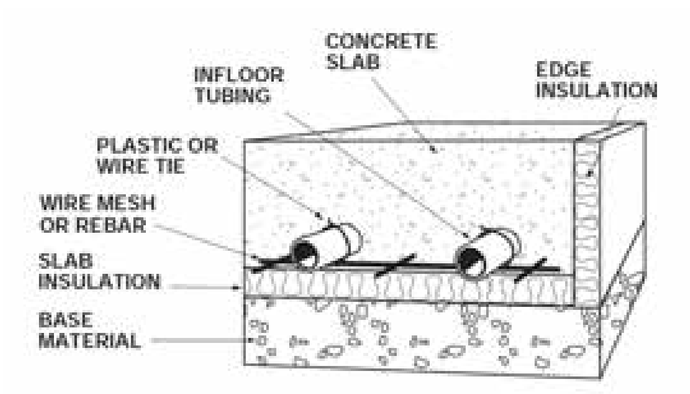
SCREW CLIP PATTERN



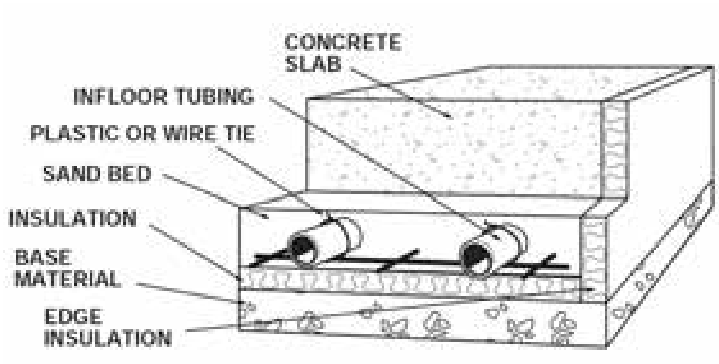
SCREW CLIPS (Part #26015)

Concrete Slab On or Below Grade
A 2" high-density, foundation approved, polystyrene insulation is placed under the slab and at the edge. It is critical to insulate the perimeter and edge of the slab for optimum system performance. Prepare a smooth base and place the insulation board. Tubing may be secured to the insulation with Infloor screw clips (#26015) or plastic staples (#26081) if fiber reinforced concrete is poured. If rebar or wire mesh is used, tie the tubing to the reinforcement wire using plastic ties (#26005) or wire ties (#26001). Clip or tie the tubing every 12" to 18" and place three clips, staples, or ties at each turn, one at the beginning and end of the turn and one in the middle of the turn.

CONCRETE SLAB DIAGRAM

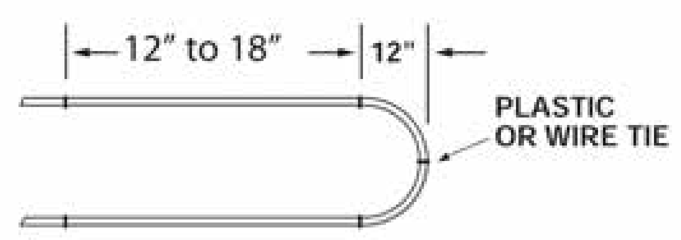


CONCRETE SLAB ON SAND BED DIAGRAM



Thermal Mass & Floor Coverings

FASTENING PATTERN



RECOMMENDED: FOR BETTER SYSTEM CONTROL AND RESPONSE TIME, PLACE INSULATION UNDER THE ENTIRE SLAB, EDGE, AND PERIMETER. INSULATION IS CRITICAL FOR PROPER RADIANT HEATING PERFORMANCE. ELIMINATION OF THIS INSULATION WILL PRODUCE UNSATISFACTORY RESULTS, ESPECIALLY WHEN HIGH WATER TABLES ARE PRESENT OR HIGH R-VALUE FLOOR COVERINGS ARE USED.

Floor Coverings

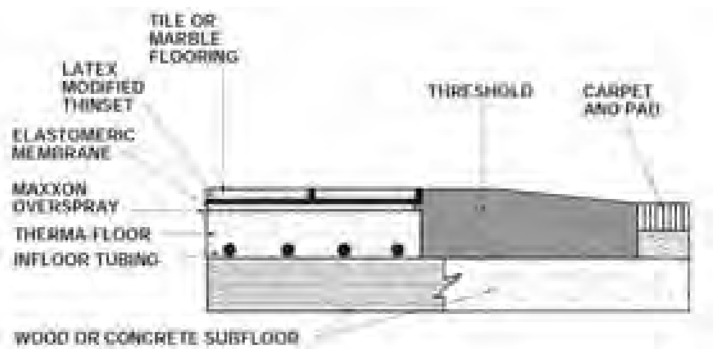
Virtually any type of floor covering can be used over an Infloor Heating System, including tile, marble, hardwood, laminate, and carpet. Each floor covering has a pronounced effect on the performance of a radiant heating system due to their insulating qualities. With a proper design, even plush carpet with pad can be used. High R-value floor coverings such as carpet will require higher delivery water temperatures and/or tighter tube spacing.

The more conductive floor coverings, such as ceramic tile, stone, and marble, perform exceptionally well. These coverings allow easy transfer of heat from the heating system. The Maxxon publication "Procedures for Attaching Finished Floor Goods to Maxxon Underlayments" details how to attach a variety of floor goods to Therma-Floor and other Maxxon underlayment products. This publication also contains information for tested adhesives.

Installing Tile or Marble over Therma-Floor

Follow the instructions in the Maxxon publication called "Procedures for Attaching Finished Floor Goods to Maxxon Underlayments." Once the Therma-Floor is dry, apply diluted Maxxon Floor Overspray as per recommendations. After the Overspray is dry, apply an elastomeric membrane and thin-set tile or marble with latex-modified thinset. Important: Wait until the tile or marble installation is complete before turning on the Infloor system.

TILE / THERMA-FLOOR DETAIL



Thermal Mass & Floor Coverings

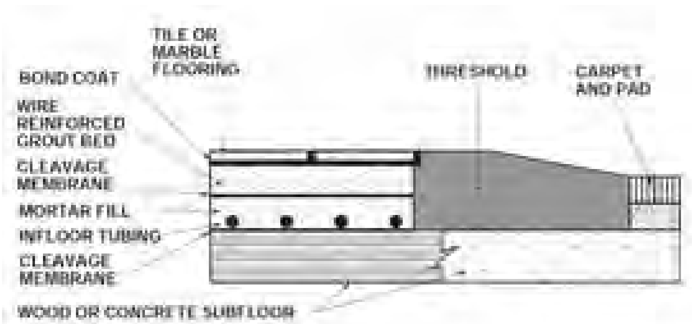
Installing Infloor Heating Systems in Mortar Beds
Follow the Cement Mortar-Cleavage Membrane procedure F111-91 in the TCA 1991 Handbook for Ceramic Tile Installation. The primary steps are:

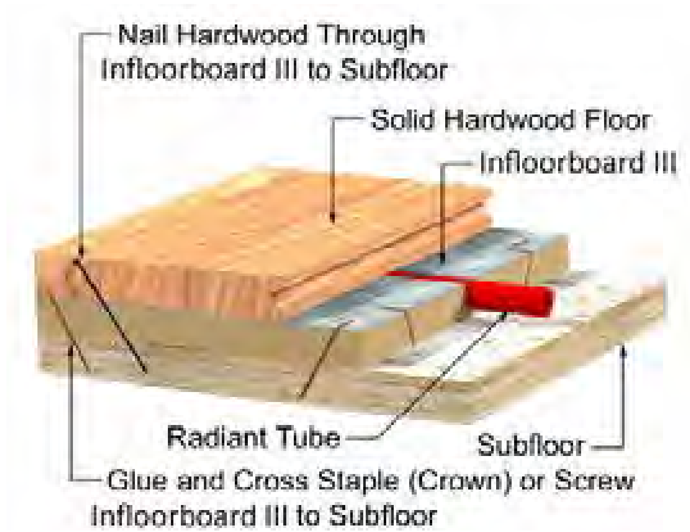
1. Place a cleavage membrane over the wood or concrete subfloor.
2. Install tubing and surround the tubing with a 3/4" (19 mm) layer of firmly packed mortar, and pressure test the tubing to 60 psi.
3. Place a second cleavage membrane over the mortar bed.
4. Install a wire-reinforced mortar bed system over the cleavage membrane.
5. Use a portland cement paste on a mortar bed that is still plastic for the bond coat. Use a dry-set mortar or latex-portland cement mortar on a cured bed.
6. Install a transition threshold between adjacent floor coverings.
7. Wait 48 hours after installing the tile or marble before turning on the Infloor system.

Installing Hardwood Floors over Infloor Heating Systems
Hardwood floors may be used with radiant heating systems. Since the floor is being heated, care must be taken to prevent the floor from becoming too hot and causing too much contraction and expansion of the wood. During the heating season, wood that is very moist will tend to be dried. This may cause gapping to occur. During the cooling season, wood will absorb moisture and expand. This may cause buckling if proper expansion is not planned. All hardwood floors should be acclimated to the radiant system prior to permanent attachment.

The radiant floor under hard wood floor system should have a maximum floor surface temperature of 85°F, this often requires the use of special mixing devices or dual sensing thermostats (#29001).When installing hardwood floors it is recommended to use the following types of flooring systems.

TILE / MORTAR BED DETAIL



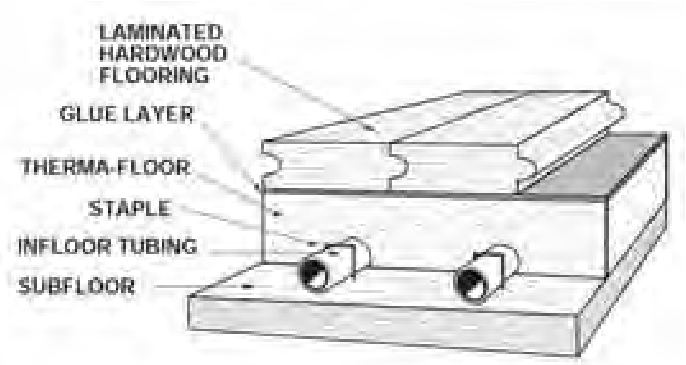


Thermal Mass & Floor Coverings

Glue-Down Laminated Hardwood

Glue-down laminated hardwood systems tend to be the most stable flooring systems for use with radiant heat. The cross-plies of the flooring boards make the flooring very stable and resistant to excessive expansion and contraction. Many wood flooring manufacturers produce pre-finished, square-edge laminated hardwood floors that are indistinguishable from nail-down systems. Since laminated systems are generally thinner than nail-down systems, the radiant system performance is improved due to lower resistance from the floor covering.

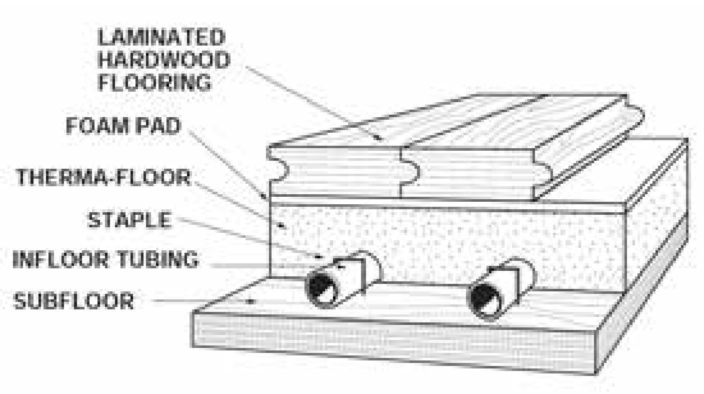
NOTICE: Check with the flooring manufacturer to ensure the flooring is compatible with a radiant heating system.



Floating Floor

Floating floor systems are another alternative to the nail-down approach. Flooring boards are glued edge to edge or some are tongue and groove and floated on a 1/8" (3 mm) foam pad. Since the flooring is laminated, it is a very stable system. Performance is about as good as with glue-down laminate systems. The foam pad adds some additional resistance, but the floating floor laminates are generally thinner than glue-down laminates so the net performance effect is similar.

NOTE: Check with the flooring manufacturer to ensure the flooring is compatible with a radiant heating system.



Solid Hardwood

Solid hardwood may be installed in several ways. Since solid wood floors perform best when they are nailed, careful planning is required.

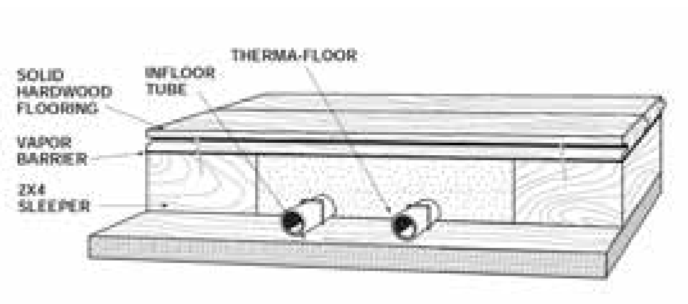
Nail-down Sleeper System

In this approach, the planning of this type system must happen at the beginning of the job. The direction of the way the hardwood floor is to be laid will have an effect on how the tubing is installed and which direction the sleepers will need to be installed. Sleepers and tubing should run perpendicular to the direction of the hardwood floor. Sleepers should be cut out of straight and flat boards that are not bowed or twisted.

Now the 2 x 4 sleepers are installed directly on the subfloor and tubing is installed between the

Thermal Mass & Floor Coverings

sleepers. The spaces are then filled with Therma-Floor to provide a thermal mass. Once the Therma-Floor has dried, a vapor barrier is laid down, the flooring boards are nailed directly into nailing sleepers that were installed on the subfloor. The advantage of this system is that the flooring creates minimal insulation above the heating system. The disadvantage is that the flooring can only be nailed to a sleeper which may not provide enough fastening.



SLEEPER SYSTEM

Carpet and Pad

Selecting carpet and pad materials with low insulated (resistance) values is the key to keeping delivery water temperatures as low as possible. Carpet pads have perhaps the greatest impact on the thermal transfer of a radiant floor. The standard "prime" or "bonded" urethane pad is over three times more insulated than rubber pads. Selecting a thinner rubber pad instead of a thick urethane pad can make as much as a 50°F (28°C) difference in the required water delivery temperature.

NOTE: TO ESTIMATE THE CARPET AND PAD R-VALUE, TAKE THE R-VALUE + PAD = TOTAL R-VALUE

FLOOR COVERING R-VALUES

Floor Coverings	Depth	R-Value
Carpet	1/8"	0.6
	1/4"	1.0
	1/2"	1.4
	3/4"	1.8
	1"	2.2
Acousti-Mat	1/4"	0.3
Urethane Pad	1/4"	1.0
	1/2"	2.0
Vinyl or Tile		0.2
Hard Wood	3/8"	0.5
	3/4"	0.8
Soft Wood	1/2"	0.6
	3/4"	0.8
	1"	1.2
Carpet + Pad = Total R Value		

NOTE: CARPET R-VALVE = CARPET HEIGHT X 2.6

Mechanical Boards

Pre-Assembled Mechanical Boards

Infloor offers 3 different styles of pre-piped and wired board configurations. All of these styles can range from 1 zone to 7 zone configurations for ease of installation and correct piping. Pipe sizing will vary based on the number of zones and required system flow rate.

