

Chapter 13: Piping schematics

Piping schematic level 1 control

- Water heater
- Closed system
- Single-temperature radiant floor heating

Where: All low-temperature radiant applications (< 145°F)

Why: This illustration shows a dedicated water heater supplying water for a single radiant manifold. The water heater provides the required supply water temperature directly to the radiant panel, with the water temperature controlled by the water heater's internal aquastat. As a result, no additional water temperature control device is needed.

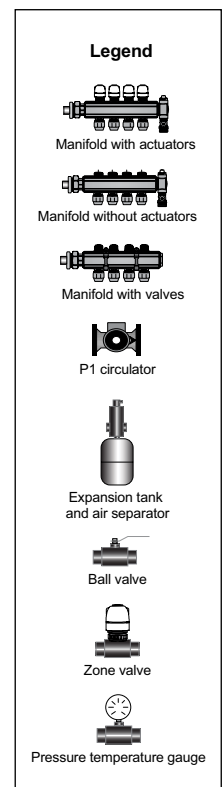
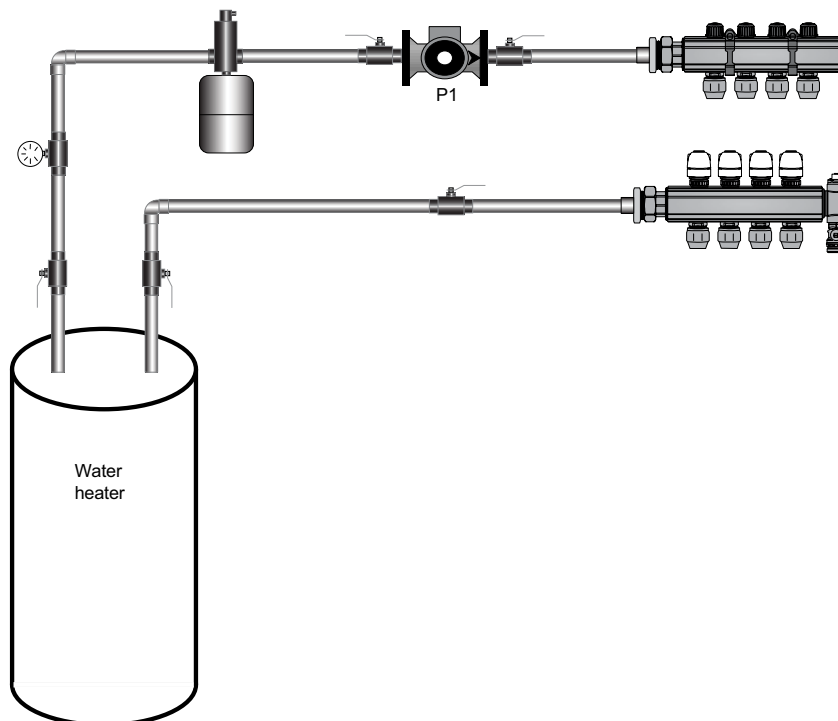


Important: Consult local building codes prior to installing a water heater as a heat source for radiant heating.

What to look for:

- **Bypass loop** – A bypass loop is not required when using a water heater with radiant heat.
- **Radiant loop circulator (P1)** – A circulator (P1) has been added in the radiant loop. This circulator is necessary to insure flow through the radiant panel.
- **Isolation valves** – Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.
- **Pressure-relief valve** – When using a water heater as a heat source, install a 30-pound relief valve in the near heat source piping. Ensure there is NO isolation between the relief valve and the water heater. Most water heaters come equipped with a Temperature and Pressure (T&P) Valve. Do not remove this valve from the water heater, as it provides additional temperature safety.

- **Pressure-reducing valve** – Uponor recommends installing a pressure-reducing valve in the fresh water makeup line to the water heater. This is necessary to properly set the system fill pressure for additional safety.
- **Zoning options 1-5** – See pages 115-119.
- **Specific wiring schematic 10** – See pages 159-160.



Piping schematic level I control

- Modulating-condensing boiler
- Single-temperature radiant floor heating

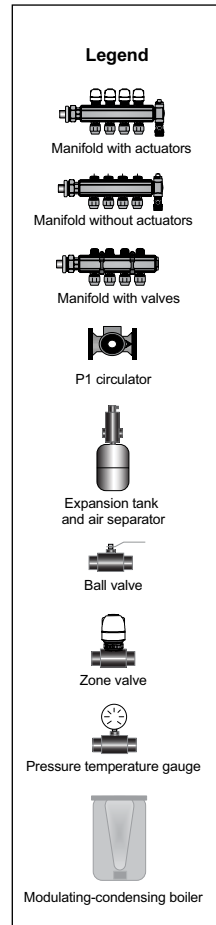
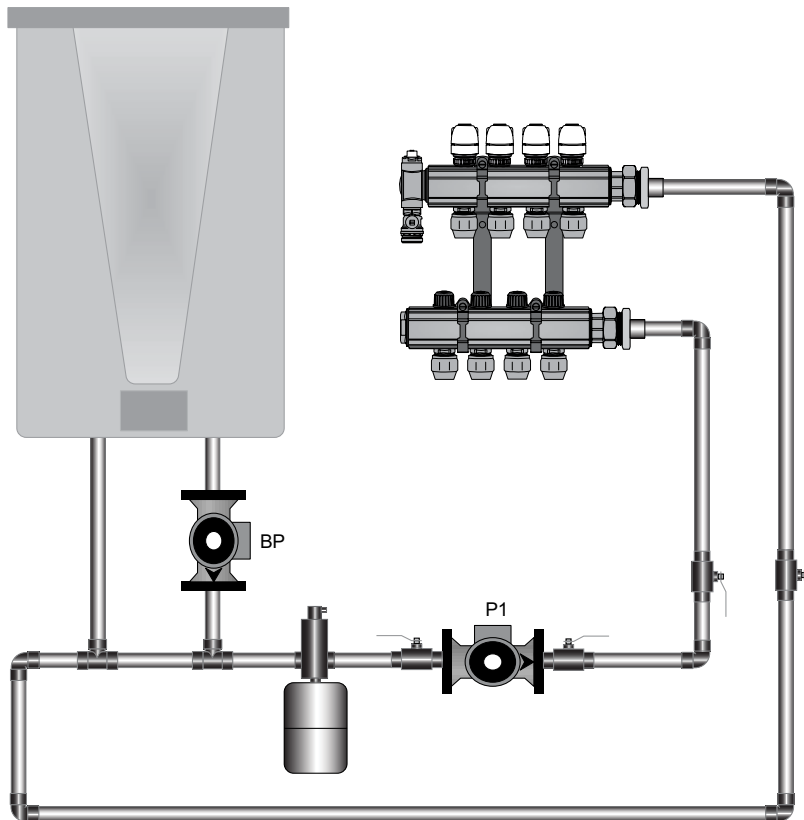
Where: All radiant and snow melt applications

Why: This illustration shows a condensing boiler supplying water to a single radiant manifold for space heat or snow melting. Condensing boilers are designed to operate safely and efficiently at low return water temperatures. As a result, no additional water temperature control device is required. The boiler operating control is set up to provide the correct supply water temperature to the radiant panel. When using a condensing boiler in radiant and snow melt applications, consult the boiler manufacturer's installation and operation instructions for specific near-boiler piping information and return water temperature limitations.

What to look for:

- **Bypass loop** – A bypass loop is not required when using a condensing boiler with radiant heat.
- **Boiler circulator** – Many condensing boilers are packaged with an internal circulator (BP), but require an additional system circulator (P1). Consult the boiler manufacturer's installation and operation instructions for specific requirements. If the boiler is equipped with a system circulator, flow (gpm) and head requirements for the radiant panels may exceed the capacity of that circulator. Review radiant flow requirements and size the system circulator appropriately.
- **Isolation valves** – Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.

- **Zoning option 1-5** – See pages 115-119.
- **Specific wiring schematic 1** – See page 145.



