As a hydronic system designer in the radiant floor heating industry, it is always a plus to have a good understanding of fluid mechanics, heat transfer and electronic control in addition to other possible architectural matters. Knowledge, built upon a good understanding of design concepts that are common to all reliable systems, helps eliminate costly surprises on the job, regardless of what products are specified.
A good system designer cannot afford to ignore the following:

1. Always pump away from expansion tank; position the circulator downstream from the expansion tank.

The point where the expansion tank connects to the system is a point of no pressure change (PNPC).

- Air in an expansion tank has to follow the basic gas laws; a change in air pressure must be accompanied by a change in air volume. Pressure changes when air expands or compresses.

- A change in the air volume in the tank must be accompanied by a change of water volume within the tank. The only ways to change air volume are to add/remove water from the tank, or to expand/contract the water by heating/cooling it.

- A change of water volume within the tank must be accompanied by a change of water volume in the system. Water volume in the tank changes only when water is added to the system, drained out of the system, or expands and contracts with variations in temperature.

- Since water is incompressible, pump operation cannot increase or decrease system water volume. Simply running the pump does not change the water volume in the system.

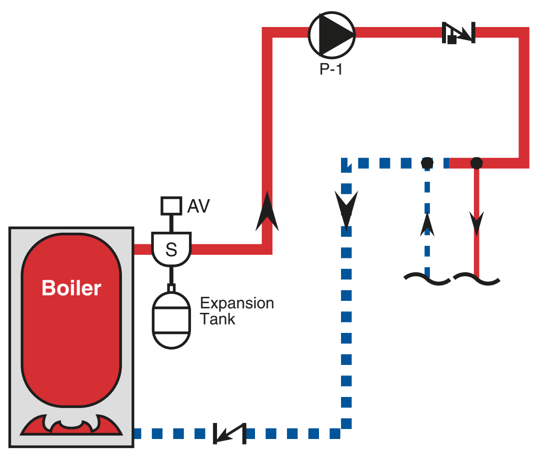
Pump operation cannot, therefore, change tank pressure. As expansion tank pressure doesn't change due to pump operation; the connection point of the expansion tank with the system must be a point of no pressure change (PNPC) regardless of pump operation.
In essence, pumping away ensures the differential pressure generated by the circulator is added to the static pressure in the system. This helps suppress the formation of any air bubbles that would be released from the water, makes the air vents work better, reduces the chance of cavitation on the circulator vane tips thus preventing a noisy circulator, and reduces the chance of any air problems in the system.

2. Do not allow any gravity flow to develop due to a temperature differential in the system.

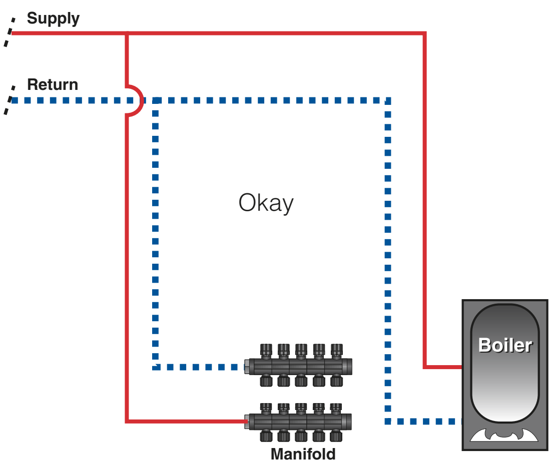
It is so easy, when focusing your attention on pump sizing and other issues, to forget about the effects of nature on a hydronic heating system. Remember: vertical flow is induced whenever there is a difference in temperature.

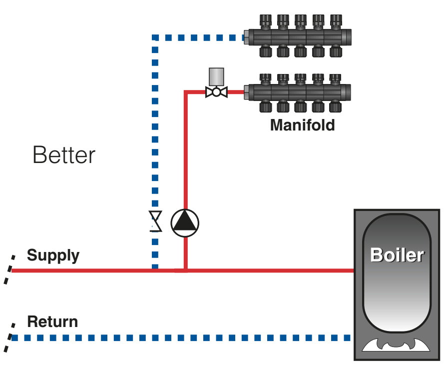
To suppress any gravity flow induced by temperature differential,

- Install a flow-check valve or spring-loaded check valve near the outlet of any heat source, such as boiler and heat exchanger. A swing check is not sufficient since it does not impede forward flow.

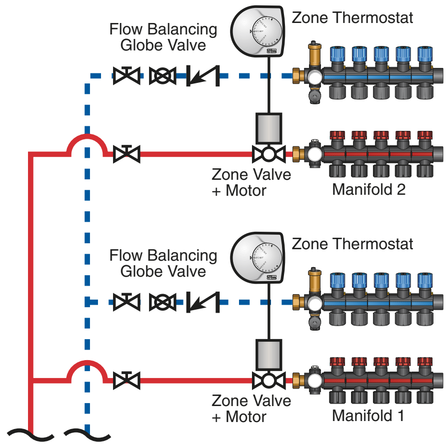


- On all primary-secondary circuits, the secondary circuits should have a flow-check valve or spring-load check valve on the supply, and one of the following options on the return:
  1) another flow-check valve,
  2) a swing check valve, or
  3) an under-slung thermal trap of no less than 12" (preferably 16" to 18") drop.