The first style is the Condensing Boiler Room Board, this board is configured to include; 2 closely spaced tees, air eliminator, fill/backflow preventer, expansion tank, pressure differential magnetic-drive system pump, from 1 to 7 supply side ball valves, purge valves, digital temperature gauges for reading supply and return temperature, from 1 to 7 zone valves, and 1 to 2 zone valve control boxes. This style board comes completely assembled and ready to pipe in primary loop circulator to closely spaced tees. The expansion tank is shipped separately.

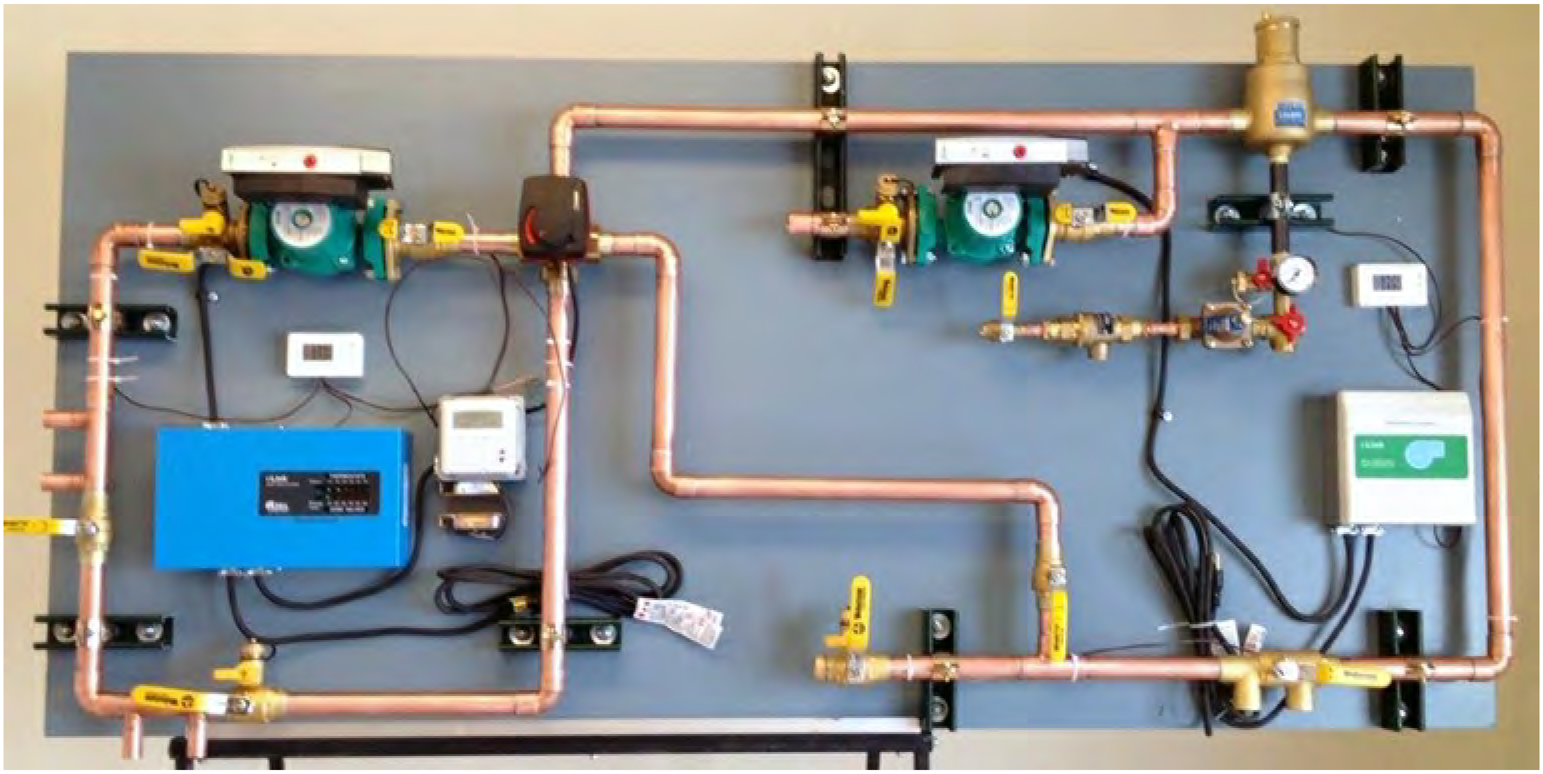
The second style is the Geo Thermal or Closed Loop Water Heater Board this board is configured to include; air eliminator, fill/backflow preventer, expansion tank, pressure differential magnetic-drive system pump, from 1 to 7 supply side ball valves, purge valves, digital temperature gauges for reading supply and return temperature, from 1 to 7 zone valves, and 1 to 2 zone valve control boxes. This comes completely assembled, except the expansion tank, which is shipped separately.

The third style is 4-Way Mixing Valve Board, this board is configured to include 4-way mixing valve, from 1 to 7 supply side ball valves, pressure differential magnetic-drive system pump, purge valves, digital temperature gauges for reading supply and return temperature, from 1 to 7 zone valves, and 1 to 2 zone valve control box. This board is designed to be used with systems that require additional water mixing features such as two-temperature systems or where high-temperature boilers are used.

HIGH-EFFICIENCY BOILER BOARD

4-WAY MIXING VALVE BOARD

Mechanical Boards



Infloor Mechanical Boards make installation quicker and easier. Each board is custom made to order, designed specifically for the project needs. They can be tailored to fit any sized radiant heating system and heat source. We build a custom crate (shown below) around each finished mechanical board to ensure it arrives at its destination the same what it left our warehouse. Please contact us to learn more or to have a custom board

GEOTHERMAL / CLOSED LOOP BOARD

CUSTOM CRATE FOR SHIPPING A BOARD

Appendix

Definitions

British Thermal Unit (Btu) - A unit for measuring quantity of heat. It is approximately the heat required to raise the temperature of one pound of water one degree Fahrenheit.
Btu per hour - A unit for measuring the rate of heat transfer.

Conduction, thermal - Heat transfer through a material in which energy is transmitted from particle to particle without displacement of the particles.

Convection - Heat transfer by movement of fluid. Natural convection is due to differences in density from temperature differences. Forced convection is produced by mechanical means.

Degree day - A unit, based on temperature difference and time, used in estimating heating system energy consumption. For any one day for which the mean temperature is below 65°F, the degree days for that day is the difference between 65°F and the mean for that day. Degree days for any period is the sum of the degree days for each day in that period.

Design temperature - The temperature an apparatus or a system is designed to maintain (inside design temperature) or operate against (outside design temperature) under the most extreme conditions to be satisfied. The difference between the inside and the outside design temperatures is the design temperature difference.

Infiltration - Air flowing inward through a crack between the window and frame, or door and frame, or frame and wall, etc.

Installed resistance, (R-) - The thermal resistance of insulation when applied according to the manufacturer's instructions in the building section that is described.

Perm - The unit of measurement of permeance equal to 1 grain divided by (square feet x hour x inch of mercury vapor pressure difference).

Permeance - The water vapor permeance of a material (or combination of materials between parallel surfaces) is the ratio of water vapor flow [grains divided by (square feet x hour)] to the vapor pressure difference (inches of mercury) between its surfaces.

Radiation, thermal - The transmission of heat through space by wave motion. The passage of heat from one object to another without warming the space in between.

Temperature - The thermal state of matter with reference to its tendency to communicate heat to matter in contact with it. If no heat flows upon contact, there is no difference in temperature.

Thermal conductance, (C) - The number of heat units (Btu) that will pass through one square foot of non-uniform material in one hour for each degree of Fahrenheit temperature difference between the two surfaces of the material.

Thermal conductivity (k) - The number of heat units (Btu) that will pass through one square foot of a uniform material one inch thick in one hour for each degree of Fahrenheit temperature difference between the two surfaces of the material.

Appendix

Thermal resistance, (R) - The ability of a material or combination of materials to retard or resist the flow of heat. It is the reciprocal of "U."

Thermal resistivity, (r) - The ability of a unit thickness of a uniform material to retard or resist the flow of heat. It is the reciprocal of thermal conductivity (l/k).

Transmission - A general term for heat travel (by conduction, convection, radiation, or any combination thereof) in thermal load calculations.

"U" (Overall coefficient of heat transfer) - The amount of heat flow, expressed in Btu per hour x square feet x degree Fahrenheit temperature difference, between the air on the inside and the air on the outside of a building section (wall, floor, roof or ceiling). The term is applied to combinations of materials, and also to single materials, such as window glass, and includes the surface conductance on both sides. This term is frequently called the "U value". (For conversion, U = 3.413W.)

Vapor barrier - A material which retards the transmission of water vapor. (Permeance not more than 1 perm.)

Ventilation - The process of supplying or removing air, naturally or mechanically, to or from any space.

"W" - The U factor converted into electrical terms for calculations for electric heating. It is the amount of heat flow, expressed in watts per square foot x degree Fahrenheit temperature difference, between the air on the inside and the air on the outside of a building section (wall, floor, roof or ceiling). (For conversion, W = 0.293 U.)

Watt - The rate of flow of electrical energy (not the quantity, but the rate.) One watt is equivalent to 3.413 Btu/hr.

SECTION 15770 (Manifold Version)
HEAT TRANSFER UNITS RECOMMENDED SPECIFICATIONS FOR HYDRONIC INFLOOR HEATING SYSTEMS WITH CROSS-LINKED POLYETHYLENE BARRIER /NON BARRIER TUBING AS THE EQUIPMENT FOR RESIDENTIAL / LIGHT COMMERCIAL RADIANT FLOOR HEATING.

PART 1 - GENERAL

1.01 - SUMMARY
A. Conditions of the Contract: The Conditions of the Contract (General, Supplementary and other Conditions) and the General Requirements (sections of Division 1) govern the provisions of this section. The articles contained in this section may modify, delete or add to the provisions of the Conditions of the Contract.

1.02 - SECTION INCLUDES
A. Infloor manifold
B. Infloor tubing
C. Primary boiler loop and circulating pump
D. System treatment
E. Therma-Floor underlayment

1.03 - SUBMITTALS
A. Product Data: Provide for manufactured products and assemblies including installation recommendations and rough-in dimensions.

Appendix

B. Operating and Maintenance Instructions: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts description.

1.04 - WARRANTY
A. Provide twenty-five (25) year manufacturer's warranty for Infloor tubing and one (1) year manufacturer's warranty for Infloor components.

1.05 - QUALITY ASSURANCE
A. Installer's Qualifications: Installation of Infloor Heating System shall be by a trained Infloor dealer authorized by Infloor Sales and Service.
B. Pressure Test: Provide pressure test of primary loop, manifolds, and tubing to 1-1/2 times operating pressure for 30 minutes.

1.06 - DELIVERY AND STORAGE HANDLING
A. General Requirements: Materials shall be delivered in their original, unopened packages, and protected from exposure to the elements. Damaged or deteriorated materials shall be removed from the premises.

PART 2 - PRODUCTS

2.01 - MATERIALS
A. Infloor manifold: Furnish and install a complete radiant heating system that includes modular copper manifolds or Infloor Brass Manifolds containing supply and return outlets with balancing adjustment for each circuit as provided by Infloor heating systems. Balance each circuit to maintain even temperature in spaces.

B. Infloor tubing: Radiant tubing shall be _______________ (Choose one of the following: Infloor barrier cross-linked polyethylene [BPEX, 3/8" {10 mm} or 1/2" {13 mm}], or InfloorPERT polyethylene raised temperature [PEX, 3/8" {10 mm} or 1/2" {13 mm}]). Tubing to be furnished by Infloor Sales and Service, Buena Vista, CO.

B1. Infloor barrier cross-linked poly ethylene (BPEX) as provided by Infloor Sales and Service, Buena Vista, CO: nominal 3/8" (inch) [10mm] inside diameter with a nominal 1/2" (inch) [13 mm] outside diameter with a wall thickness of 0.059" (inch) [1.5 mm], rated for 100 psig (689.5 kPa) at 180°F (82.2°C) with an external ethylene vinyl alcohol (EVOH) oxygen diffusion barrier allowing no more than 0.1 gram per cubic meter per day (0.1g/m3/d). Individual circuit length to be up to 300' (feet) [90 m] maximum.

B2. Infloor barrier cross-linked poly ethylene (BPEX) as provided by Infloor Sales and Service, Buena Vista, CO: 1/2" (inch) diameter with an nominal 5/8" (inch) [16 mm] outside diameter with a wall thickness of 0.059" (inch)[1.5 mm], rated for 100 psig (689.5 kPa) at 180°F (82.2°C) with an external ethylene vinyl alcohol (EVOH) oxygen diffusion barrier allowing no more than 0.1 gram per cubic meter per day (0.1g/m3/d). Individual circuit length to be up to 300' (feet) [90 m] maximum.

B3. InfloorPert polyethylene raised temperature (PERT) as provided Infloor Sales and Service, Buena Vista CO. 3/8"with an nominal 1/2" (inch) [13 mm] outside diameter with a wall thickness of 0.059"

Appendix

(inch) [1.5 mm], rated for 80 psig (689.5 kPa) at 180°F (82.2°C). Individual circuit length to be up to 200' (feet) [90 m] maximum.

B4. InfloorPERT polyethylene raised temperature (PERT) as provided by Infloor Sales and Service, Buena Vista CO. 1/2" (inch) [12.7 mm] inside diameter with an nominal 5/8" (inch) [15.87 mm] outside diameter with a wall thickness of 0.062" (inch) [1.575 mm], manufactured in accordance with ASTM standard F2623 and rated for 80 psi (689.5 kPa) at 180°F (82.2°C). Individual circuit length to be up to 300' (feet) [90 m] maximum.

C. Primary boiler loop and circulating pump: Primary circulating loop shall be supplied by others with sufficient system water flow to provide boiler supply temperature between 140°F (60.0°C) to 180°F (82.2°C), unless using condensing boiler or water heater, with a 20°F (11°C) maximum temperature drop between primary loop supply and return piping.

D. System Treatment: Install _______________ (Choose one of the following: Formula 10, or Infloor Closed System Treatment.)

D1. Formula 10, a silicate-based corrosion inhibitor in concentration of one (1) quart [0.95 liter] treatment per fifty (50) gallons [190 liters] water as provided by Infloor Sales and Service. , Buena Vista, CO.
NOTE: Not to be used with glycol additives.