Piping schematic level I control

- Modulating-condensing boiler
- Single-temperature radiant floor heating
- Multiple manifolds

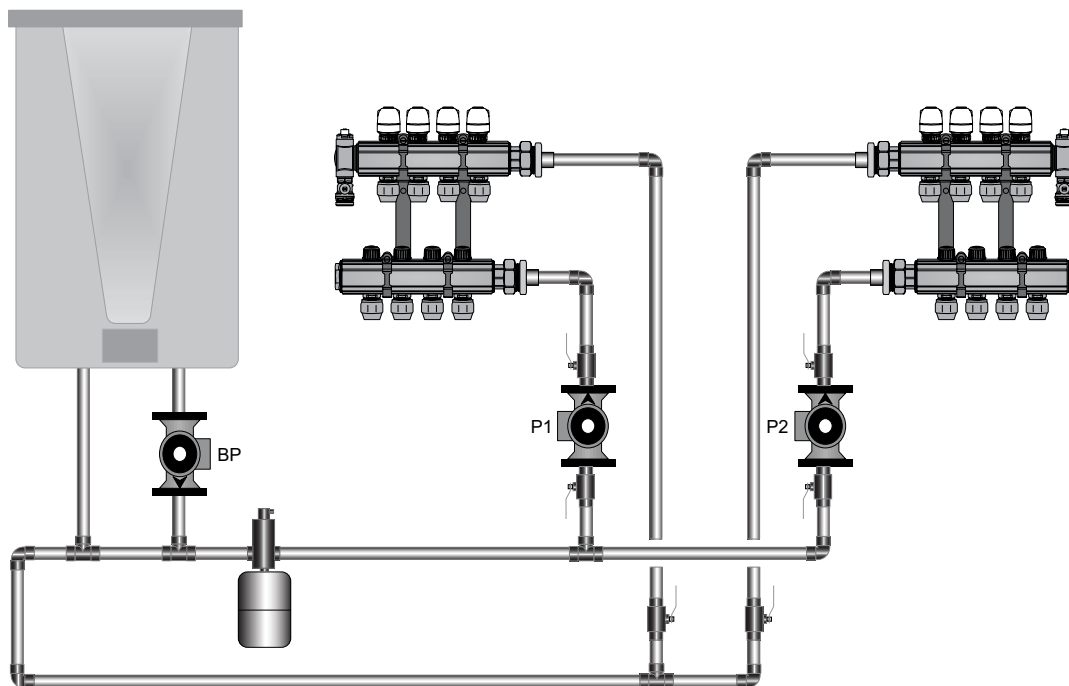
Where: All radiant and snow melt applications

Why: This illustration shows a condensing boiler supplying water to multiple radiant manifolds operating at the same supply water temperature. Condensing boilers are designed to operate safely and efficiently at low return water temperatures. As a result, no additional water temperature control device is required. The boiler operating control is set up to provide the correct supply water temperature to the radiant panel. When using a condensing boiler in radiant and snow melt applications, consult the boiler manufacturer's installation and operation instructions for specific near-boiler piping information and return water temperatures limitations.

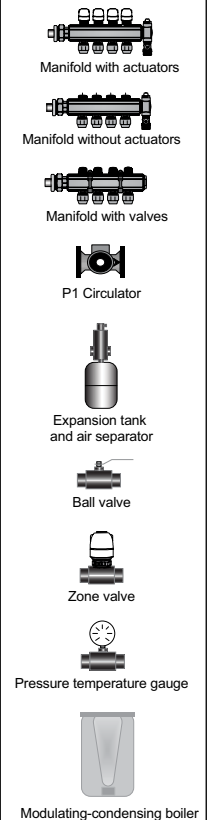
What to look for:

- **Bypass loop** — A bypass loop is not required when using a condensing boiler with radiant heat.
- **Boiler circulator** — Many condensing boilers are packaged with an internal circulator (BP), but require additional system circulators (P1). Consult the boiler manufacturer's installation and operation instructions for specific requirements. If the boiler is equipped with a system circulator, flow (gpm) and head requirements for the radiant panels may exceed the capacity of that circulator. Review radiant flow requirements and size the system circulator appropriately.
- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.

- **Zoning options 1-5** — See pages 115-119.
- **Specific wiring schematic 8** — See pages 155-156.



Legend



Piping schematic level I control

- Modulating-condensing boiler
- Dual-temperature radiant floor heating
- Three-way tempering valve

Where: Multiple temperature radiant applications

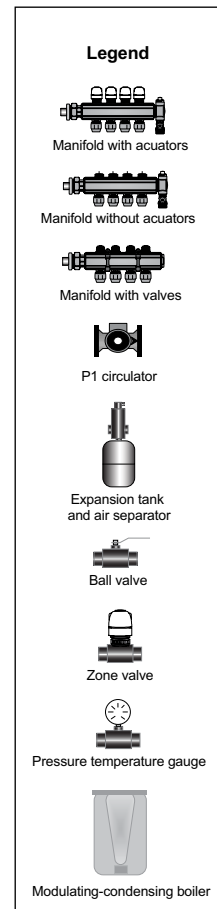
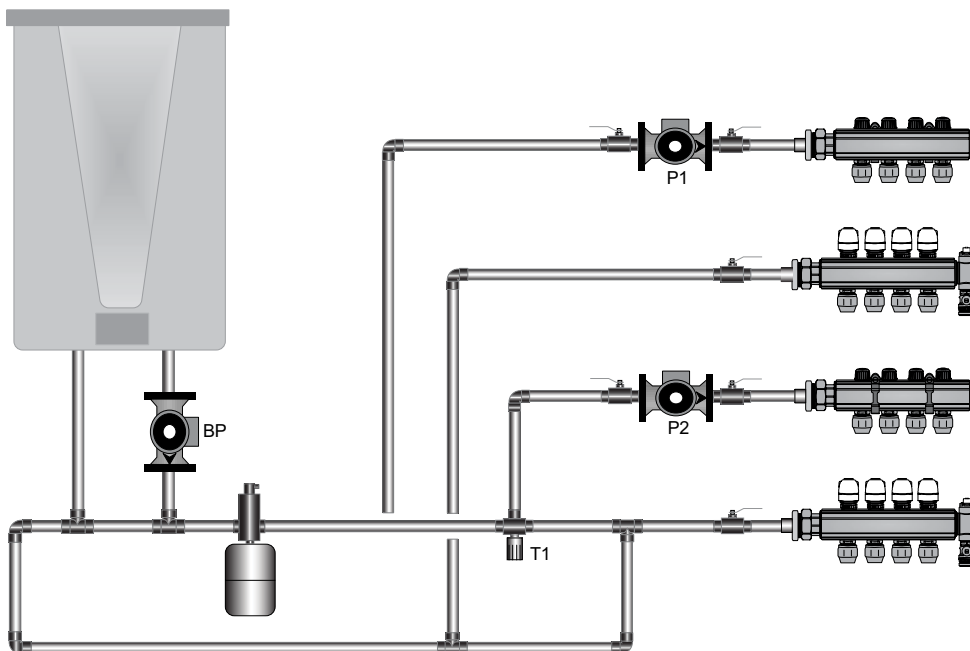
Why: This illustration shows a condensing boiler supplying water to multiple radiant panels requiring dramatically different supply water temperature, or having different installation methods (i.e. concrete vs. Joist Trak™). Condensing boilers are designed to operate safely and efficiently at low return water temperatures. As a result, no additional water temperature control device is required for the higher temperature radiant. The boiler operating control is set up to provide the correct supply water temperature to the high temperature radiant panel. For the low-temperature radiant panel, an Uponor Three-way Tempering Valve (T1) will mix hotter boiler water with cooler radiant return water to achieve

the selected radiant supply water temperature per the valve setting (See **Chapter 12** for details on Three-way Tempering Valve operation). A Three-way Tempering Valve allows the radiant supply water temperature to be adjusted from 80°F to 160°F. When using a condensing boiler in radiant applications, consult the boiler manufacturer's installation and operation instructions for specific near boiler piping information and return water temperature limitations.

What to look for:

- **Bypass loop** — A bypass loop is not required when using a condensing boiler with radiant heat.
- **Low-temperature radiant loop circulator** — Circulators (P1) have been added on the radiant loop side of the Three-way Tempering Valve. This circulator is necessary to insure flow through the radiant panel. Without this circulator, flow through the radiant panel would stop once the tempering valve senses the supply water has reached the desired temperature, closing the hot (+) port of the valve.

- **High-temperature radiant loop circulator** — Many condensing boilers are packaged with an internal circulator (BP), but require an additional system circulator (P2). Consult the boiler manufacturer's installation and operation instructions for specific requirements. If the boiler is equipped with a system circulator, flow (gpm) and head requirements for the radiant panel may exceed the capacity of that circulator. Review radiant flow requirements and sized the system circulator appropriately.
- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.
- **Zoning options 1-5** — See **pages 115-119**.
- **Specific wiring schematic 8** — See **pages 155-156**.



Piping schematic level I control

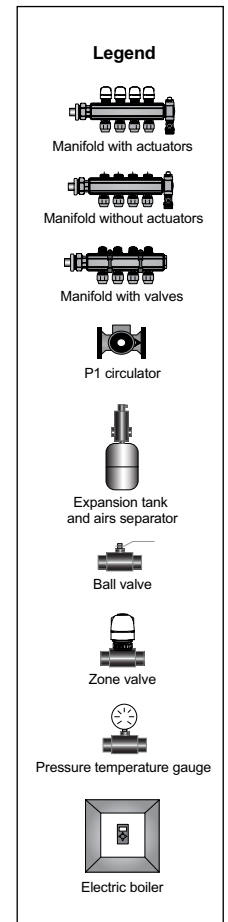
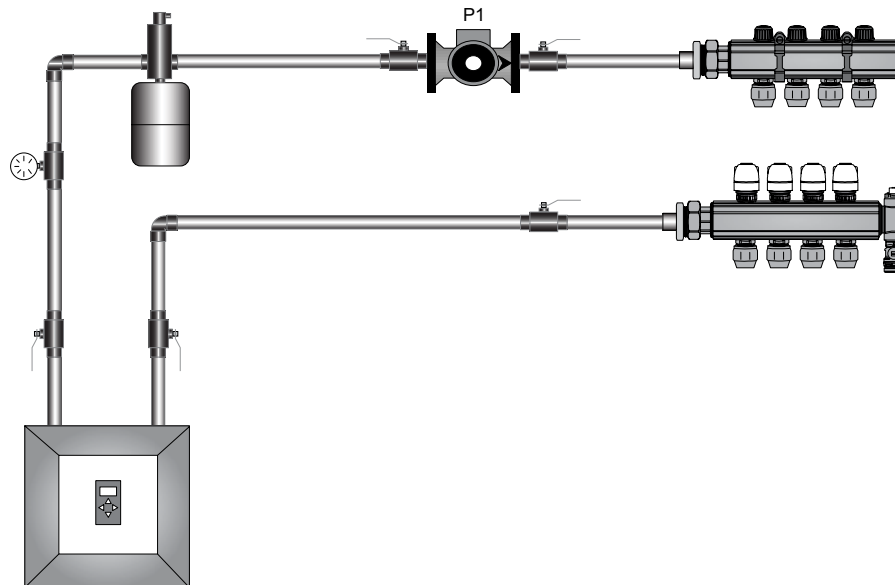
- Electric boiler
- Single-temperature radiant floor heating