- Install zone valves on the supply side of zone circuits to block upward gravity flow. Install a swing check valve on the return side of each zone to block the return side in addition to a circuit setter or flow balancing valve. The check valve on the return is necessary to stop the buoyancy force from inducing a two-way flow in the return pipe.



3. Install controls to protect conventional boilers from flue gas condensation.

Hydronic heating systems often pair a conventional boiler with a high mass distribution system, such as concrete floor slabs. These operate at lower water temperatures, and should be provided with the means of protecting the boiler from sustained flue gas condensation.

Cool high thermal mass heat distribution components extract heat from the flowing warm water much faster than the boiler can possibly replace the heat loss. The rapid drop in temperature, of water returning to the boiler, can be so low that it is below the dew point of the exhaust gases. This can lead to flue gas condensation, which causes subsequent corrosion of the fireside surfaces, as well as the flue piping.

To protect a boiler from sustained flue gas condensation,

- Provide a controlling device that will sense the temperature of boiler return water, so the rate of heat flow from the boiler based on this temperature can be regulated. Boiler protection would be impossible without such temperature sensing.

Normally, the controller partially closes the mixing valve, or slows the speed of the injection pump, and thus prevents the heat emitting system from stripping heat out of the water faster than the boiler can produce it. Such boiler protection does not slow down the rate at which the high mass heat emitter warms up, because the boiler is firing constantly to generate all the heat it can during this warming up process

4. Install ΔP bypass valve on parallel zoned systems.

The pressure differential across the circulator on the system increases each time a zone valve closes. High differential pressures can lead to flow noises due to high flow velocity, overheated pumps, flow leakage in other closed zone valves, and faster erosion of piping materials in the system.
To protect the hydronic system,

- Provide a differential pressure bypass valve across the supply and return mains of the distribution system. This will limit the differential pressure across the mains for small to medium sized systems.

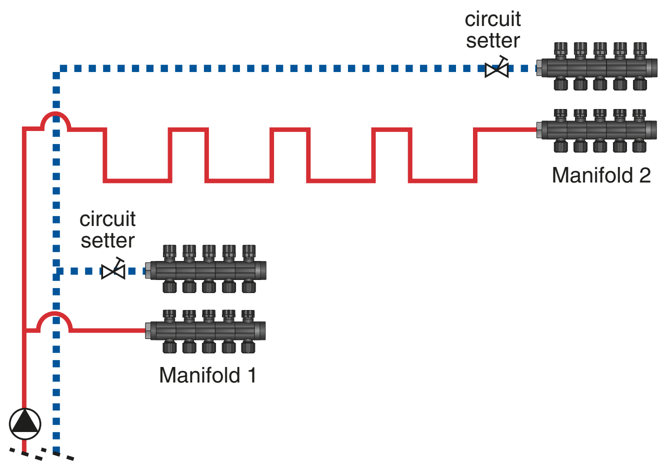
- Use a variable speed (VSD) circulator in place of the regular one for larger sized systems. In addition to regulating pressure, this approach saves pump energy consumption under partial load conditions. Remember that zone valve closing means a reduction in calling for heat requirements from the system.

5. Install a flow-balancing valve (circuit setter) on the returns of a parallel zoned systems.

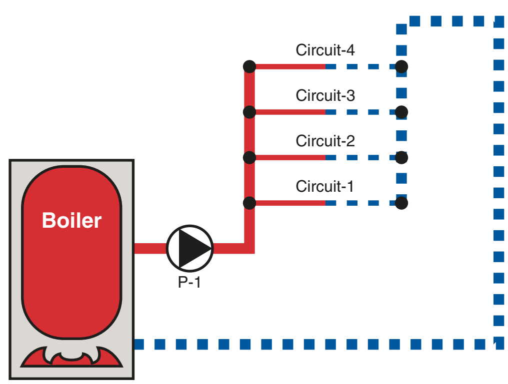
A difference in pressure is what causes water to flow in a hydronic system. If there is no pressure differential, the fluid simply can't move. In order to get water flowing, there must be a difference in pressure between the inlet and outlet of a heat emitter. And, everything being equal, the greater the pressure differential, the greater the flow rate is.

To solve a possible pressure imbalance problem,

- Provide circuit setter balancing valves on the return side of each circuit loop. By setting the circuit setters to the appropriate setting, the pressure drop in each circuit will be the same. With equal pressure drops in each circuit loop, there is no path of least resistance to flowing water, and so there will be adequate flow in each circuit, ensuring a heat output to meet the design.



- Provide a reverse-return piping system. With these types of systems, where the heating circuit loop is the same throughout, the reverse-return piping provides an equal pressure drop throughout the entire piping system to ensure adequate flow to all the circuit loops. Of course, there is a bit more piping involved, but the lack of service calls will make it well worth installing.



6. Install isolation valves (gate or ball type) upstream and downstream from a circulator, and a check valve downstream from it.

Without the isolation valves, the only way to service the pump is to drain part or all of the system. This is something that no one wants to do, especially if the system contains expensive glycol and other corrosive inhibitors. Don't forget, glycol cannot be allowed down a municipal drain. The check valve is to prevent any unexpected back flow from the system.

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