D2. Infloor Closed System treatment, a borate-nitrite corrosion inhibitor in concentration of 1400 ppm (one [1] gallon {3.8 liters} treatment per fifty [50] gallons {189.3 liters} water) as provided by Infloor Sales and Service, Buena Vista, CO.

E. Therma-Floor Underlayment: Floor underlayment shall be Therma-Floor by Maxxon Corporation, Hamel, MN (see section 03540)

Appendix

TUBE SIZES AND SPECIFICATIONS

BPEX TUBING

Part #	Tube Size	Tube Length	Weight
25000	3/8"	600'	29 lbs.
25011	1/2"	300'	21 lbs.
25010	1/2"	900'	56 lbs.
25009	1/2"	1000'	62 lbs.
25100	5/8"	500'	36 lbs.
25101	5/8"	1000'	52 lbs.
25031	3/4"	300'	36 lbs.
25030	3/4"	1000'	104 lbs.
25040	1"	500'	95 lbs.

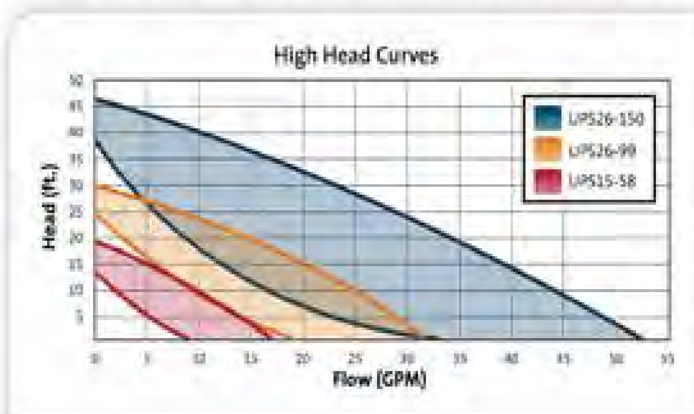
INFLOORPERT TUBING

Part #	Tube Size	Tube Length	Weight
25200	3/8"	600'	25 lbs.
25201	1/2"	300'	16 lbs.
25202	1/2"	1000'	54 lbs.
25203	5/8"	500'	38 lbs.
25204	5/8"	1200'	91 lbs.
25205	3/4"	300'	31 lbs.
25206	3/4"	500'	51 lbs.
25207	3/4"	1200'	122 lbs.
25208	1"	300'	50 lbs.

Characteristics	BPEX	PERT
Performance Characteristic	ASTM F876	ASTM F2623
SDR	9	9
Oxygen Barrier	EVOH on outside	EVOH on inside
DIN	4726	4726
PSI	100 psi (689 kPa)	80 psi
Temperature	180°F (82°C)	180°F (82°C)
Linear Expansion	1.1 in./(10°F•100 ft)	
Thermal Conductivity	2.7 Btu•in./hr•ft$_2$•°F	3.15 Btu•in./hr•ft$_2$•°F
Quick Burst Strength @ 73°F	440 psi	440 psi
Sizes	3/8" (10 mm) 1/2" (13 mm) 3/4" (19 mm)	3/8" (10 mm) 1/2" (13 mm) 5/8" (16 mm) 3/4" (19 mm
Bend Radius 3/8" 1/2" 5/8" 3/4"	 6 x o.d. 6 x o.d. 6 x o.d. 6 x o.d.	 2.5" 3.125" 3.75" 4.375"
Warranty	25 years	25 years

GRUNDFOS PUMP PERFORMANCE

– SuperBrute 3-speed performance curves – 60 Hz



Head Loss Chart 1

	Head Loss / 100 FT At 100 F									
	with 50% Propylene Glycol					with Water				
GPM	3/8" PEX/BPEX	1/2" PEX/BPEX	5/8" PEX/BPEX	3/4" PEX/BPEX	1" PEX/BPEX	3/8" PEX/BPEX	1/2" PEX/BPEX	5/8" PEX/BPEX	3/4" PEX/BPEX	1" PEX/BPEX
0.10	1.22	0.37	0.19	0.09	0.05	0.27	0.07	0.05	0.02	0.00
0.20	2.47	0.74	0.35	0.19	0.07	0.09	0.23	0.09	0.05	0.02
0.30	3.70	1.13	0.53	0.30	0.12	1.85	0.44	0.18	0.09	0.02
0.40	4.94	1.50	0.72	0.39	0.14	3.05	0.74	0.30	0.14	0.05
0.50	6.91	1.87	0.90	0.49	0.19	4.5	1.09	0.46	0.21	0.07
0.60	9.49	2.31	1.06	0.58	0.21	6.21	1.50	0.62	0.3	0.09
0.70	12.42	3.02	1.25	0.67	0.25	8.13	1.96	0.81	0.39	0.12
0.80	15.7	3.81	1.57	0.76	0.28	10.28	2.49	1.04	0.51	0.16
0.90	19.29	4.69	1.94	0.92	0.32	12.64	3.07	1.27	0.60	0.18
1.00	23.19	5.64	2.33	1.13	0.35	15.18	3.7	1.53	0.74	0.23
1.20	31.92	7.74	3.21	1.55	0.46	20.88	5.08	2.10	1.02	0.30
1.40	41.78	10.14	4.20	2.03	0.62	27.35	6.65	2.75	1.32	0.39
1.60	52.80	12.82	5.31	2.56	0.79	34.56	8.39	3.47	1.66	0.51
1.80	64.89	15.75	6.51	3.14	0.95	42.48	10.3	4.27	2.06	0.62
2.00	78.03	18.94	7.83	3.79	1.16	51.07	12.4	5.13	2.47	0.76
2.20	92.19	22.38	9.26	4.46	1.36	60.34	14.65	6.05	2.91	0.88
2.40	107.35	26.06	10.79	5.20	1.57	70.27	17.05	7.07	3.40	1.04
2.60		29.98	12.41	5.98	1.83		19.61	8.13	3.90	1.20
2.80		34.12	14.11	6.82	2.08		22.34	9.24	4.46	1.36
3.00		38.51	15.94	7.67	2.33		25.2	10.44	5.04	1.53
3.20		43.1	17.83	8.59	2.61		28.29	11.69	5.64	1.71
3.40		47.93	19.84	9.56	2.91		31.37	12.98	6.26	1.89
3.80		58.24	24.09	11.62	3.53		38.12	15.77	7.60	2.31
4.20		69.39	28.71	13.84	4.20		45.41	18.8	9.06	2.75
4.60		81.36	33.68	16.22	4.94		53.27	22.04	10.63	3.23
5.00			38.97	18.78	5.71			25.50	12.29	3.74
5.40			44.58	21.48	6.54			29.18	14.07	4.27
5.80			50.52	24.35	7.39			33.06	15.94	4.85
6.20			56.76	27.35	8.32			37.17	17.9	5.45
6.60			63.34	30.52	9.29			41.46	19.98	6.08
7.00				33.84	10.28				22.15	6.72
7.40				37.28	11.34				24.42	7.42
7.80				40.89	12.43				26.78	8.13
8.60				48.51	14.74				31.76	9.66
9.40					17.23					11.27
10.20	Velocity rate exceeds 8 feet per second				19.89	Velocity rate exceeds 8 feet per second				13.01
11.00					22.68					14.85
11.80					25.66					16.79
12.60					28.78					18.83
13.40					32.04					20.97
14.20					35.46					23.22

(For pressure drop, divide head loss by 2.31)

Head Loss Chart 2

	Head Loss / 100 FT At 120 F									
	with 50% Propylene Glycol					with Water				
GPM	3/8" PEX/BPEX	1/2" PEX/BPEX	5/8" PEX/BPEX	3/4" PEX/BPEX	1" PEX/BPEX	3/8" PEX/BPEX	1/2" PEX/BPEX	5/8" PEX/BPEX	3/4" PEX/BPEX	1" PEX/BPEX
0.10	0.88	0.28	0.12	0.07	0.02	0.25	0.07	0.02	0.02	0.00
0.20	1.76	0.53	0.25	0.14	0.05	0.85	0.21	0.09	0.05	0.02
0.30	2.63	0.81	0.37	0.21	0.07	1.76	0.42	0.18	0.09	0.03
0.40	4.27	1.06	0.51	0.28	0.09	2.89	0.69	0.30	0.14	0.05
0.50	6.31	1.52	0.62	0.35	0.12	4.27	1.04	0.44	0.21	0.07
0.60	8.66	2.10	0.88	0.42	0.16	5.89	1.43	0.60	0.28	0.09
0.70	11.34	2.75	1.13	0.55	0.18	7.69	1.87	0.76	0.37	0.12
0.80	14.35	3.49	1.43	0.69	0.21	9.73	2.36	0.97	0.46	0.14
0.90	17.63	4.27	1.78	0.85	0.25	11.97	2.91	1.20	0.58	0.18
1.00	21.18	5.15	2.13	1.02	0.32	14.37	3.49	1.46	0.69	0.21
1.20	29.15	7.07	2.93	1.41	0.44	19.77	4.80	1.99	0.95	0.30
1.40	38.18	9.26	3.83	1.85	0.55	25.92	6.28	2.61	1.25	0.39
1.60	48.23	11.71	4.85	2.33	0.72	32.73	7.95	3.28	1.59	0.49
1.80	59.27	14.39	5.96	2.86	0.88	40.22	9.77	4.04	1.94	0.60
2.00	71.26	17.30	7.16	3.44	1.04	48.37	11.73	4.85	2.33	0.72
2.20	84.22	20.44	8.45	4.09	1.25	57.15	13.88	5.75	2.77	0.83
2.40	98.06	23.82	9.84	4.76	1.43	66.55	16.15	6.68	3.21	0.97
2.60		27.37	11.34	5.45	1.66		18.57	7.69	3.70	1.13
2.80		31.18	12.89	6.21	1.89		21.16	8.76	4.23	1.29
3.00		35.18	14.55	7.02	2.13		23.86	9.89	4.76	1.46
3.20		39.39	16.31	7.85	2.38		26.73	11.06	5.34	1.62
3.40		43.80	18.11	8.73	2.66		29.71	12.29	5.94	1.80
3.80		53.20	22.01	10.60	3.23		36.11	14.95	7.21	2.19
4.20		63.39	26.22	12.64	3.83		43.01	17.81	8.57	2.61
4.60		74.31	30.75	14.83	4.50		50.43	20.86	10.05	3.05
5.00			35.6	17.16	5.22			24.14	11.64	3.53
5.40			40.73	19.64	5.96			27.63	13.31	4.04
5.80			46.15	22.25	6.77			31.30	15.08	4.60
6.20			51.86	24.99	7.6			35.18	16.96	5.15
6.60			57.84	27.88	8.48			39.25	18.92	5.75
7.00				30.91	9.4				20.97	6.38
7.40				34.07	10.35				23.12	7.02
7.80				37.35	11.37				25.34	7.72
8.60				44.31	13.47				30.08	9.15
9.40					15.73					10.67
10.20	Velocity rate exceeds 8 feet per second				18.16	Velocity rate exceeds 8 feet per second				12.31
11.00					20.72					14.07
11.80					23.42					15.89
12.60					26.29					17.83
13.40					29.27					19.89
14.20					32.41					21.99

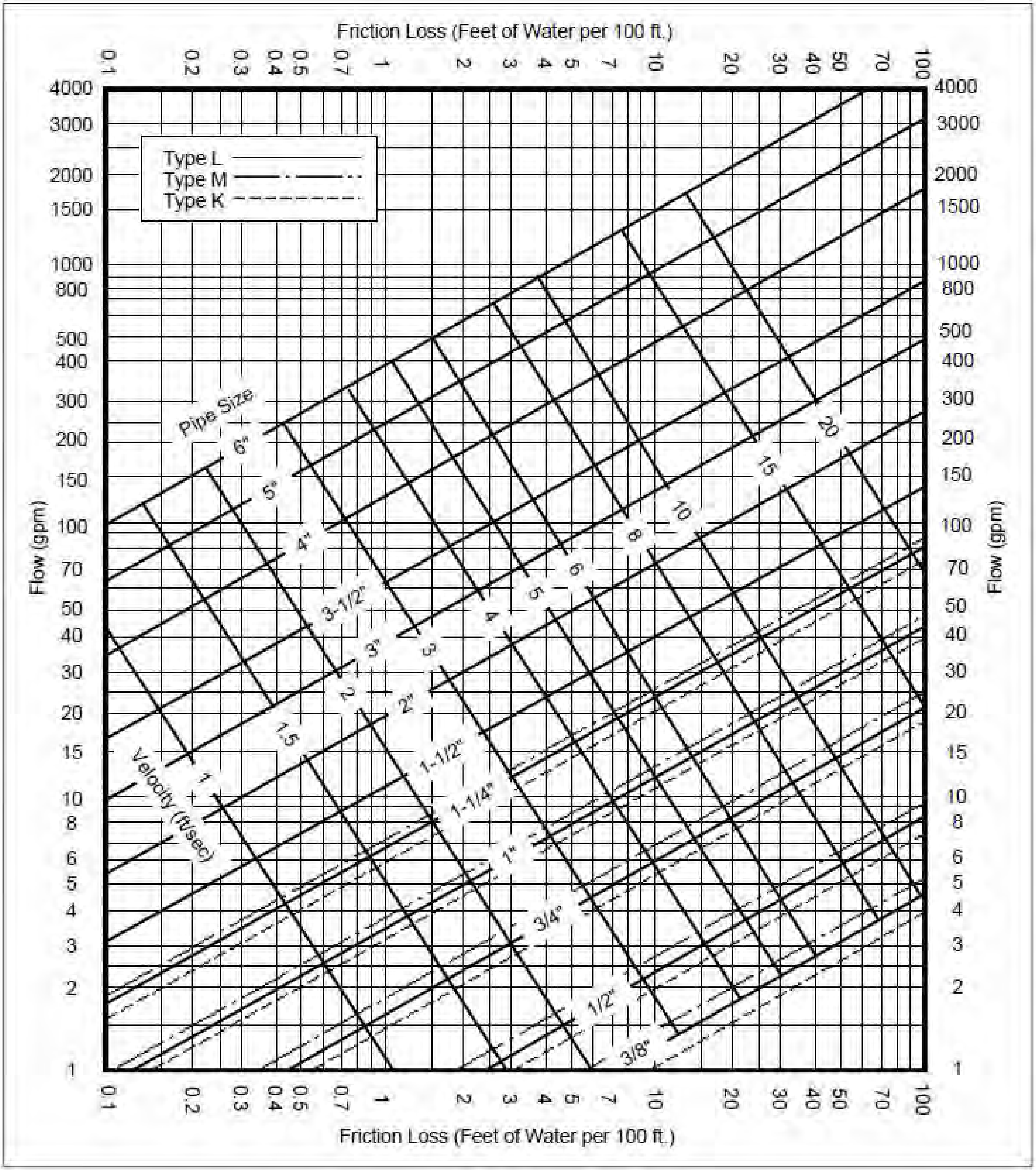
(For pressure drop, divide head loss by 2.31)