Where: All radiant applications

Why: This illustration shows an electric boiler supplying water to a single radiant panel. Electric boilers are designed to operate safely and efficiently at low return water temperatures. As a result, no additional water temperature control device is required. The boiler high limit is set to provide the maximum supply water temperature to the radiant panel. When using an electric boiler in radiant applications, consult the boiler manufacturer's installation and operation instructions for specific near-boiler piping information and return water temperature limitations.

What to look for:

- **Bypass loop** — A bypass loop is not required when using an electric boiler with radiant heat.
- **Boiler circulator** — Electric boilers are not typically packaged with a circulator, and therefore require the installation of a system circulator (P1). Review radiant flow requirements (gpm and head) and size the system circulator appropriately.
- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.
- **Zoning options 1-5** — See pages 115-119.
- **Specific wiring schematic 1** — See page 145.



Piping schematic level I control

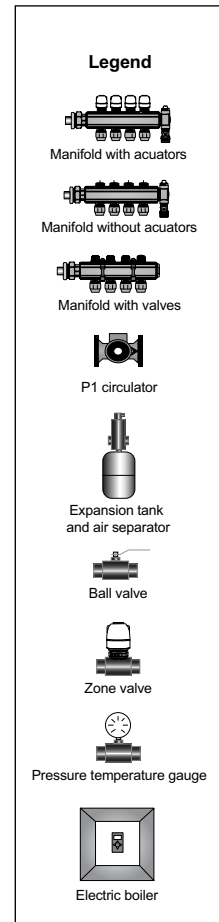
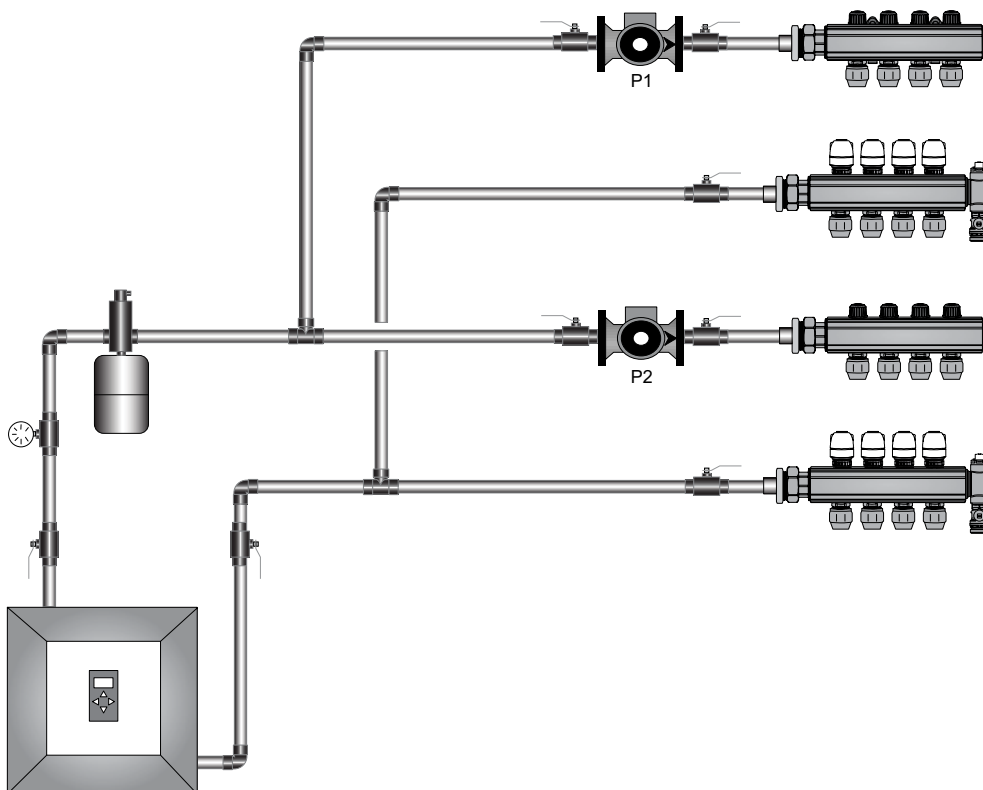
- Electric boiler
- Single-temperature radiant floor heating
- Multiple manifolds

Where: All radiant applications

Why: This illustration shows an electric boiler supplying water to multiple radiant panels operating at the same supply water temperature. Electric boilers are designed to operate safely and efficiently at low return water temperatures. As a result, no additional water temperature control device is required. The boiler high limit is set to provide the maximum supply water temperature to the radiant panel. When using an electric boiler in radiant applications, consult the boiler manufacturer's installation and operation instructions for specific near-boiler piping information.

What to look for:

- **Bypass loop** — A bypass loop is not required when using an electric boiler with radiant heat.
- **Boiler circulator** — Electric boilers are not packaged with a circulator, and therefore require the installation of additional system circulators (P1 and P2). Review radiant flow requirements (gpm and head) and size the system circulators appropriately.
- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.
- **Zoning options 1-5** — See [pages 115-119](#).
- **Specific wiring schematic 8** — See [pages 155-156](#).



Piping schematic level I control

- Electric boiler
- Multiple-temperature radiant floor heating
- Three-way tempering valve

Where: Multiple temperature radiant applications

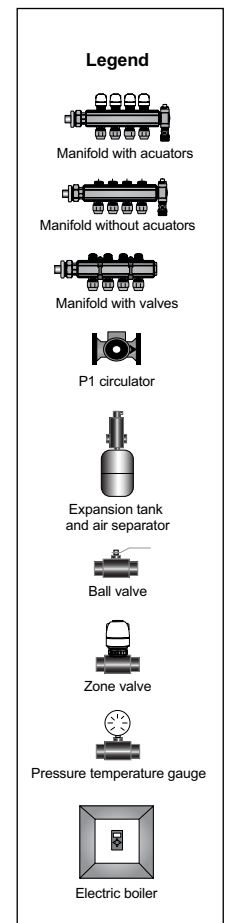
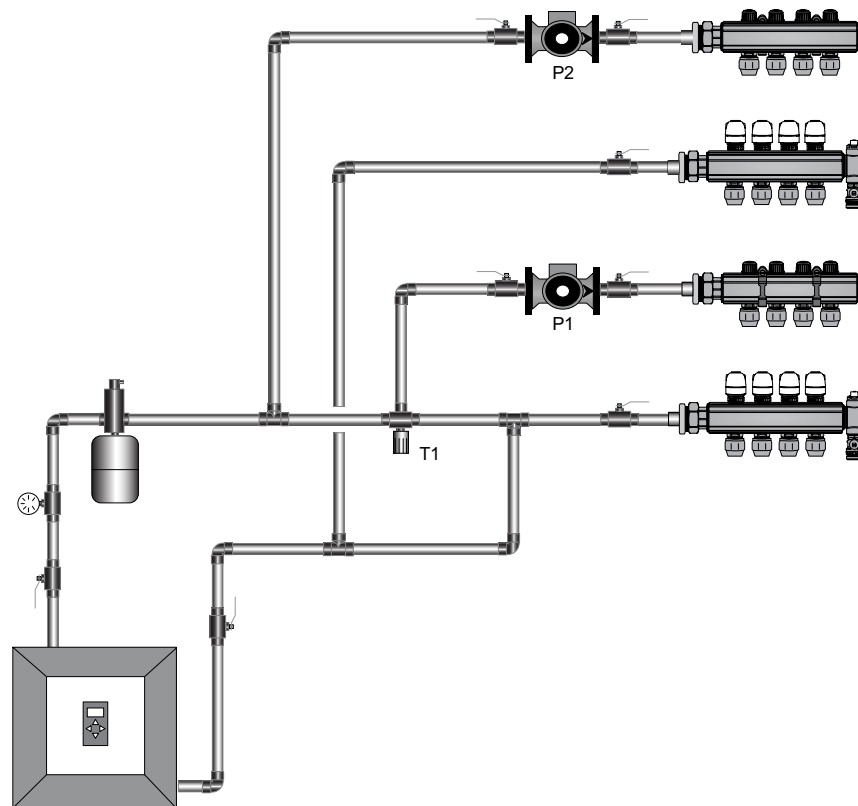
Why: This illustration shows an electric boiler supplying water to multiple radiant panels requiring dramatically different supply water temperatures, or having different installation methods (i.e. concrete vs. Joist Trak). Electric boilers are designed to operate safely and efficiently at low return water temperatures. As a result, no additional water temperature control device is required for the higher temperature radiant. The boiler high limit is set to provide the maximum supply water temperature to the high temperature radiant panel. For the low temperature radiant panel, an Uponor Three-way Tempering Valve is used to mix hot boiler water with cooler radiant return water to achieve the selected radiant

supply water temperature per the valve setting (see **Chapter 12** for details on Three-way Tempering Valve operation). A Three-way Tempering Valve allows the radiant supply water temperature to be adjusted from 80°F to 160°F. When using an electric boiler in radiant applications, consult the boiler manufacturer's installation and operation instructions for specific near boiler piping information and return water temperature limitations.