Head Loss Chart 3

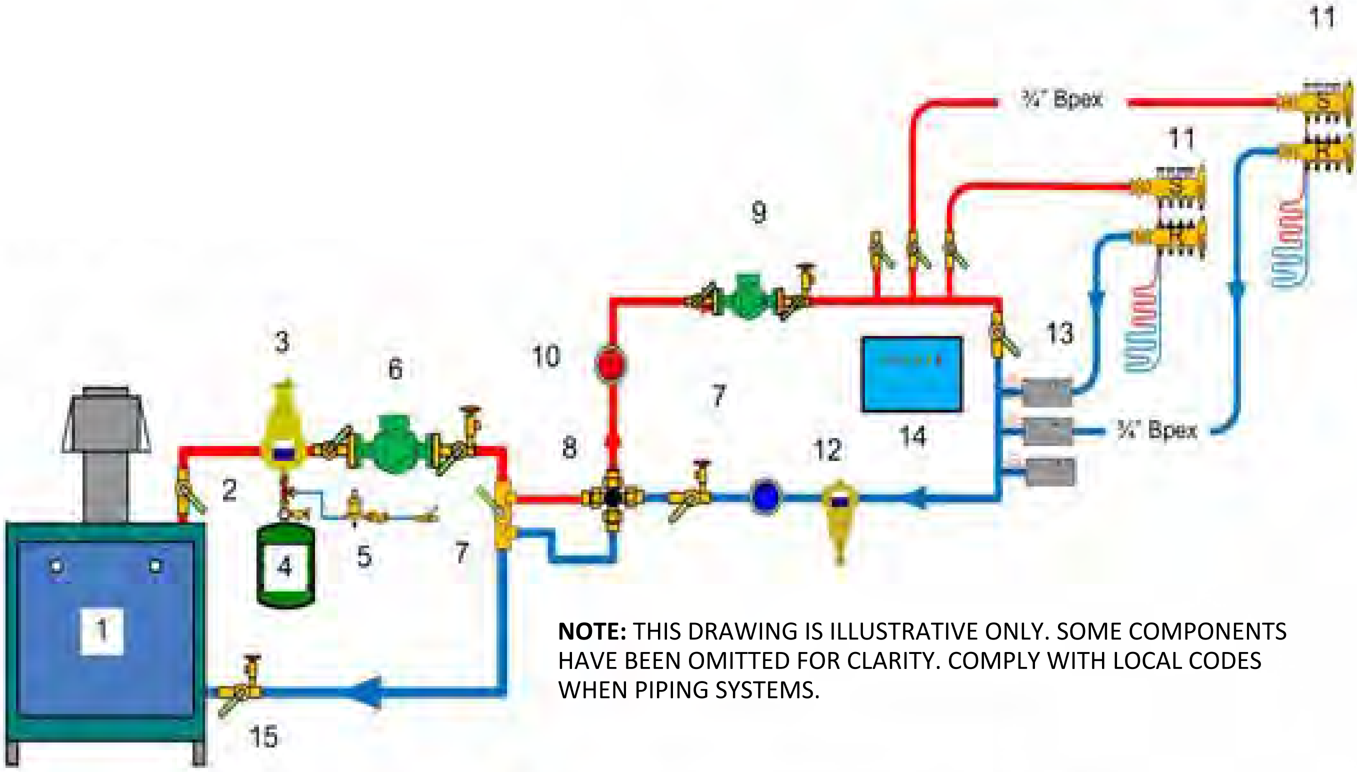
	Head Loss / 100 FT At 140 F									
	with 50% Propylene Glycol					with Water				
GPM	3/8" PEX/BPEX	1/2" PEX/BPEX	5/8" PEX/BPEX	3/4" PEX/BPEX	1" PEX/BPEX	3/8" PEX/BPEX	1/2" PEX/BPEX	5/8" PEX/BPEX	3/4" PEX/BPEX	1" PEX/BPEX
0.10	0.67	0.21	0.09	0.05	0.02	0.25	0.07	0.02	0.02	0.00
0.20	1.34	0.42	0.18	0.12	0.05	0.83	0.21	0.09	0.05	0.02
0.30	2.40	0.62	0.30	0.16	0.07	1.66	0.42	0.16	0.07	0.02
0.40	3.97	0.97	0.39	0.21	0.07	2.75	0.67	0.28	0.14	0.05
0.50	5.87	1.43	0.58	0.28	0.09	4.07	0.99	0.42	0.21	0.07
0.60	8.06	1.96	0.81	0.39	0.12	5.61	1.36	0.55	0.28	0.09
0.70	10.56	2.56	1.06	0.51	0.16	7.35	1.78	0.74	0.35	0.12
0.80	13.33	3.23	1.34	0.65	0.19	9.29	2.26	0.92	0.44	0.14
0.90	16.40	3.97	1.64	0.79	0.23	11.41	2.77	1.12	0.55	0.16
1.00	19.70	4.78	1.99	0.95	0.30	13.72	3.33	1.39	0.67	0.21
1.20	27.12	6.58	2.73	1.32	0.39	18.87	4.57	1.89	0.92	0.28
1.40	35.5	8.62	3.56	1.71	0.53	24.72	6.01	2.47	1.20	0.37
1.60	44.86	10.88	4.50	2.17	0.67	31.21	7.58	3.14	1.50	0.46
1.80	55.12	13.38	5.54	2.68	0.81	38.37	9.31	3.86	1.85	0.55
2.00	66.30	16.10	6.65	3.21	0.97	46.13	11.20	4.64	2.24	0.67
2.20	78.33	19.01	7.88	3.79	1.16	54.49	13.24	5.47	2.63	0.81
2.40	91.2	22.13	9.17	4.41	1.34	63.46	15.41	6.38	3.07	0.92
2.60		25.48	10.53	5.08	1.55		17.72	7.32	3.53	1.09
2.80		28.99	11.99	5.78	1.76		20.17	8.34	4.02	1.22
3.00		32.71	13.54	6.51	1.99		22.75	9.42	4.55	1.39
3.20		36.64	15.15	7.30	2.22		25.48	10.56	5.08	1.55
3.40		40.73	16.86	8.13	2.47		28.34	11.73	5.66	1.71
3.80		49.48	20.47	9.86	3.00		34.42	14.25	6.86	2.08
4.20		58.95	24.39	11.76	3.58		41.03	16.98	8.18	2.49
4.60		69.12	28.60	13.79	4.18		48.09	19.91	9.59	2.91
5.00			33.10	15.96	4.85			23.03	11.11	3.37
5.40			37.86	18.25	5.54			26.36	12.71	3.86
5.80			42.92	20.67	6.28			29.87	14.39	4.37
6.20			48.23	23.24	7.07			33.56	16.17	4.92
6.60			53.80	25.94	7.88			37.45	18.04	5.47
7.00				28.74	8.73				20.01	6.08
7.40				31.67	9.63				22.04	6.70
7.80				34.74	10.56				24.16	7.35
8.60				41.21	12.52				28.67	8.71
9.40					14.65					10.19
10.20	Velocity rate exceeds 8 feet per second				16.89	Velocity rate exceeds 8 feet per second				11.76
11.00					19.27					13.42
11.80					21.78					15.15
12.60					24.44					17.00
13.40					27.23					18.94
14.20					30.12					20.97

(For pressure drop, divide head loss by 2.31)

Friction Loss Chart
(Feet of Water Per 100 ft.)
For Copper Pipe



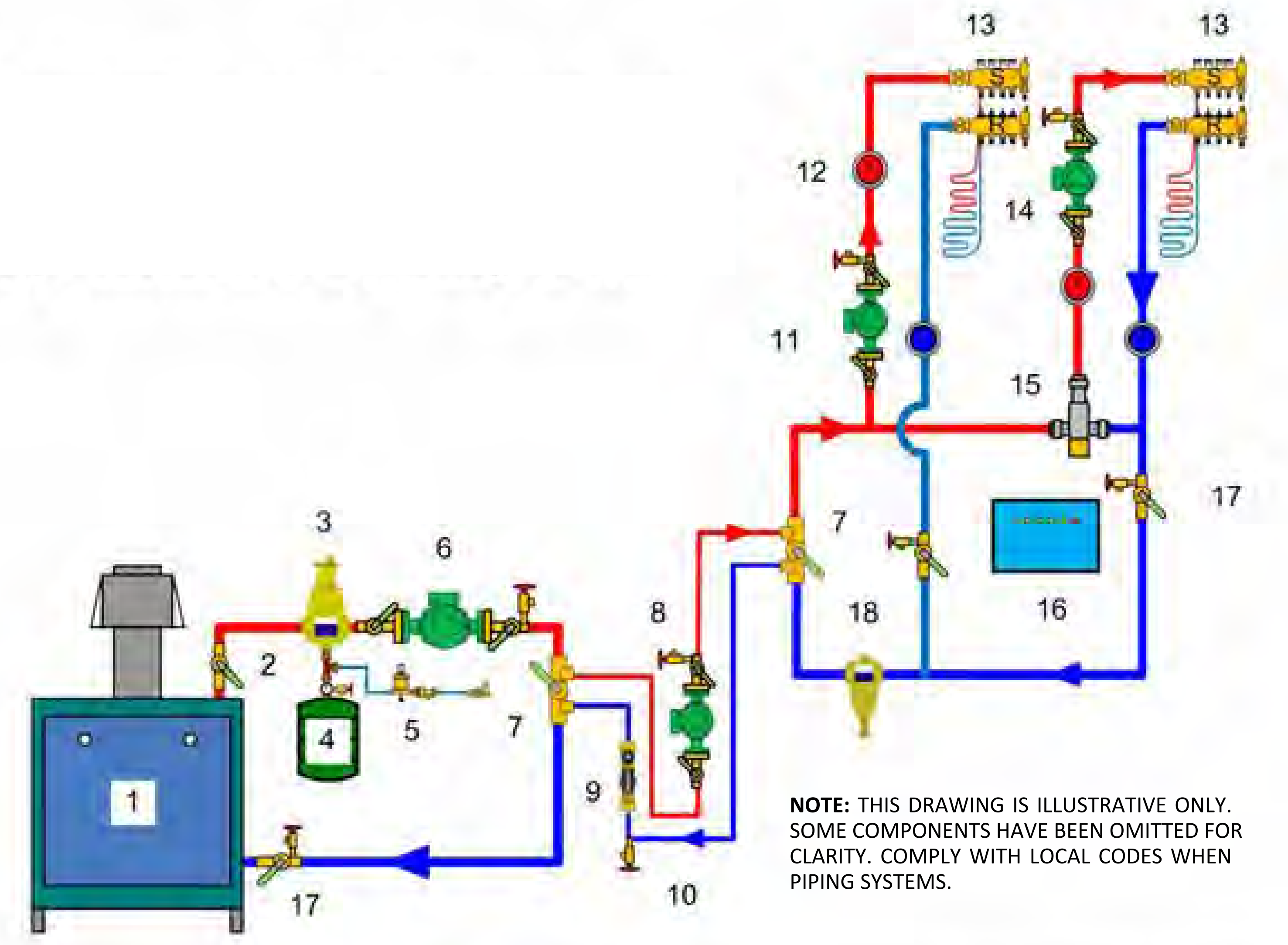
Cast Iron Boiler with 4-Way Mixing Valve, Single Temperature



NOTE: THIS DRAWING IS ILLUSTRATIVE ONLY. SOME COMPONENTS HAVE BEEN OMITTED FOR CLARITY. COMPLY WITH LOCAL CODES WHEN PIPING SYSTEMS.

1	Cast Iron Boiler	9	Pressure Differential Radiant Pump with iso flanges
2	Ball Valve Typical	10	Thermometer w/ well typical
3	Air Eliminator	11	Radiant Remote Manifold
4	Expansion Tank	12	Magnetic Dirt Separator
5	Fill / Backflow Preventer	13	Zone Valve Typical
6	Primary Pump with isolation flanges	14	Control Box
7	Closely Space Tee Assembly	15	Ball Valve with Drain Typical
8	4 Way Mixing Valve with Motor		

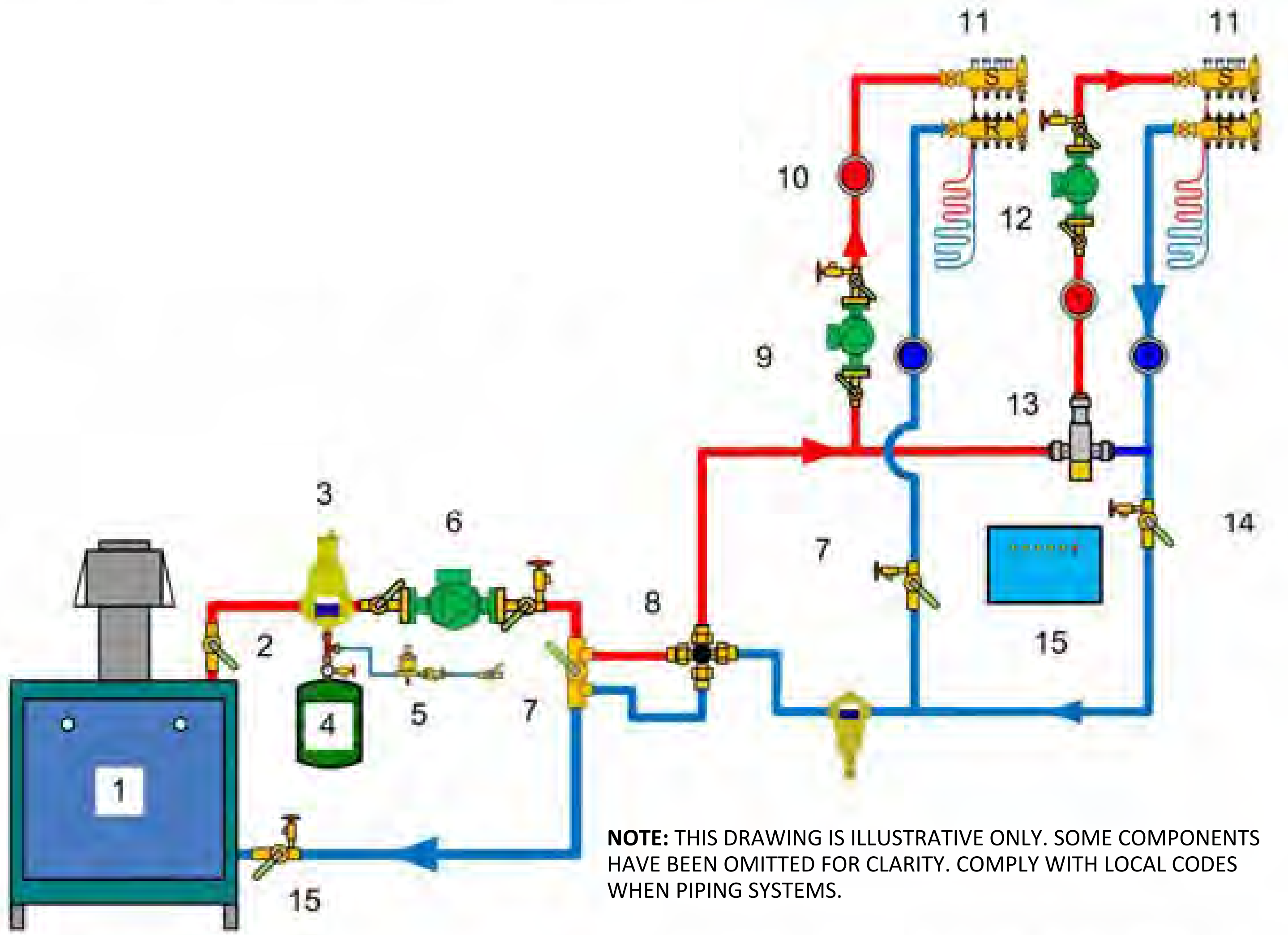
Cast Iron Boiler with Injection Pump, 2 Temperature, 3-Way Thermostatic Mixing Valve



NOTE: THIS DRAWING IS ILLUSTRATIVE ONLY. SOME COMPONENTS HAVE BEEN OMITTED FOR CLARITY. COMPLY WITH LOCAL CODES WHEN PIPING SYSTEMS.

1	Cast Iron Boiler	7	Closely Spaced Tee Assembly	13	Radiant Remote Manifold
2	Ball Valve Typical	8	Injection Pump with isolation flanges	14	Low Temperature Radiant Pump with iso flanges
3	Air Eliminator	9	Balancing Valve	15	Thermostatic 3 Way Mixing Valve with Check
4	Expansion Tank	10	Boiler Drain	16	Control Box
5	Fill / Backflow Preventer	11	High Temperature Radiant Pump with iso flanges	17	Ball Valve with Drain Typical
6	Primary Pump with isolation flanges	12	Thermometer w/ well typical	18	Magnetic Dirt Separator

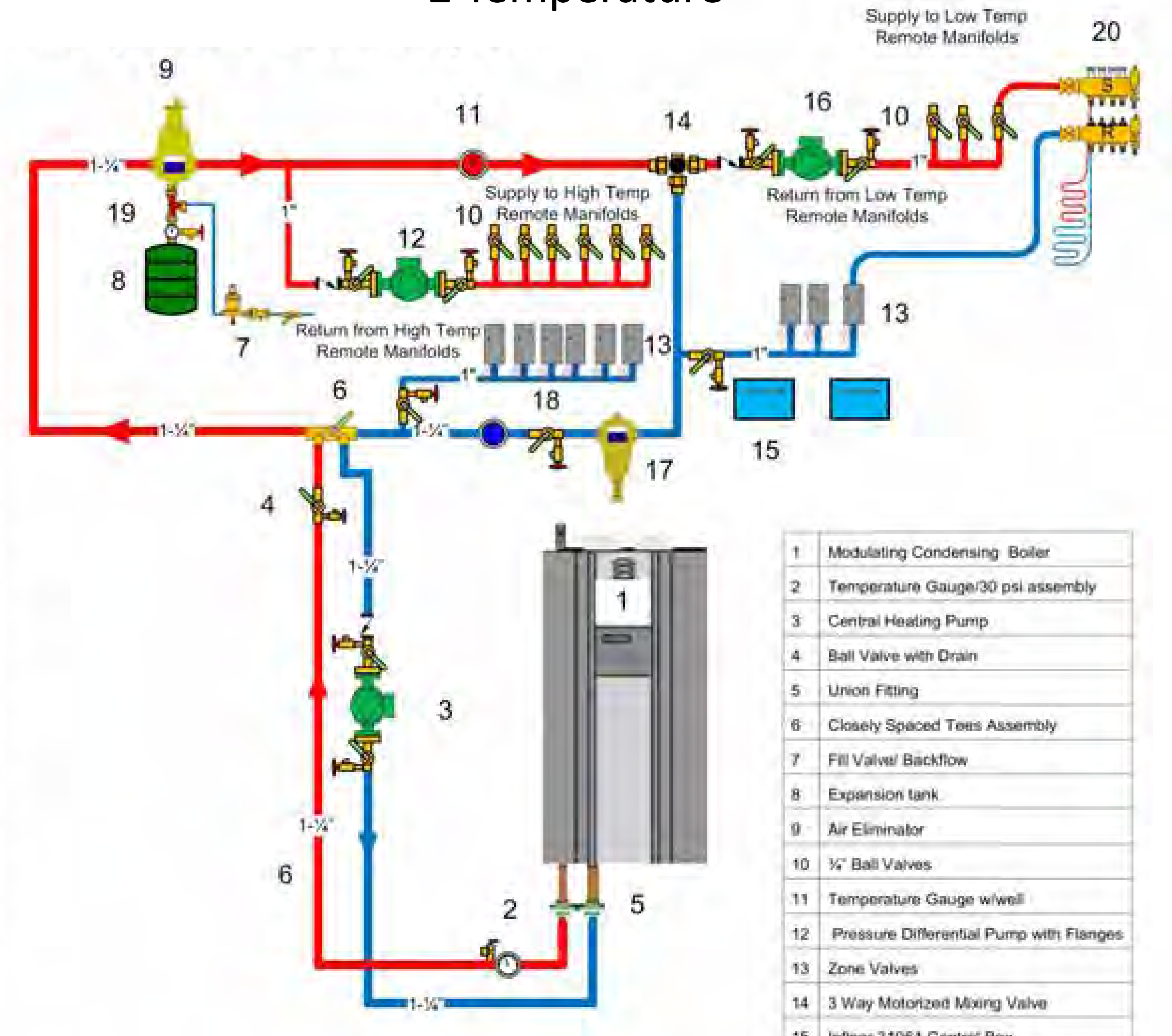
Cast Iron Boiler with 4-Way Mixing Valve, 2 Temperature, 3-Way Thermostatic Mixing Valve



NOTE: THIS DRAWING IS ILLUSTRATIVE ONLY. SOME COMPONENTS HAVE BEEN OMITTED FOR CLARITY. COMPLY WITH LOCAL CODES WHEN PIPING SYSTEMS.

1	Cast Iron Boiler	9	High Temperature Radiant Pump with iso flanges
2	Ball Valve Typical	10	Thermometer w/ well typical
3	Air Eliminator	11	Radiant Remote Manifold
4	Expansion Tank	12	Low Temperature Radiant Pump with iso flanges
5	Fill / Backflow Preventer	13	Thermostatic 3 Way Mixing Valve with Check
6	Primary Pump with isolation flanges	14	Control Box
7	Closely Space Tee Assembly	15	Ball Valve with Drain Typical
8	4 Way Mixing Valve with Motor	16	Magnetic Dirt Seperator

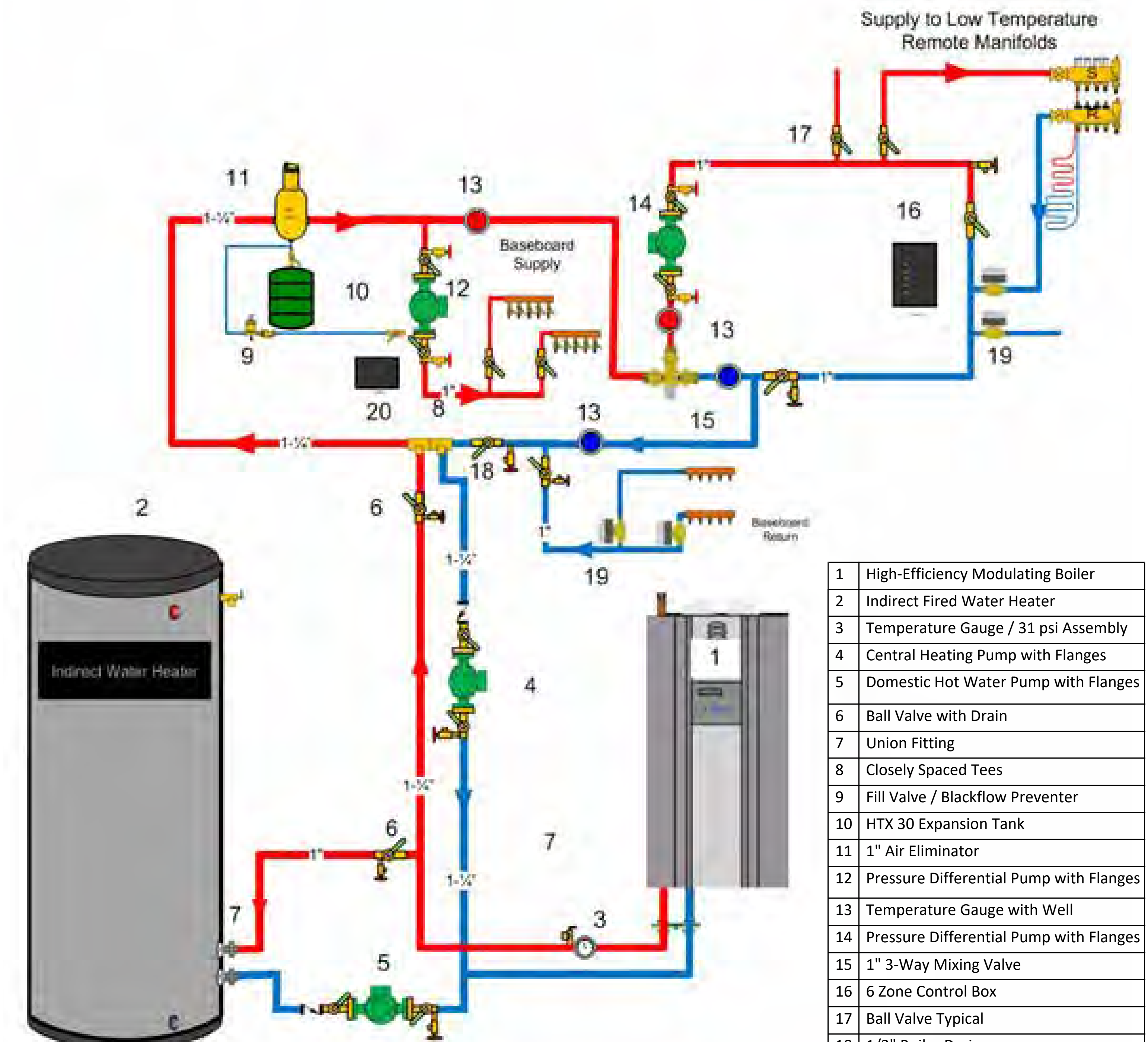
High-Efficiency Modulating Boiler, 2 Temperature



1	Modulating Condensing Boiler
2	Temperature Gauge/30 psi assembly
3	Central Heating Pump
4	Ball Valve with Drain
5	Union Fitting
6	Closely Spaced Tees Assembly
7	Fill Valve/ Backflow
8	Expansion tank
9	Air Eliminator
10	¾" Ball Valves
11	Temperature Gauge w/well
12	Pressure Differential Pump with Flanges
13	Zone Valves
14	3 Way Motorized Mixing Valve
15	Infloor 31064 Control Box
16	Pressure Differential Pump with Flanges
17	1-¼" Magnetic Dirt Separator
18	1-¼" Ball Valve with Drain
19	Residential Boiler Fill Fitting
20	Remote Manifold

NOTE: THIS DRAWING IS ILLUSTRATIVE ONLY. SOME COMPONENTS HAVE BEEN OMITTED FOR CLARITY. COMPLY WITH LOCAL CODES WHEN PIPING SYSTEMS.

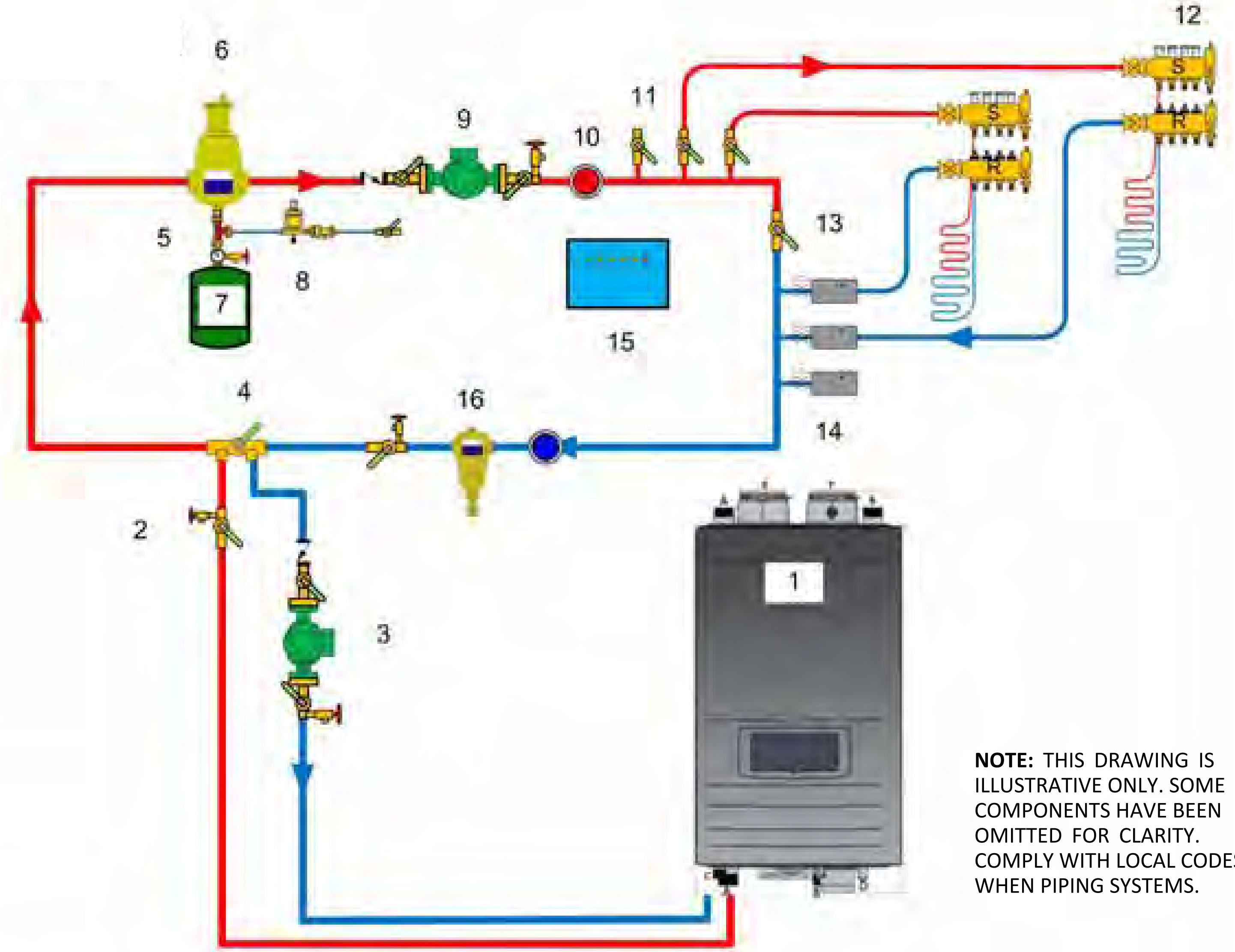
High-Efficiency Modulating Boiler, 2 Zone Low Temperature, and 2 Zone Baseboard with Domestic Hot Water



1	High-Efficiency Modulating Boiler
2	Indirect Fired Water Heater
3	Temperature Gauge / 31 psi Assembly
4	Central Heating Pump with Flanges
5	Domestic Hot Water Pump with Flanges
6	Ball Valve with Drain
7	Union Fitting
8	Closely Spaced Tees
9	Fill Valve / Blackflow Preventer
10	HTX 30 Expansion Tank
11	1" Air Eliminator
12	Pressure Differential Pump with Flanges
13	Temperature Gauge with Well
14	Pressure Differential Pump with Flanges
15	1" 3-Way Mixing Valve
16	6 Zone Control Box
17	Ball Valve Typical
18	1/2" Boiler Drain
19	Zone Valve Typical
20	#31040 Single Zone Pump Control

NOTE: THIS DRAWING IS ILLUSTRATIVE ONLY. SOME COMPONENTS HAVE BEEN OMITTED FOR CLARITY. COMPLY WITH LOCAL CODES WHEN PIPING SYSTEMS.