What to look for:

- **Bypass loop** — A bypass loop is not required when using an electric boiler with radiant heat.
- **Low-temperature radiant loop circulator** — A circulator (P1) has been added on the radiant loop side of the Three-way Tempering Valve. This circulator is necessary to insure flow through the radiant panel. Without this circulator, flow through the radiant panel would stop once the Three-way Tempering Valve senses the supply water has reached the desired temperature, closing the hot (+) port of the valve.

- **High-temperature radiant loop circulator** — Electric boilers are not packaged with circulators, and therefore require an additional system circulator (P2). Consult the boiler manufacturer's installation and operation instructions for specific requirements. Review radiant flow requirements and size the system circulator appropriately.
- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.
- **Zoning options 1-5** — See pages 115-119.
- **Specific wiring schematic 8** — See pages 155-156.



Piping schematic level II control

- Non-condensing boiler
- Three-way tempering valve

Where: All low-temperature radiant applications (< 160°F)

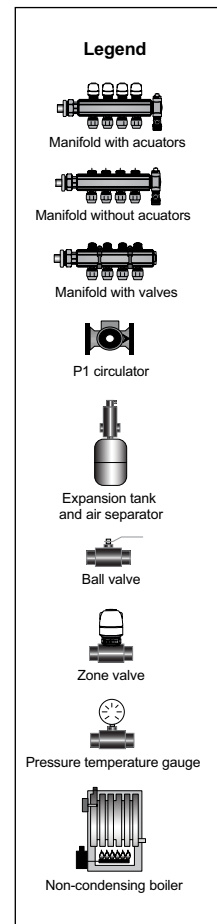
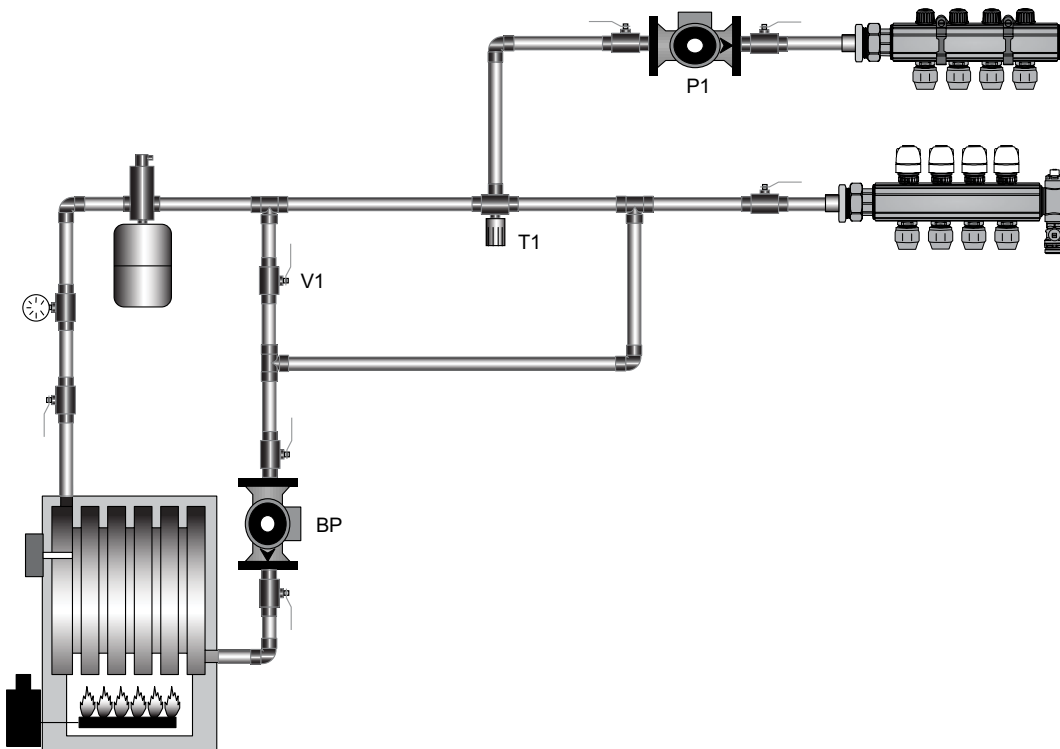
Why: This illustration shows a non-condensing boiler supplying water to a single radiant panel. The Uponor Three-way Tempering Valve (T1) is used to mix hot boiler water with cooler radiant return water to achieve the selected radiant supply water temperature per the valve setting (see **Chapter 12** for details on Three-way Tempering Valve operation). In low-temperature (< 160°F) radiant heating applications using a non-condensing boiler, the boiler supply water temperature must be reduced to the proper radiant supply water temperature. A Three-way Tempering Valve allows the radiant supply water temperature to be adjusted from 80°F to 160°F.

What to look for:

- **Bypass loop** — This piping schematic includes a “bypass” loop at the boiler. Non-condensing boilers require minimum return water temperatures of 140°F or higher (see boiler manufacturer’s installation instructions for specific requirements) to prevent flue gas condensation, potential internal corrosion, and potential thermal shock. The bypass loop allows an amount of hot boiler water (depending on bypass valve position) to circulate through the boiler to maintain return water temperatures above the minimum, preventing the boiler’s flue gasses from condensing. Condensed flue gasses are highly corrosive and will shorten the boiler’s life and may void the boiler’s warranty. The bypass valve (V1) should never be left in the full open position during normal operation.
- **Bypass valve setting** — At system startup, position a suitable valve (V1) in the half-open position. If the radiant

supply water does not reach the desired temperature, continue to close the valve in small increments until that temperature is reached.

- **Radiant loop circulator** — A circulator (P1) has been added on the radiant loop side of the Three-way Tempering Valve. This circulator is necessary to insure flow through the radiant panel. Without this circulator, flow through the radiant panel would stop once the Three-way Tempering Valve senses the supply water has reached the desired temperature, closing the hot (+) port of the valve.
- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.
- **Zoning options 1-5** — See pages 115-119.
- **Specific wiring schematic 1** — See page 145.



Piping schematic level II control

- Non-condensing boiler
- Three-way tempering valve
- Dual-temperature radiant floor heating

Where: All low-temperature radiant applications (< 160°F)

Why: This illustration shows a non-condensing boiler supplying water to a multiple radiant panels requiring dramatically different supply water temperatures, or having different installation methods (i.e. concrete vs. Joist Trak). The Uponor Three-way Tempering Valves (T1 and T2) will mix hot boiler water with cooler radiant return water to achieve the selected radiant supply water temperatures per the valve settings (see **Chapter 12** for details on Three-way Tempering Valve operation).

In low-temperature (< 160°F) radiant heating applications using a non-condensing boiler, the boiler supply water temperature must be reduced to the proper radiant supply water temperature. A Three-way Tempering Valve allows the radiant supply water temperature to be adjusted from 80°F to 160°F.

What to look for:

- **Bypass loop** — This piping schematic includes a “bypass” loop at the boiler. Non-condensing boilers require minimum return water

temperatures of 140°F or higher (see boiler manufacturer’s installation instructions for specific requirements) to prevent flue gas condensation, potential internal corrosion, and potential thermal shock. The bypass loop allows an amount of hot boiler water (depending on bypass valve position) to circulate through the boiler to maintain return water temperatures above the minimum, preventing the boiler’s flue gasses from condensing. Condensed flue gasses are highly corrosive and will shorten the boiler’s life and may void the boiler’s warranty. The bypass valve (V1) should never be left in the full open position during normal operation.

• Bypass valve setting —

At system startup, position a suitable valve (V1) in the half-open position. If the radiant supply water does not reach the desired temperature, continue to close the valve in small increments until that temperature is reached.

• Radiant loop circulator —

Circulators (P1 and P2) have been added on the radiant loop sides of each Three-way Tempering Valve. These circulators are necessary to insure flow through the radiant panels. Without these circulators, flow through the radiant panels would stop once the Three-way Tempering Valves sense the supply water has reached the desired temperature, closing the hot (+) port of the valve.