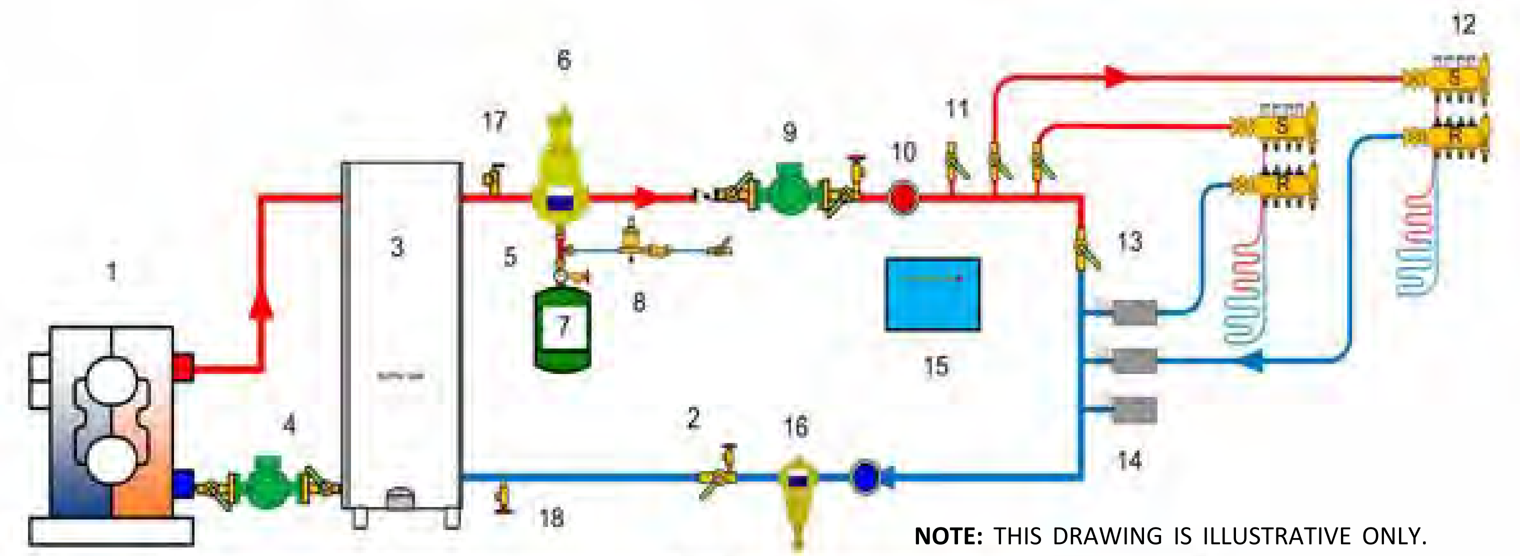
Modulating Condensing Boiler, Single Temperature



NOTE: THIS DRAWING IS ILLUSTRATIVE ONLY. SOME COMPONENTS HAVE BEEN OMITTED FOR CLARITY. COMPLY WITH LOCAL CODES WHEN PIPING SYSTEMS.

1	High Efficiency Modulating Boiler	9	Pressure Differential Radiant Pump with iso flanges
2	Ball Valve with drain Typical	10	Thermometer w/ well typical
3	Primary Pump with isolation flanges	11	Ball Valve Typical
4	Closely Space Tee Assembly	12	Radiant Remote Manifold
5	Residential boiler fill fittings	13	By pass valve
6	Air Eliminator	14	Zone Valve Typical
7	Expansion Tank	15	Control Box
8	Fill / Backflow Preventer	16	Magnetic Dirt Separator

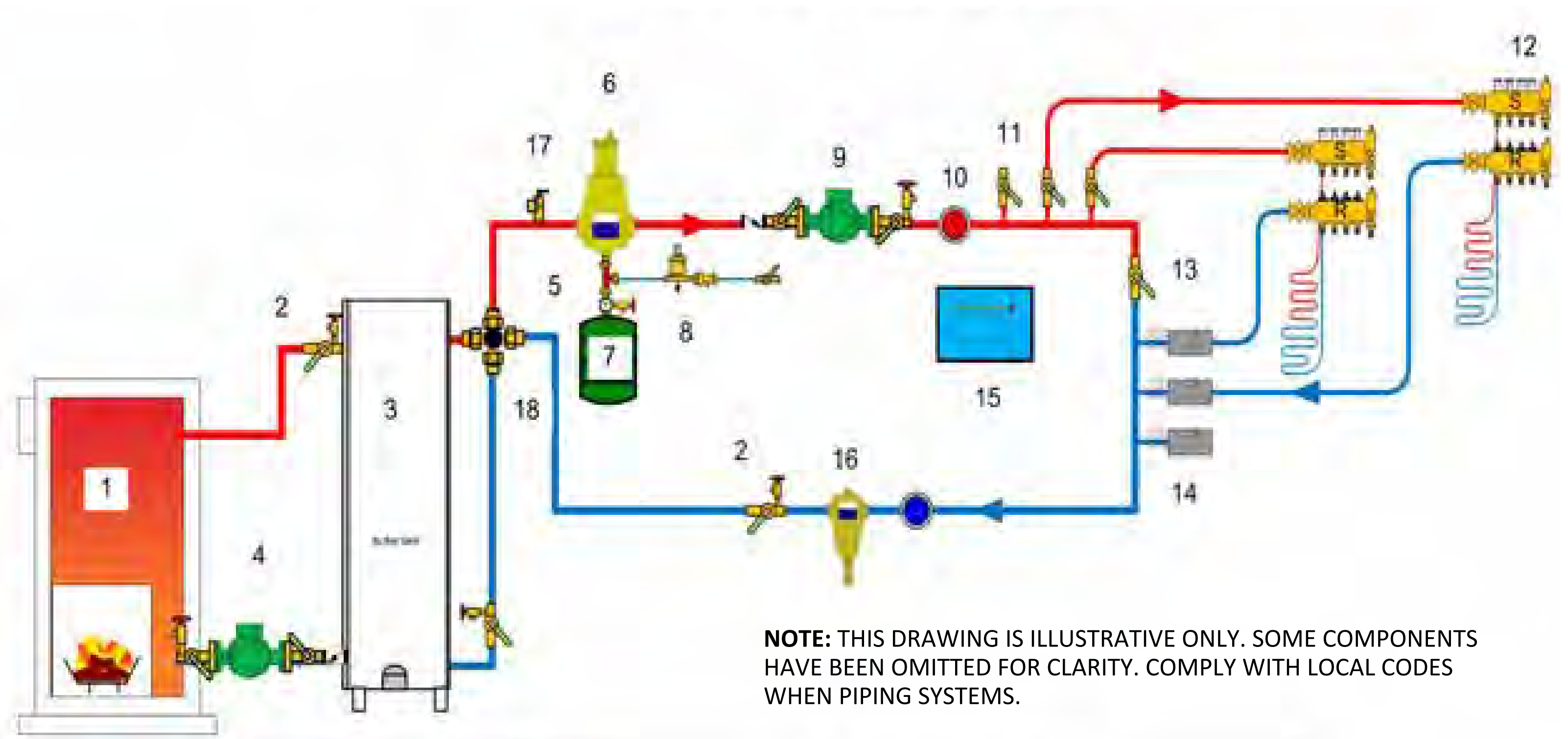
Geothermal Heat Pump Application



NOTE: THIS DRAWING IS ILLUSTRATIVE ONLY. SOME COMPONENTS HAVE BEEN OMITTED FOR CLARITY. COMPLY WITH LOCAL CODES WHEN PIPING SYSTEMS.

1	Ground Source Heat Pump	10	Thermometer w/ well typical
2	Ball Valve with drain Typical	11	Ball Valve Typical
3	Buffer Tank	12	Radiant Remote Manifold
4	Pump from Buffer tank to Ground Source Heat Pump	13	By pass valve
5	Residential boiler fill fittings	14	Zone Valve Typical
6	Air Eliminator	15	Control Box
7	Expansion Tank	16	Magnetic Dirt Separator
8	Fill / Backflow Preventer	17	30 Psi Relief Valve
9	Pressure Differential Radiant Pump with iso flanges	18	Boiler Drain

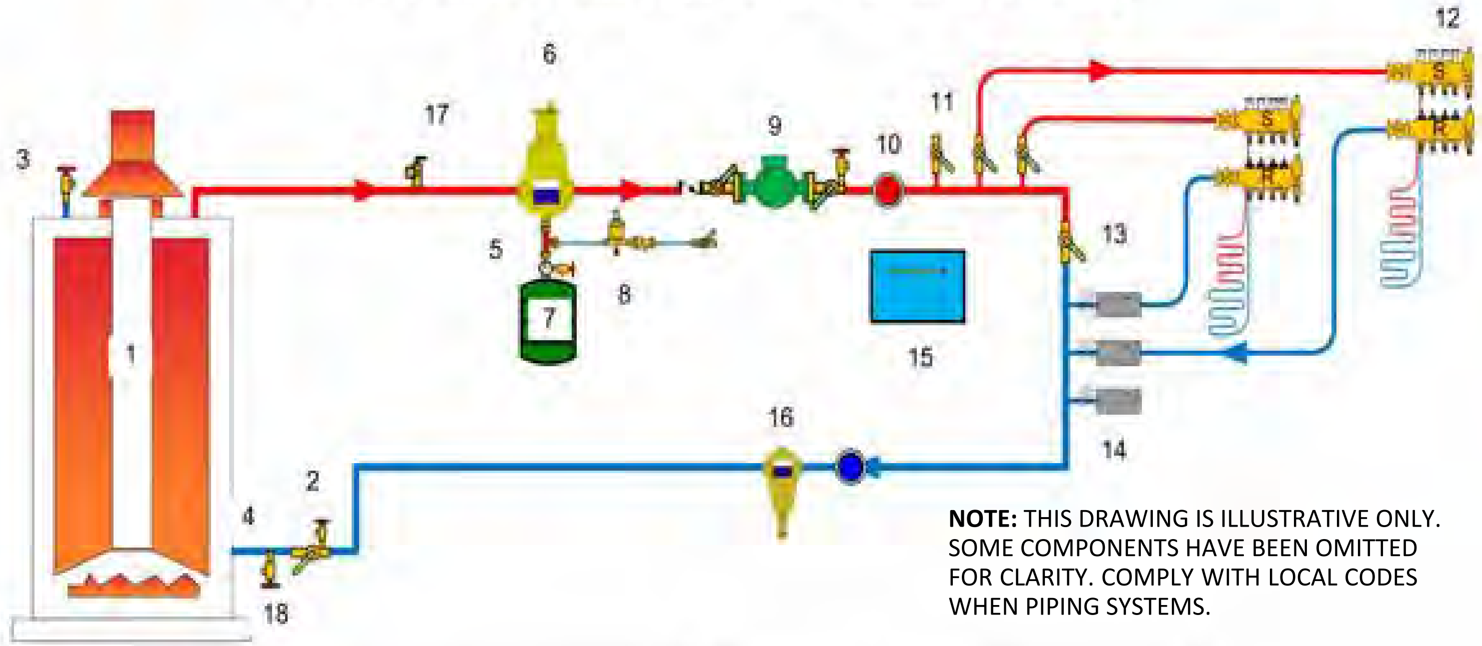
Pressurized Wood/Coal Boiler, Multi-Zone with 4-Way Mixing Valve



NOTE: THIS DRAWING IS ILLUSTRATIVE ONLY. SOME COMPONENTS HAVE BEEN OMITTED FOR CLARITY. COMPLY WITH LOCAL CODES WHEN PIPING SYSTEMS.