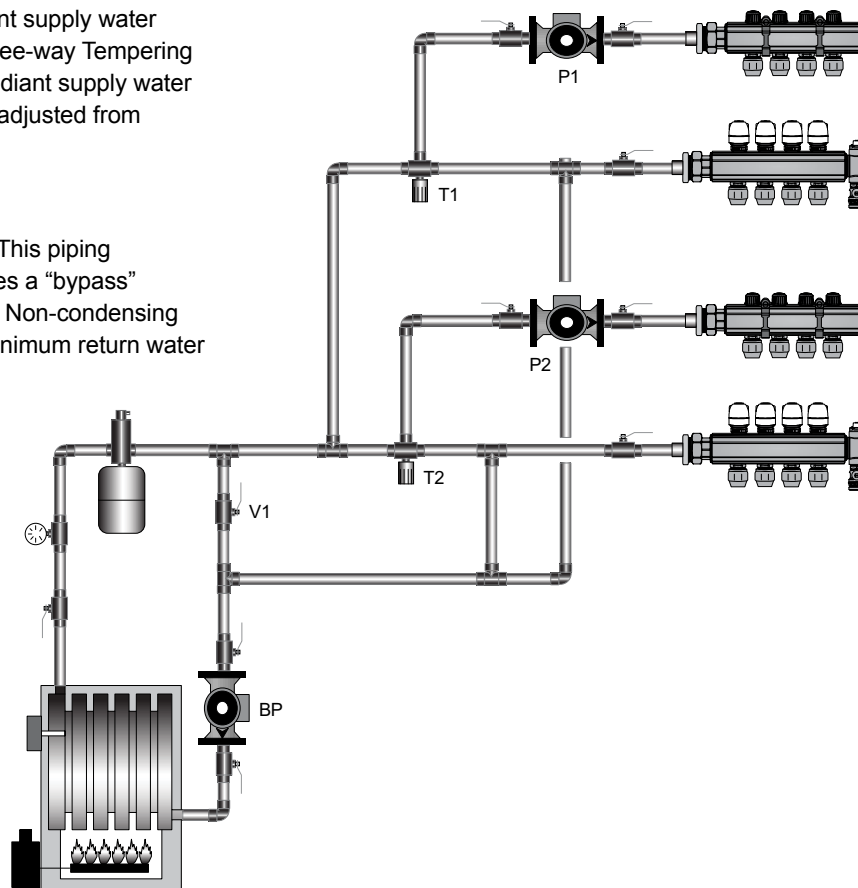
- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.

• Zoning options 1-5 —

See **pages 115-119**.

• Specific wiring schematic 8 —

See **pages 155-156**.



Piping schematic level II control

- Non-condensing boiler
- Three-way tempering valve
- Dual-temperature radiant floor heating
- High-temperature radiation

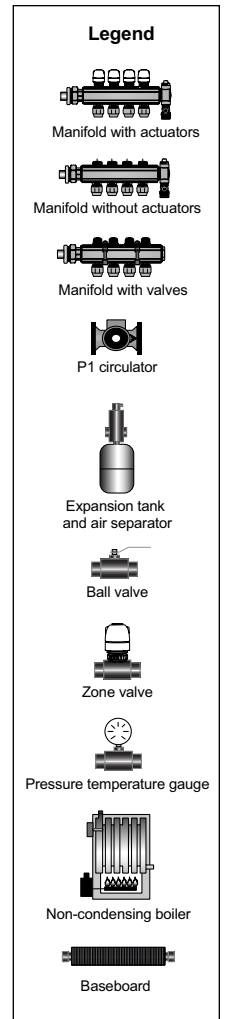
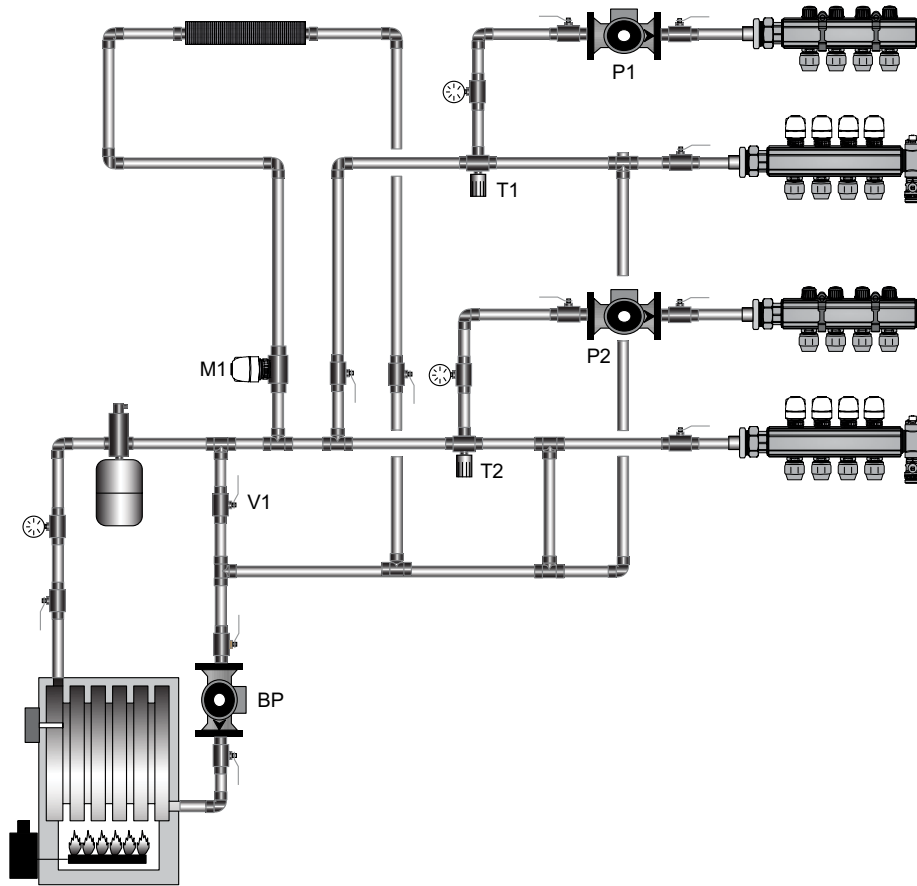
Where: All low-temperature radiant applications (< 160°F), with high-temperature radiation

Why: This illustration shows a non-condensing boiler supplying water to multiple radiant panels requiring dramatically different supply water temperatures or having different installation methods (i.e. concrete vs. Joist Trak) plus high-temperature radiation (baseboard, panel radiators, fan coils, etc.). The Uponor Three-way Tempering Valves (T1 and T2) are used to mix hot boiler water with cooler radiant return water to achieve the selected radiant supply water temperature per the valve settings (see **Chapter 12** for details on Three-way Tempering Valve operation). In low-temperature (< 160°F) radiant heating applications using a non-condensing boiler, the boiler supply water temperature must be reduced to the proper radiant supply water temperature. A Three-way Tempering Valve allows the radiant supply water temperature to be adjusted from 80°F to 160°F. The high-temperature radiation is supplied directly with boiler water.

What to look for:

- **Bypass loop** — This piping schematic includes a “bypass” loop at the boiler. Non-condensing boilers require minimum return water temperatures of 140°F or higher (see boiler manufacturer’s installation instructions for requirements) to prevent flue gas condensation, potential internal corrosion, and potential thermal shock. The bypass loop allows an amount of hot boiler water (depending on bypass valve position) to circulate through the boiler to maintain return water temperatures above the minimum, preventing the boiler’s flue gasses from condensing. Condensed flue gasses are highly corrosive and will shorten the boiler’s life and may void the boiler’s warranty. The bypass valve (V1) should never be left in the full open position during normal operation.
- **Bypass valve setting** — At system startup, position a suitable valve (V1) in the half-open position. If the radiant supply water does not reach the desired temperature, continue to close the valve in small increments until that temperature is reached.

- **Radiant loop circulator** — Circulators (P1 and P2) have been added on the radiant loop sides of the Three-way Tempering Valves (T1 and T2). These circulators are necessary to insure flow through the radiant panels. Without these circulators, flow through the radiant panels would stop once the Three-way Tempering Valves sense the supply water has reached the desired temperatures, closing the hot (+) port of the valves.
- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.
- **Baseboard zone control** — In this schematic, the baseboard loop(s) are controlled with a zone valve (M1), which operates independently of the radiant heat.
- **Zoning options 1-5** — See **pages 115-119**.
- **Specific wiring schematic 7** — See **pages 153-154**.



Piping schematic level II control

- Non-condensing boiler
- Heat exchanger

Where: All radiant and snow melt applications

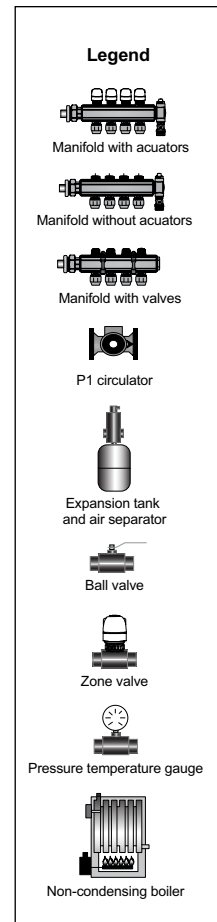
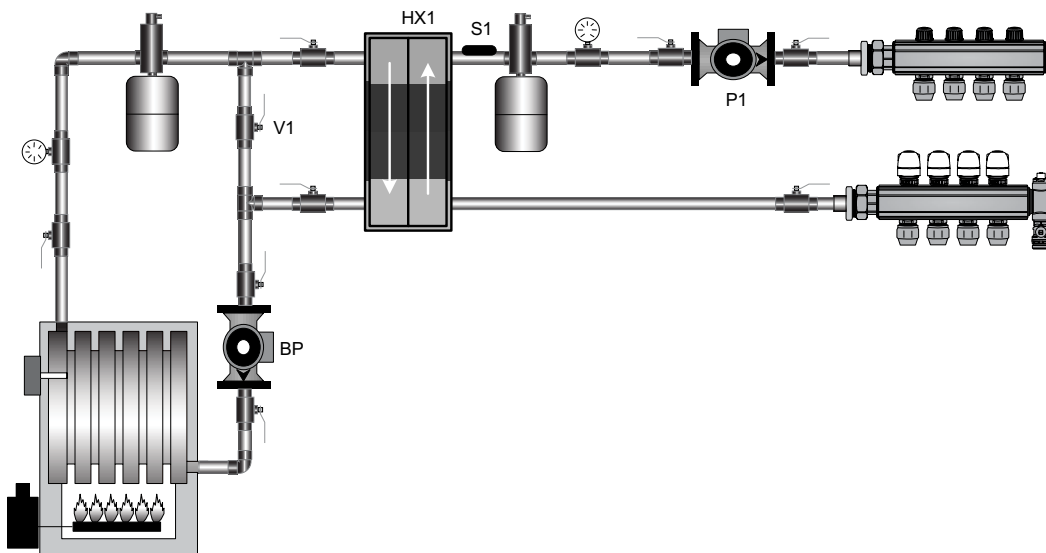
Why: This illustration shows a non-condensing boiler supplying water to a heat exchanger (HX1) to provide water temperature control and isolation where necessary. Water temperature for the radiant panel or snow melt system is controlled by a sensor (S1), either immersion type or strap-on type, placed on the supply outlet of the heat exchanger. The sensor is wired to a set-point controller or aquastat, which is set for the desired supply water temperature. When the supply water temperature drops below the desired level, the set-point controller or aquastat will fire the boiler circulator and/or boiler to send hot water through the boiler side of the heat exchanger. The radiant supply water temperature will increase until the desired level is reached, shutting off the boiler circulator and/or boiler. Besides controlling water temperature, a heat exchanger can be used for isolating the boiler and its ferrous (corrodible) components when Uponor AquaPEX (non-barrier) piping is used on the radiant or snow melt side of the heat exchanger. A heat exchanger will also

protect non-condensing boilers from thermal shock and low return water temperatures, and allows for glycol to be added to the radiant/snow melt portion of the system only.

What to look for:

- **Bypass loop** — This piping schematic includes a “bypass” loop at the boiler. Non-condensing boilers require minimum return water temperatures of 140°F or higher (see boiler manufacturer’s installation instructions for specific requirements) to prevent flue gas condensation,, and potential thermal shock potential internal corrosion. The bypass loop allows an amount of hot boiler water (depending on bypass valve position) to circulate through the boiler to maintain return water temperatures above the minimum, preventing the boiler’s flue gasses from condensing. Condensed flue gasses are highly corrosive and will shorten the boiler’s life and may void the boiler’s warranty. The bypass valve (V1) should never be left in the full open position during normal operation.
- **Bypass valve setting** — At system startup, position a suitable valve (V1) in the half-open position. If the radiant supply water does not reach the desired temperature, continue to close the valve in small increments until that temperature is reached.

- **Radiant loop circulator** — A circulator (P1) has been added on the radiant loop side of the heat exchanger (HX1). This circulator is necessary to insure flow through the radiant panel.
- **Expansion tank** — An expansion tank and air separator are added to the radiant/snow melt side of the heat exchanger. This is required for proper air elimination and thermal expansion due to isolation from the boiler loop by the heat exchanger.
- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.
- **Zoning options 1-5** — See pages 115-119.
- **Specific wiring schematic 12** — See page 162.

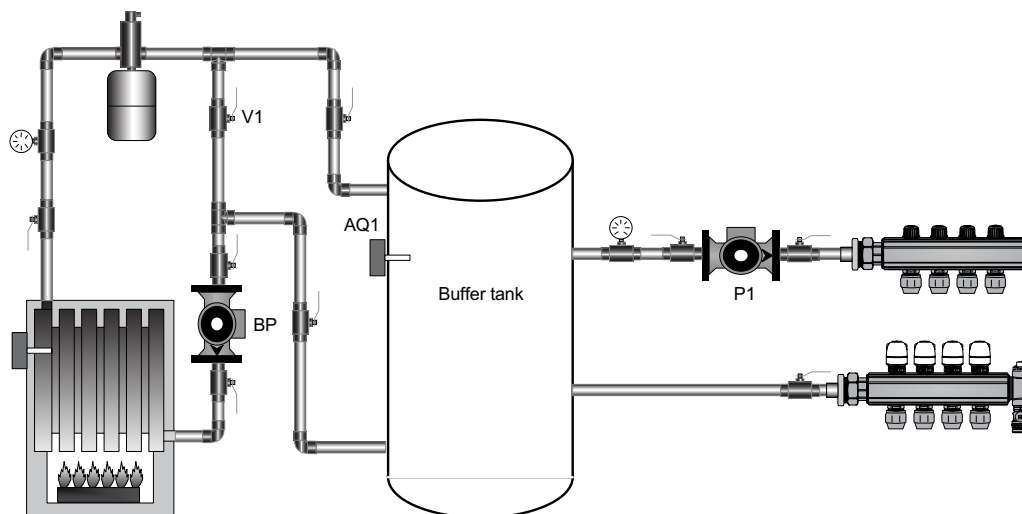


Piping schematic Level II Control

- Wood boiler
- Mixing tank
- Single-temperature radiant floor heating

Where: All radiant applications

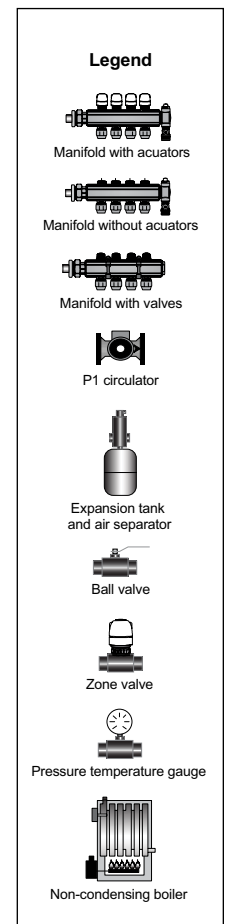
Why: This illustration shows a wood boiler supply water for a single radiant panel, using a mixing, or “buffer”, tank as a tempering device. The wood boiler supplies hot boiler water to the tank that will mix with the cooler radiant return water to deliver the proper radiant supply water temperature. An aquastat (AQ1), either an immersion type or strap-on type, controls the tank temperature. When the aquastat senses the radiant supply water temperature has dropped below the desired level, it starts the boiler pump (P1), mixing hot boiler water into the tank until the desired temperature has been reached. In all radiant applications using a wood boiler, a buffer tank must be used to control the radiant supply water temperature, and to protect the radiant panel from excessive boiler water temperatures.



What to look for:

- **Bypass loop** — This piping schematic includes a “bypass” loop at the boiler. The installation of a bypass will allow an amount of hot boiler supply water (depending on bypass valve position) to circulate through the boiler to prevent low boiler return water temperatures, preventing the boiler’s flue gasses from condensing. Condensed flue gasses are highly corrosive and will shorten the boiler’s life and may void the boiler’s warranty. The bypass valve (V1) should never be left in the full open position during normal operation.
- **Bypass valve setting** — At system startup, position a suitable valve (V1) in the half-open position. If the radiant supply water does not reach the desired temperature, continue to close the valve in small increments until that temperature is reached.
- **Radiant loop circulator** — A circulator (P1) has been added on the radiant loop side of the buffer tank. This circulator is necessary to insure flow through the radiant panel.

- **Aquastat** — An aquastat (AQ1) is used to sense and control water temperature inside the buffer tank. The aquastat is set to the desired radiant supply water temperature, and is wired to a relay that controls the boiler circulator (P1).
- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.
- **Zoning options 1-5** — See pages 115-119.
- **Specific wiring schematic 9** — See pages 157-158.