1	Wood or Coil Pressurized Boiler	10	Thermometer w/ well typical
2	Ball Valve with drain Typical	11	Ball Valve Typical
3	Buffer Tank	12	Radiant Remote Manifold
4	Pump from Buffer tank to Wood or Coil Boiler	13	By pass valve
5	Residential boiler fill fittings	14	Zone Valve Typical
6	Air Eliminator	15	Control Box
7	Expansion Tank	16	Magnetic Dirt Separator
8	Fill / Backflow Preventer	17	30 Psi Relief Valve
9	Pressure Differential Radiant Pump with iso flanges	18	4 Way Mixing Valve with Motor

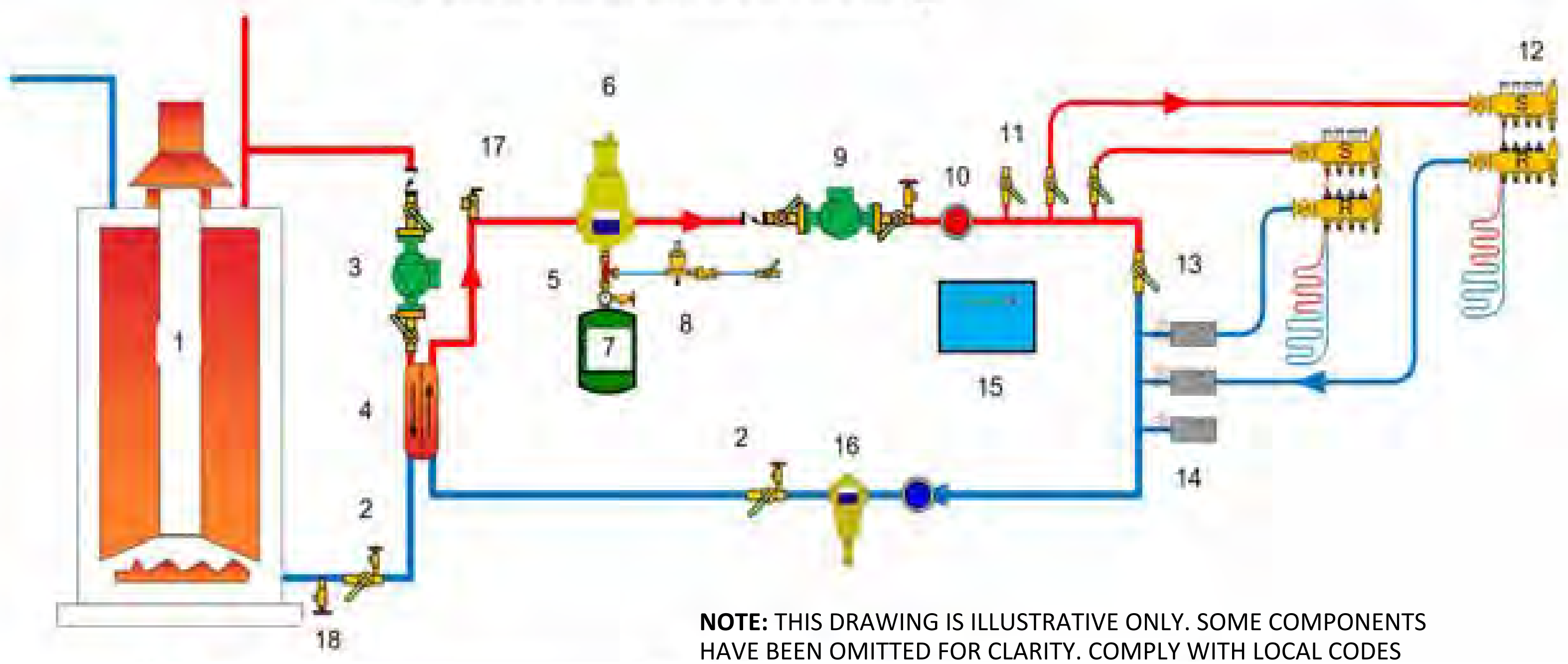
Dedicated Water Heater for a Radiant Heating System



NOTE: THIS DRAWING IS ILLUSTRATIVE ONLY. SOME COMPONENTS HAVE BEEN OMITTED FOR CLARITY. COMPLY WITH LOCAL CODES WHEN PIPING SYSTEMS.

1	Water Heater	10	Thermometer w/ well typical
2	Ball Valve with drain Typical	11	Ball Valve Typical
3	Place Purge Valve on cold water side	12	Radiant Remote Manifold
4	Remove Drain and pipe return here	13	By pass valve
5	Residential boiler fill fittings	14	Zone Valve Typical
6	Air Eliminator	15	Control Box
7	Expansion Tank	16	Magnetic Dirt Separator
8	Fill / Backflow Preventer	17	30 Psi Relief Valve
9	Pressure Differential Radiant Pump with iso flanges	18	Boiler Drain

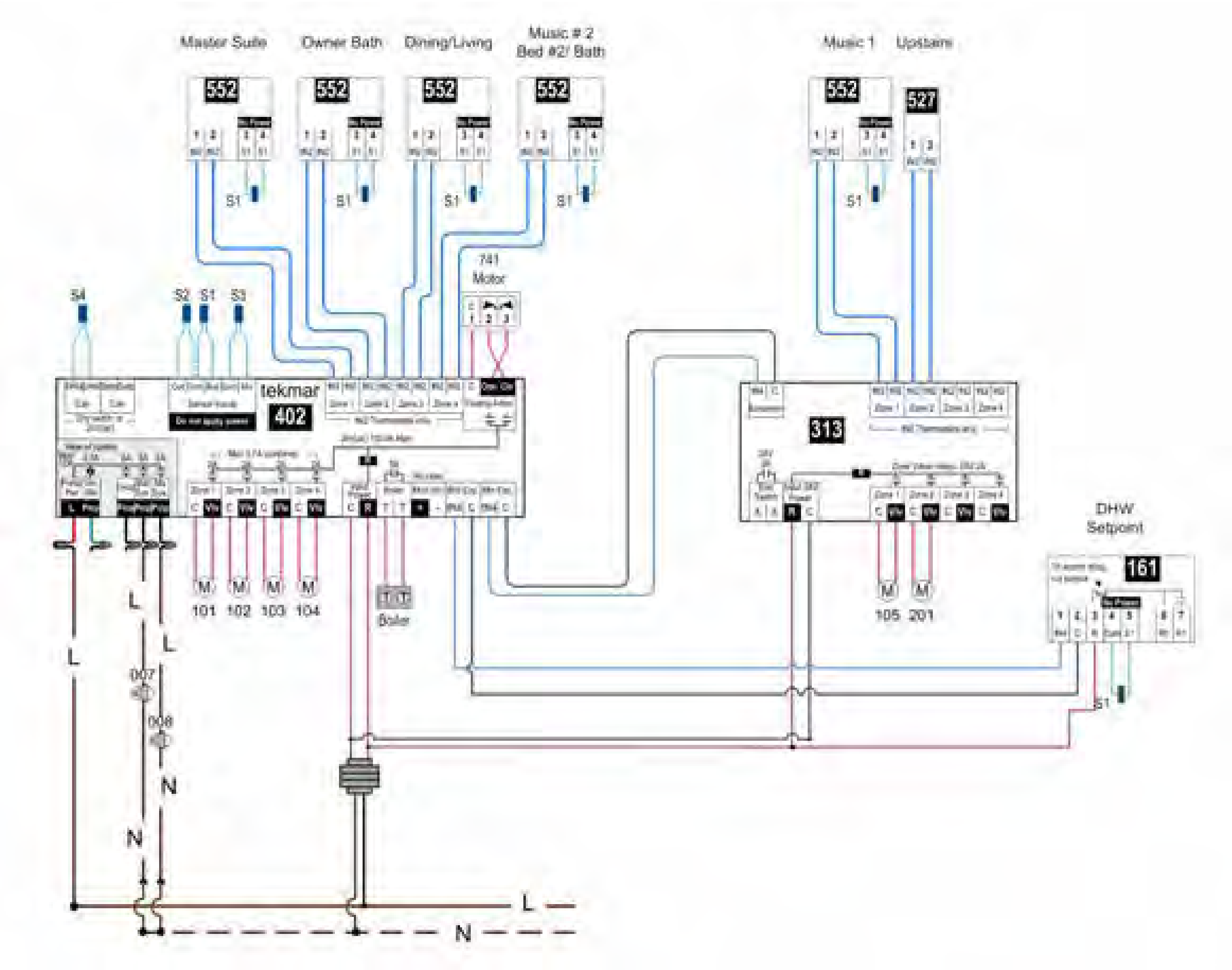
Water Heater with Brazed Plate Heat Exchanger for use with both Domestic Hot Water and Radiant Heating



NOTE: THIS DRAWING IS ILLUSTRATIVE ONLY. SOME COMPONENTS HAVE BEEN OMITTED FOR CLARITY. COMPLY WITH LOCAL CODES WHEN PIPING SYSTEMS.

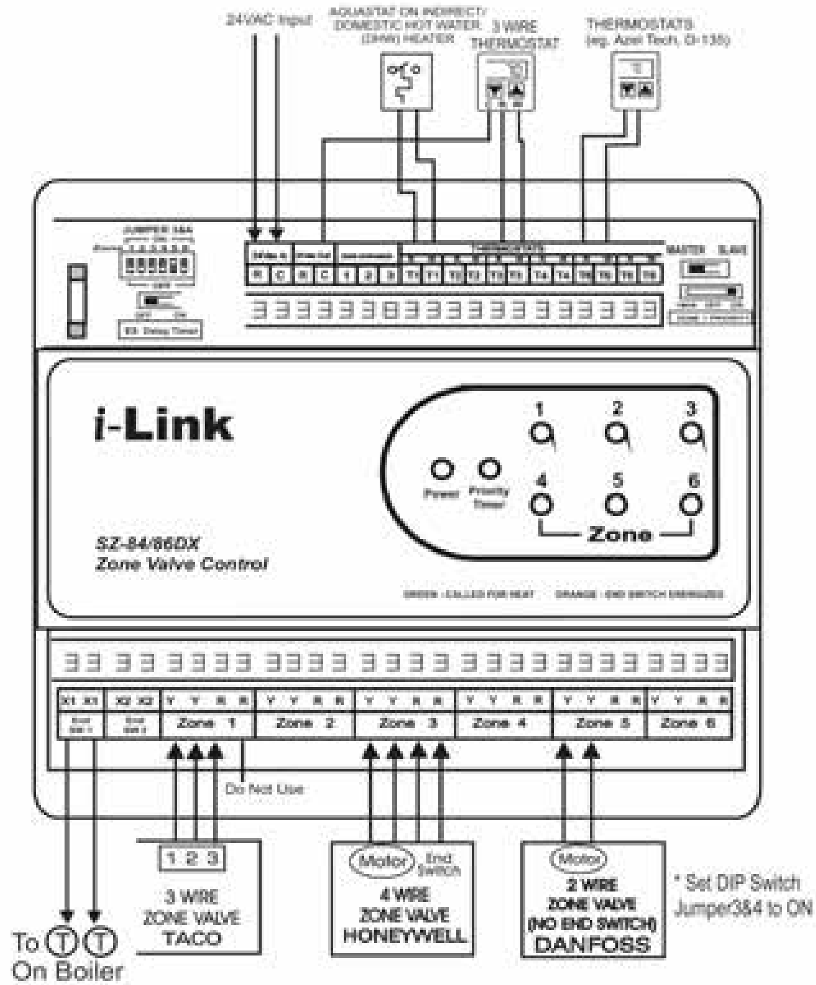
1	Water Heater	10	Thermometer w/ well typical
2	Ball Valve with drain Typical	11	Ball Valve Typical
3	Stainless Steel Pump with isolation flanges	12	Radiant Remote Manifold
4	Brazed Plate Heat Exchanger	13	By pass valve
5	Residential boiler fill fittings	14	Zone Valve Typical
6	Air Eliminator	15	Control Box
7	Expansion Tank	16	Magnetic Dirt Separator
8	Fill / Backflow Preventer	17	30 Psi Relief Valve
9	Pressure Differential Radiant Pump with iso flanges	18	Boiler Drain

Tekmar Energy Management System Wiring Diagram



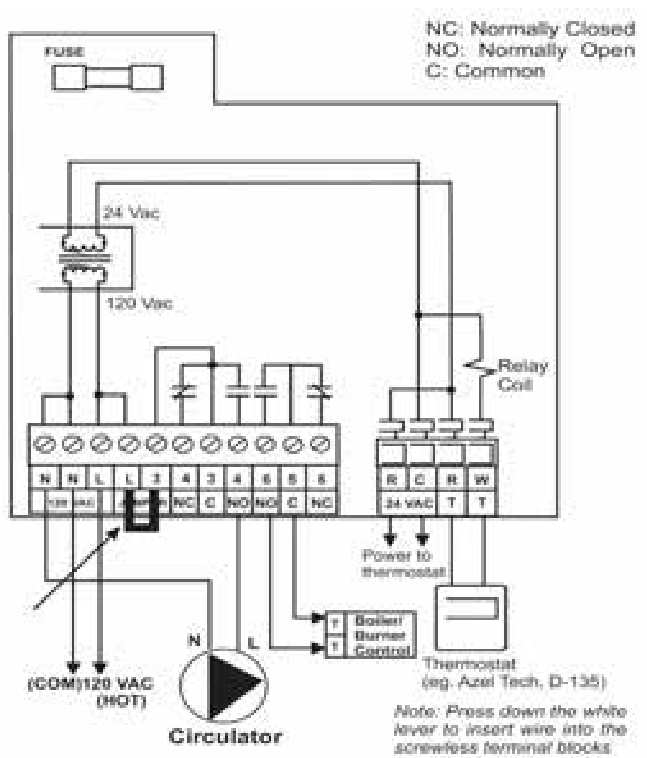
Appendix

CONTROL BOX #30062 - WIRING DIAGRAM



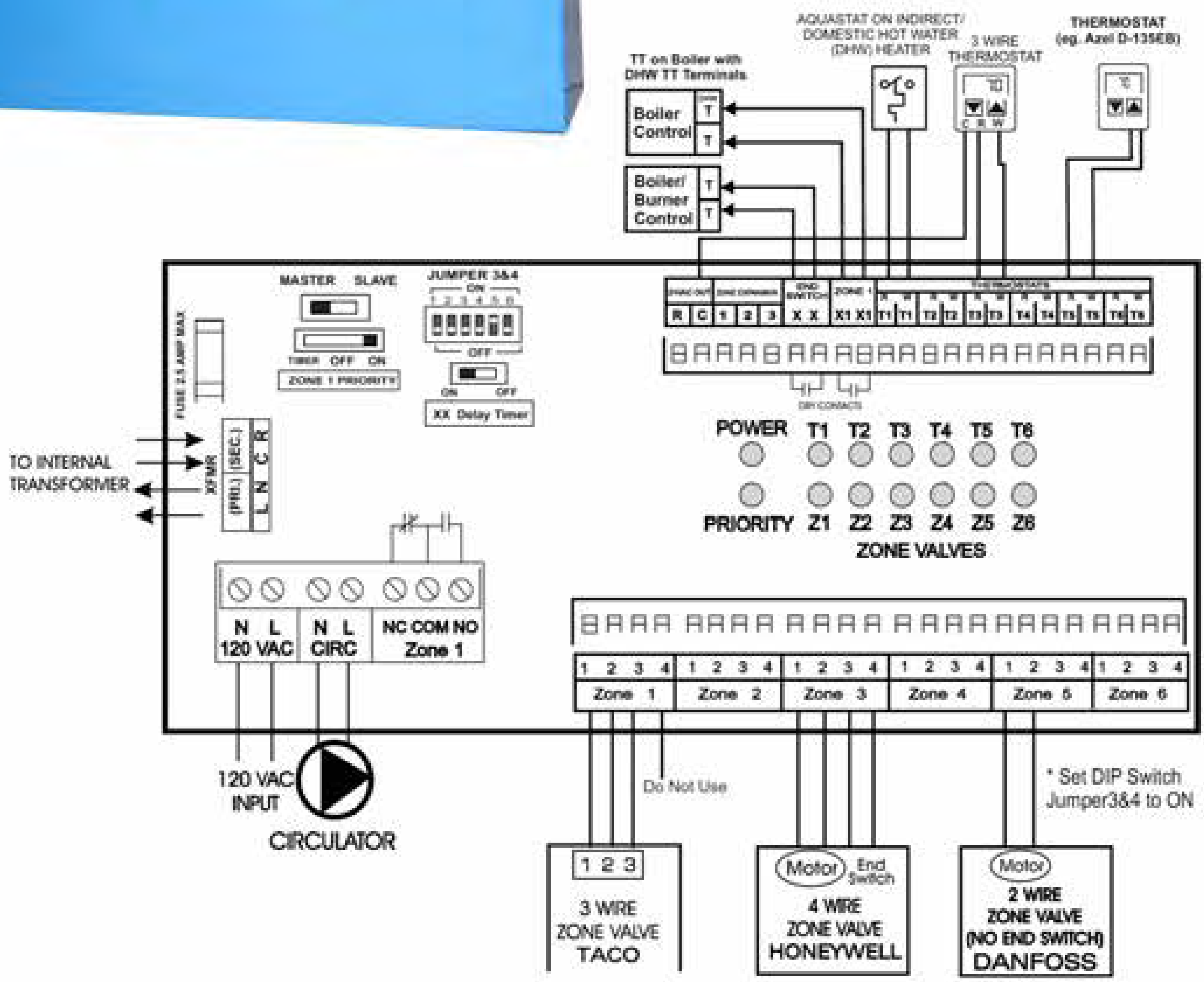
30061-30062 CONTROL BOX WITH 29019 THERMOSTATS, WITH 29001 DUAL SENSING THERMOSTAT, AND DHW PRIORITY