Piping schematic level II control

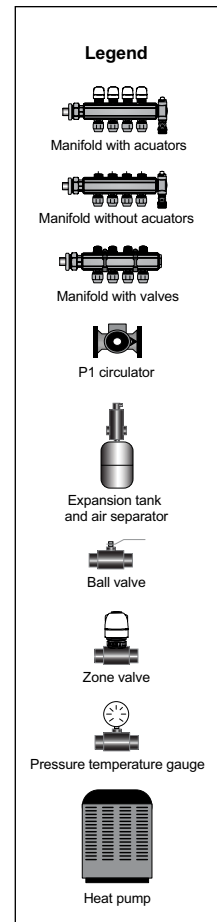
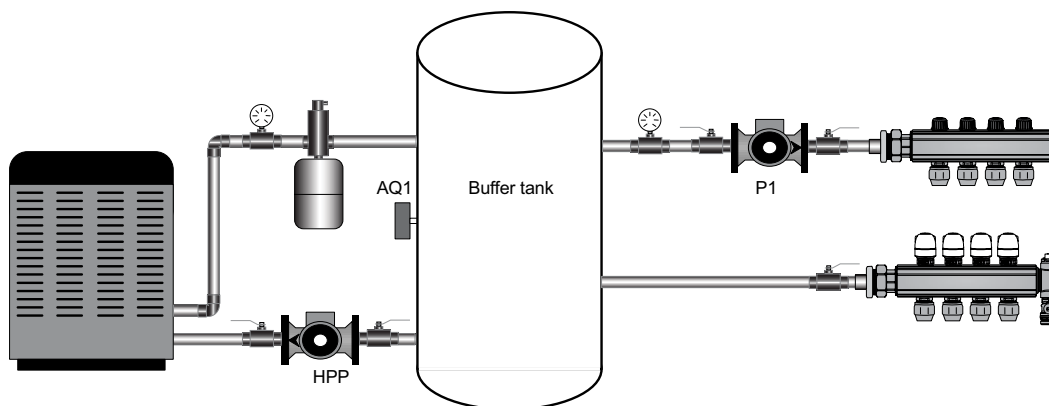
- Heat pump
- Mixing tank
- Single-temperature radiant floor heating

Where: All low-temperature radiant applications (< 120°F)

Why: This illustration shows a geo-thermal heat pump supplying water for a single radiant panel, using a mixing, or “buffer”, tank as a tempering device. The geo-thermal heat pump supplies warm water to the tank that will mix with cooler radiant return water to deliver the proper radiant supply water temperature. An aquastat (AQ1), either an immersion type or strap-on type, controls the tank temperature. When the aquastat senses the radiant supply water temperature has dropped below the desired level, it starts the heat pump circulator (P1), mixing warmer heat pump water into the tank until the desired temperature has been reached. Some geothermal manufacturers make buffer tanks and controls available for their equipment in radiant applications. Refer to the manufacturer’s installation and operation instructions for specifics.

What to look for:

- **Radiant loop circulator** — A circulator (P1) has been added on the radiant loop side of the buffer tank. This circulator is necessary to insure flow through the radiant panel.
- **Aquastat** — An aquastat (AQ1) is used to sense and control water temperature inside the buffer tank. The aquastat is set to the desired radiant supply water temperature, and is wired to a relay that controls the system circulator (P1).
- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.
- **Zoning options 1-5** — See **pages 115-119**.
- **Specific wiring schematic 9** — See **pages 157-158**.



Piping schematic level III control

- Non-condensing boiler
- Three-way modulating valve
- Single-temperature radiant floor heating

Where: All radiant and hydronic applications where full outdoor reset with a weather-responsive reset control is desirable

Why: This illustration shows a non-condensing boiler supplying water to a single radiant panel.

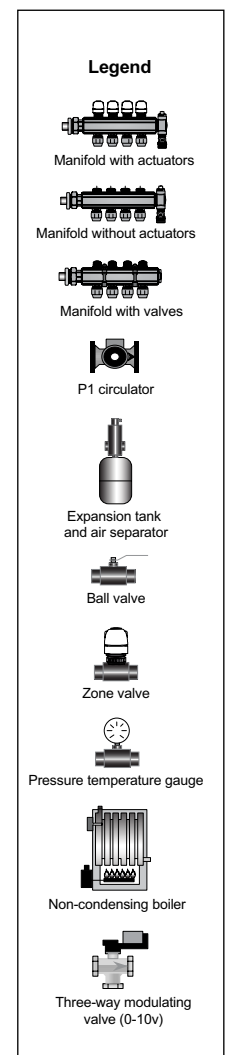
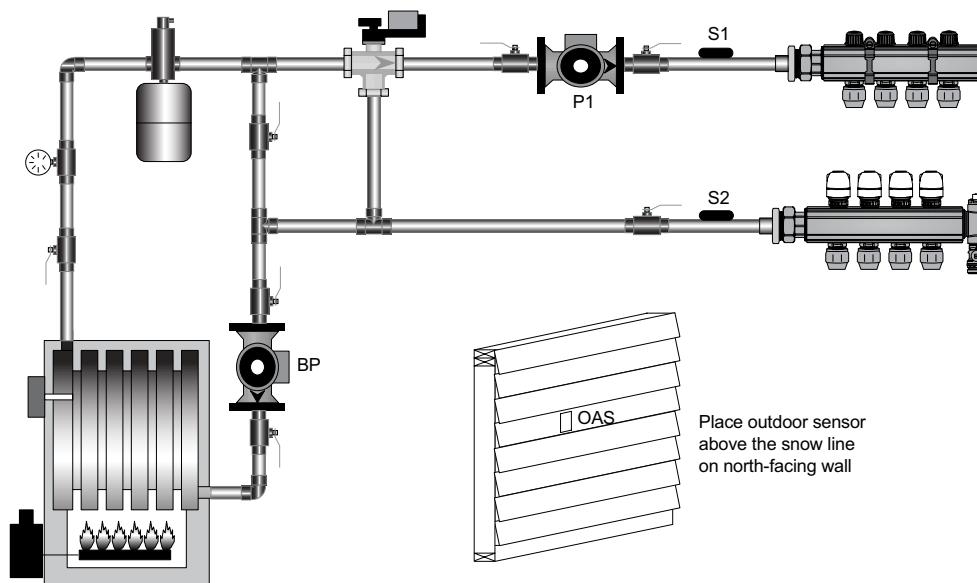
What to look for:

- **Bypass loop** — This piping schematic includes a “bypass” loop at the boiler. Non-condensing boilers require minimum return water temperatures of 140°F or higher (see boiler manufacturer’s installation instructions for specific requirements) to prevent flue gas condensation and potential internal corrosion. The bypass loop allows an amount of hot boiler water (depending on bypass valve position and Three-way Modulating Valve position) to

circulate through the boiler to maintain return water temperatures above the minimum, preventing the boiler’s flue gasses from condensing. Condensed flue gasses are highly corrosive and will shorten the boiler’s life and may void the boiler’s warranty. The bypass valve (V1) should never be left in the full open position during normal operation.

- **Bypass valve setting** — At system startup, position a suitable valve (V1) in the half-open position. If the radiant supply water does not reach the desired temperature, continue to close the valve in small increments until that temperature is reached.
- **Radiant loop circulator** — A circulator (P2) has been added on the radiant side of the Three-way Modulating Valve (MV1). This circulator is necessary to insure adequate flow through the radiant panel. Without this circulator, flow through the radiant panel would vary based on the position of the Three-way Modulating Valve.

- **Sensors** — Strap-on sensors (S1 and S2) are placed on the piping between the MIX port of the Three-way Modulating Valve and the radiant manifolds, on the boiler return piping (S3) near the boiler return inlet, and outdoors (OAS) on the north side of the structure, preferably out of direct sunlight.
- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.
- **Zoning options 1-5** — See pages 115-119.
- **Specific wiring schematic 13** — See pages 163-164.



Piping schematic level III control

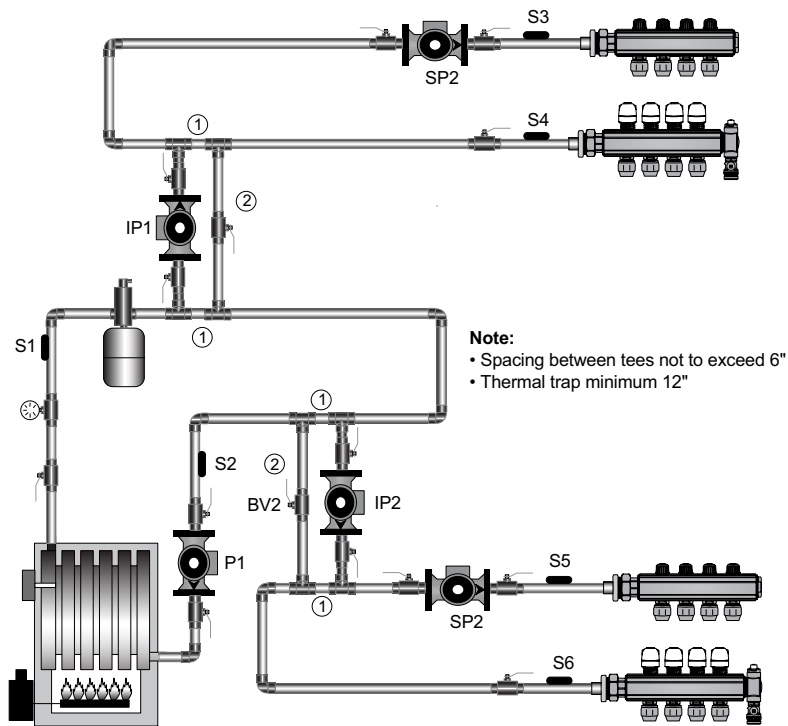
- Non-condensing boiler
- Multiple-temperature radiant floor heating and snow melting
- Variable-speed injection mixing

Where: All single-temperature radiant floor heating or other hydronic applications, plus integrated snow melting where full outdoor reset with a weather-responsive control is desirable, using primary/secondary piping.

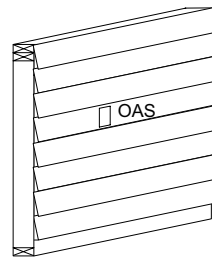
Why: This illustration shows a non-condensing boiler supplying water to a single radiant panel.

What to look for:

- **Bypass loop** — Even though a non-condensing boiler is used in this application, an additional bypass loop is not required. The primary loop will suffice as a bypass loop.
- **Primary loop circulator** — The primary circulator (BP) should be sized to meet the flow (gpm) demands of the entire heating system. The primary pump head should be sized to the pressure drop of the primary loop only, plus associated valves and fittings.
- **Radiant and snow melt loop circulators** — Circulators (SP1 and SP2) have been added to the secondary loops. These circulators are necessary to insure flow through the radiant panels. These are considered secondary circulators and should be sized to the flow (gpm) and head loss of the secondary loops only.
- **Injection circulators** — These circulators (IP1 and IP2) are used to inject hot water from the primary boiler loop into the secondary radiant loops. This variable-speed injection mixing will change the radiant and snow melt supply water temperatures based on outdoor weather conditions (see **Appendix I** for injection pump sizing).
- **Thermal traps** — Thermal traps are required in the injection piping to prevent thermal migration of hot water from the primary loop into the secondary loops, possibly affecting radiant supply water temperature control (see **Appendix I** for variable-speed injection mixing piping detail).
- **Balancing valves** — Balancing valves (BV1 and BV2) are required on the return legs of the injection piping to balance flow through the injection legs and to maximize circulator operation.
- **Tee spacing** — Spacing between supply and return tees off the boiler primary loop and off the secondary loops should not exceed 6 inches. This will eliminate pressure drop between the tees. As a result, flow will only occur in the secondary loop when the secondary circulator is in operation.
- **Sensors** — Strap-on sensors (S1 and S2) are placed on the boiler piping near the boiler, on the secondary radiant/snow melt loops (S3 through S6) between the secondary loop circulators and the radiant manifolds, and outdoors (OAS) on the north side of the structure, preferably out of direct sunlight.
- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.
- **Expansion tank** — An expansion tank and air separator are added to the snow melt side of the heat exchanger. This allows for proper air elimination and thermal expansion, as the snow melt loop is isolated from the boiler loop by the heat exchanger.
- **Zoning options 1-5** — See **pages 115-119**.
- **Specific wiring schematic 14** — See **pages 165-166**.












Note:
 • Spacing between tees not to exceed 6"
 • Thermal trap minimum 12"



Place outdoor sensor above the snow line on north-facing wall

Legend

-  Manifold with actuators
-  Manifold without actuators
-  Manifold with valves
-  P1 circulator
-  Expansion tank and air separator
-  Ball valve
-  Zone valve
-  Pressure temperature gauge
-  Non-condensing boiler

Piping schematic level III control

- Non-condensing boiler
- Three-way modulating valve
- Dual-temperature radiant floor heating
- High-temperature radiation
- Domestic hot water
- Primary/secondary piping

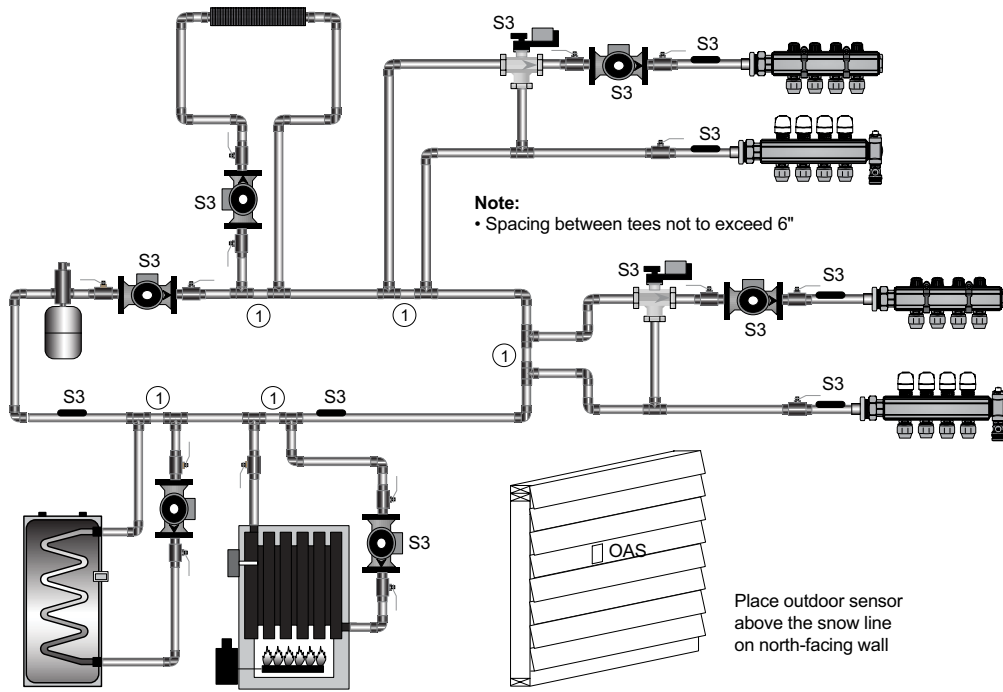
Where: All low-temperature radiant applications (< 160°F), with high-temperature radiation and indirect domestic hot water using primary/secondary piping

Why: This illustration shows a non-condensing boiler supplying water to multiple radiant panels requiring dramatically different supply water temperatures or having different installation methods (i.e. concrete vs. Joist Trak) plus high temperature radiation (base board, panel radiators, fan coils, etc.) and an indirect hot water tank using a single pipe primary/secondary boiler piping arrangement. The Three-way Modulating Valves (MV1 and MV2) are used to mix hot boiler water from the primary loop with cooler radiant return water from the secondary loop to achieve the selected radiant supply water temperature per the valve settings. The radiant panel loop(s) become the secondary piping. Hot boiler water off the primary boiler loop will feed the Secondary loops for both the high-temperature radiation and the domestic hot water tank. Primary/secondary boiler piping allows for simplified piping in multiple temperature applications, protects the boiler against low return water temperature, possible flue gas condensation and possible short cycling. In low-temperature (< 160°F) radiant heating applications using a non-condensing boiler, the boiler supply water temperature must be reduced to the proper radiant supply water temperature. A Three-way Modulating Valve allows the radiant supply water temperature to be mixed from 80°F to 160°F. The high-temperature radiation is supplied directly with boiler water.

What to look for:

- **Bypass loop** — Even though a non-condensing boiler is used in this application, an additional bypass loop is not required. The primary loop will suffice as the bypass loop and will protect the boiler.
- **Primary loop circulator** — The primary circulator (PP) should be sized to meet the flow (gpm) demands of the entire heating system. The primary pump head should be sized to the pressure drop of the primary loop only, plus associated valves and fittings.
- **Radiant loop circulator** — Circulators (SP1 and SP2) have been added on the radiant loop side of the Three-way Modulating Valves (MV1 and MV2). These circulators are necessary to insure flow through the radiant panels. Without these circulators, flow through each radiant panel would stop once the Three-way Modulating Valves sense the supply water has reached the desired temperatures, closing the hot (+) port of the valves. These are considered secondary circulators, and should be sized to the flow (gpm) and head loss of the secondary loops only.
- **Baseboard control** — In this schematic, the baseboard loop(s) is controlled with a circulator (ZP1), which will provide flow through the high-temperature radiation during a call for heat. Multiple high-temperature zones may be controlled by multiple circulators or zone valves.
- **Tee spacing** — Spacing between tees off the boiler Primary loop and off the secondary loop should not exceed 6 inches. This will eliminate pressure drop between the tees. As a result, flow will only occur in the secondary loop when the secondary circulator is in operation.
- **Sensors** — Strap-on sensors (S1 and S2) are placed on the boiler piping near the boiler, on the secondary radiant/snow melt loops (S3 through S6) between the secondary loop circulators and the radiant manifolds, and outdoors (OAS) on the north side of the structure, preferably out of direct sunlight.

- **Isolation valves** — Isolation valves are recommended at the supply and return radiant manifolds to facilitate purging and service. Isolation valves or flanges are recommended at all circulators for easy service.
- **Zoning options 1-5** — See pages 115-119.
- **Specific wiring schematic 15** — See pages 167-168.



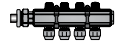
Legend



Manifold with actuators



Manifold without actuators



Manifold with valves



P1 circulator



Expansion tank and air separator



Ball valve



Zone valve



Pressure temperature gauge



Non-condensing boiler



Domestic hot water tank



Three-way modulating valve (0-10v)



Baseboard