INFLOOR SINGLE ZONE SWITCHING RELAY



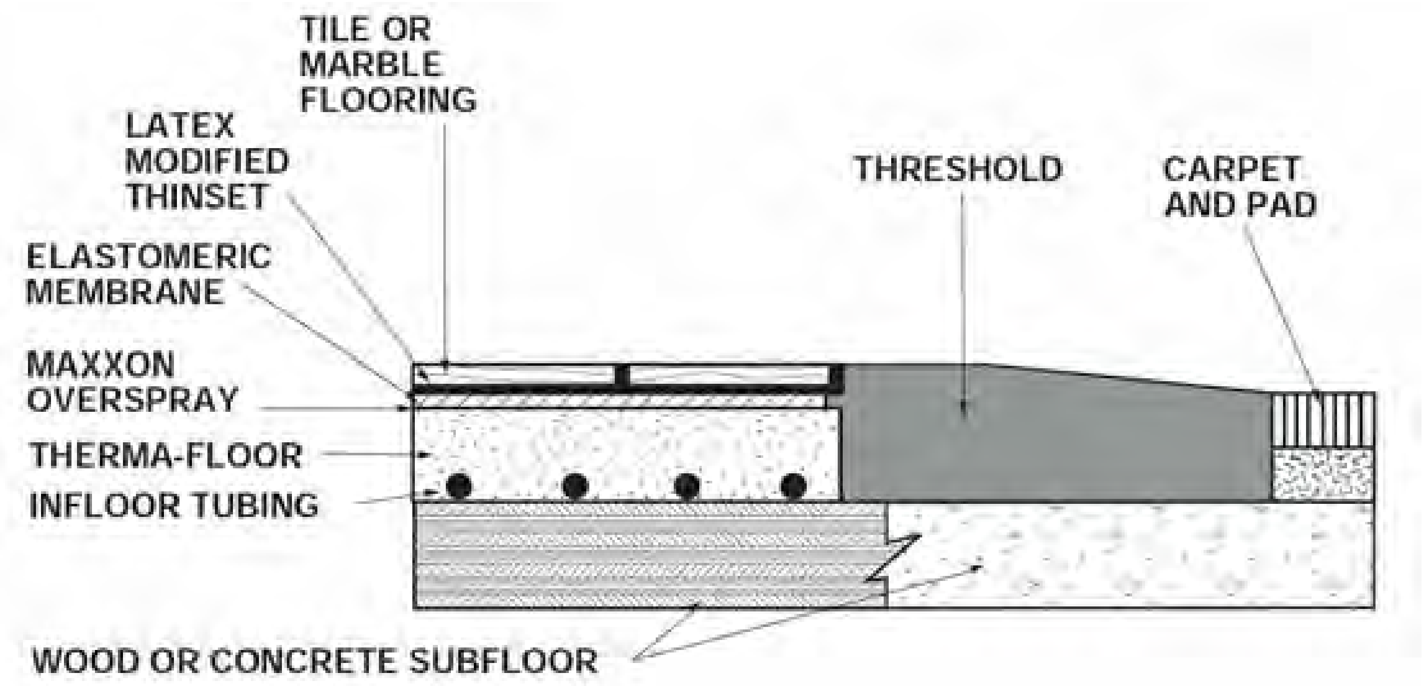
Appendix

CONTROL BOX 30063-30064 WITH 29019 THERMOSTATS, DHW PRIORITY, SECONDARY PUMPS, AND BOILER

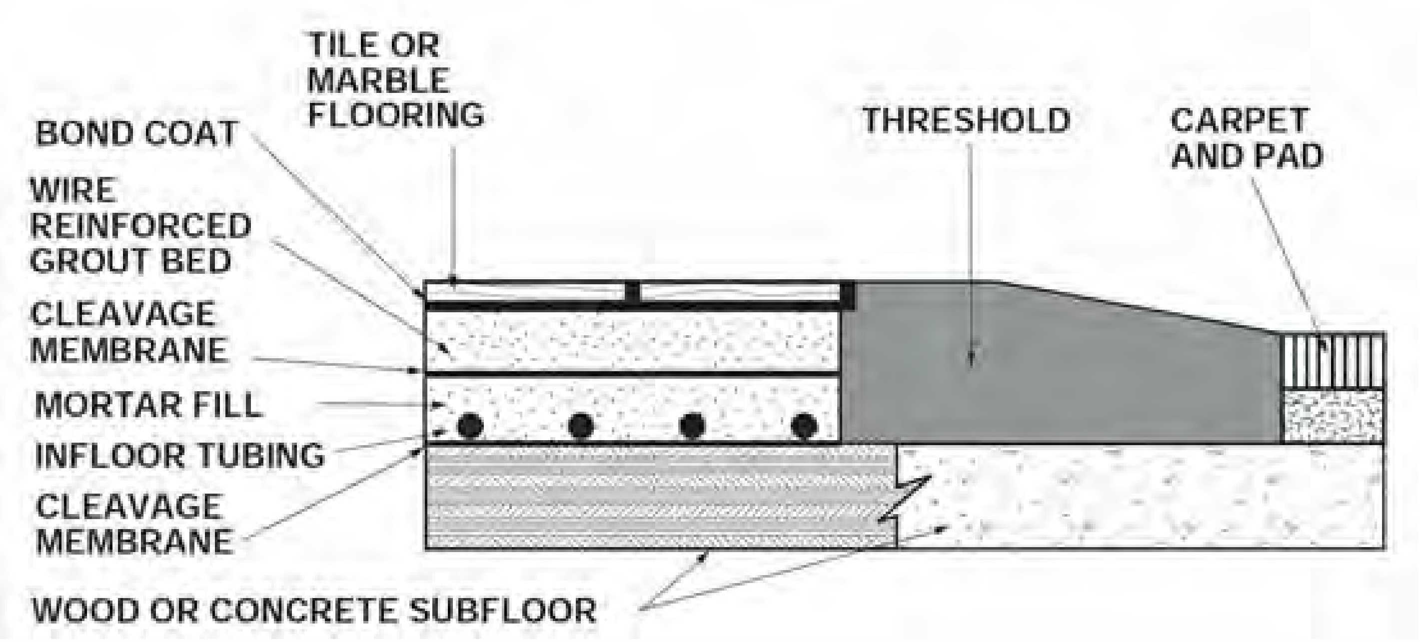


Appendix

TRANSITION DETAIL FOR TILE WITH THERMA-FLOOR

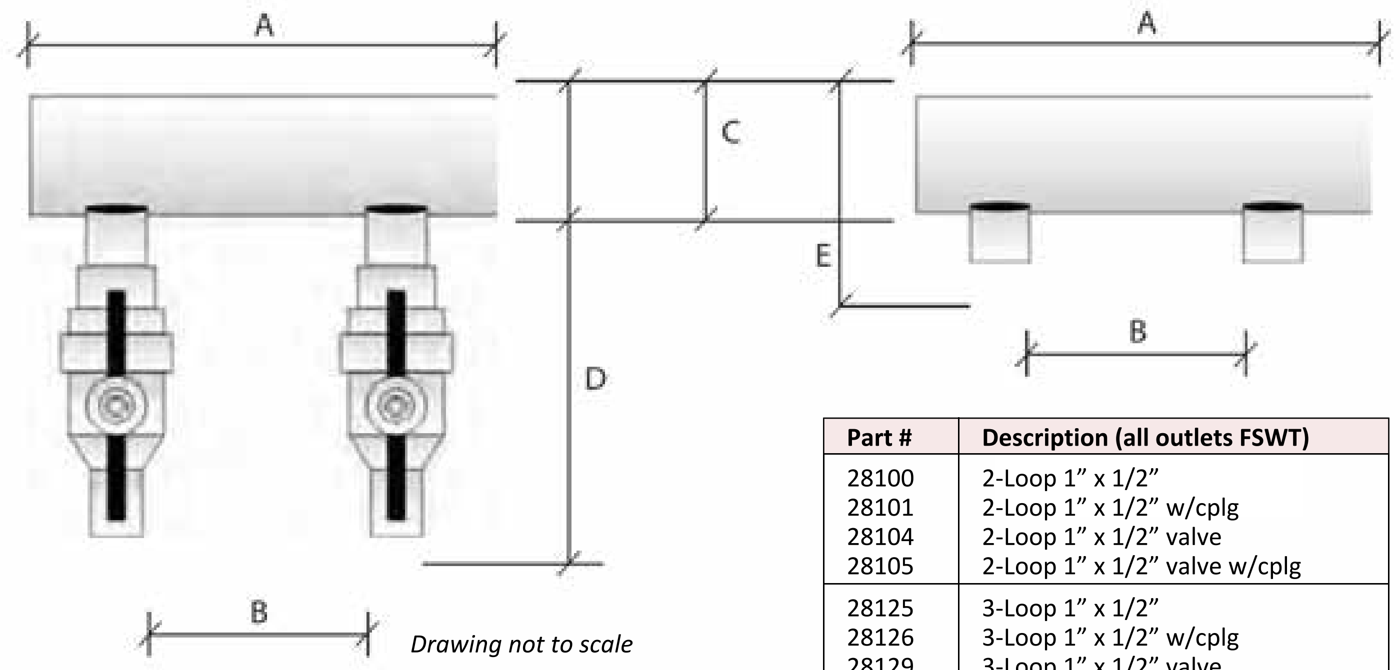


TRANSITION DETAIL FOR TILE WITH THERMA-FLOOR



Appendix

COPPER MANIFOLD DIMENSIONS



Drawing not to scale

Dimension	Manifold Configuration			
A	1" x 1/2" 5-1/4"	1-1/4" x 1/2" 6-3/8"	1-1/4" x 3/4" 6-3/8"	1-1/2" x 3/4" 7-1/8"
B	2-1/23"	3"	3"	3"
C	1"	1-1/4"	1-1/4"	1-1/2"
D	4"	4-1/4"	4-3/4"	5"
E	2"	2-1/8"	2-5/8"	2-7/8"
Add'l Loop W/Coupling	A + 2-1/2" A + 7/8"	A + 3" A + 1-1/4"	A + 3" A + 1-1/4"	A + 3" A + 1-1/8"

Use these charts to determine size of the various copper manifold configurations. For example: to determine the size of a 5-loop 1-1/4" manifold with 3/4" ball valve outlets do the following:

1. "A" dimension: 6-3/8"
2. "B" dimension: 3" on center
3. "C" dimension: 1-1/4" pipe size
4. "D" dimension: 4-3/4" top of manifold to btm valve
5. "E" dimension: not applicable
6. Additional Loop: A + (3 * 3") = 15-3/8"
7. w/Coupling: 15-3/8" + 1-1/8" = 16-1/2"

NOTE: ADD ANY ADDITIONAL LOOPS TO DETERMINE "A" DIMENSION BEFORE ADDING THE DIMENSION FOR THE COUPLING.

Part #	Description (all outlets FSWT)
28100 28101 28104 28105	2-Loop 1" x 1/2" 2-Loop 1" x 1/2" w/cplg 2-Loop 1" x 1/2" valve 2-Loop 1" x 1/2" valve w/cplg
28125 28126 28129 28130	3-Loop 1" x 1/2" 3-Loop 1" x 1/2" w/cplg 3-Loop 1" x 1/2" valve 3-Loop 1" x 1/2" valve w/cplg
28200 28201 28204 28205	2-Loop 1-1/4" x 1/2" 2-Loop 1-1/4" x 1/2" w/cplg 2-Loop 1-1/4" x 1/2" valve 2-Loop 1-1/4" x 1/2" valve w/cplg
28225 28226 28229 28230	3-Loop 1-1/4" x 1/2" 3-Loop 1-1/4" x 1/2" w/cplg 3-Loop 1-1/4" x 1/2" valve 3-Loop 1-1/4" x 1/2" valve w/cplg
28250 28251 28254 28255	2-Loop 1-1/4" x 3/4" 2-Loop 1-1/4" x 3/4" w/cplg 2-Loop 1-1/4" x 3/4" valve 2-Loop 1-1/4" x 3/4" valve w/cplg
28275 28276 28279 28280	3-Loop 1-1/4" x 3/4" 3-Loop 1-1/4" x 3/4" w/cplg 3-Loop 1-1/4" x 3/4" valve 3-Loop 1-1/4" x 3/4" valve w/cplg
28300 28301 28304 28305	2-Loop 1-1/2" x 3/4" 2-Loop 1-1/2" x 3/4" w/cplg 2-Loop 1-1/2" x 3/4" valve 2-Loop 1-1/2" x 3/4" valve w/cplg
28325 28326 28329 28330	3-Loop 1-1/2" x 3/4" 3-Loop 1-1/2" x 3/4" w/cplg 3-Loop 1-1/2" x 3/4" valve 3-Loop 1-1/2" x 3/4" valve w/cplg
28350 28351 28354 28355	5-Loop 1-1/2" x 3/4" 5-Loop 1-1/2" x 3/4" w/cplg 5-Loop 1-1/2" x 3/4" valve 5-Loop 1-1/2" x 3/4" valve w/cplg

Bringing You The Very Best In Radiant Heating

Infloor Heating Systems is a pioneer in the radiant heating industry, designing and providing systems since 1984. Infloor specializes in electric and hydronic radiant heating, snowmelt systems, and energy-saving solutions such as solar and geo thermal additions. The benefits of radiant heating are superior to conventional forced-air and baseboard systems. Radiant heating is energy-efficient, reducing gas and electric bills, eliminates duct work and duct losses, creates a quieter home, and is a healthier way of living for those with allergies. Infloor Heating Systems is proud to offer premium, innovative radiant heating systems and products designed to improve your everyday living and comfort.

INFLOOR HEATING SYSTEMS

P.O. Box 4945
Buena Vista, CO 81211

info@infloor.com • (800) 608-0562 • (719) 395-3400 • www.infloor.com