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Geo-Flo HCT Buffer Tank Installation, Operating, and Maintenance Manual



Geo-Flo Corporation
905 Williams Park Drive
Bedford, Indiana 47421, U.S.A.

Main Number: 812-275-8513
Toll Free: 800-784-8069
Fax: 888-477-8829

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NOTES:

Geo-Flo Corporation is continually working to improve its products. As a result, the design and specifications of products in this catalog may change without notice and may not be as described herein. For the most up-to-date information, please visit our website, or contact our customer service department. Statements and other information contained in this document are not express warranties and do not form the basis of any bargain between the parties, but are merely Geo-Flo's opinion or commendation of its products.

Overview

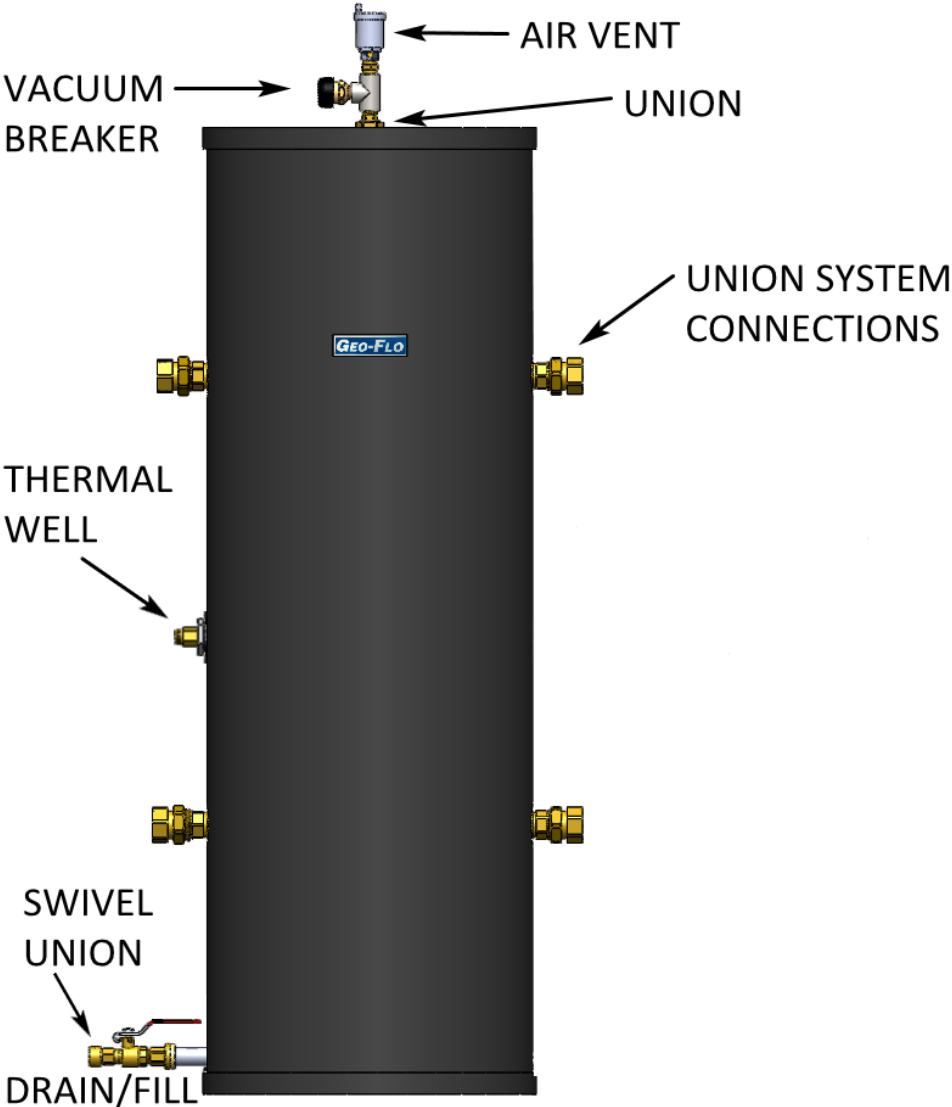
A buffer tank is used in heat pump and boiler hydronic systems to prevent equipment short-cycling, reduced system efficiency, and reduced equipment life due to a mismatch between the equipment output (BTUs) when operating and the system load (BTUs) at any point in time. A buffer tank “de-couples” the heat pump flow requirements from the hydronic system flow requirements.

A geothermal water-to-water heat pump almost always needs a buffer tank to allow for heat pump flow rates that are different from hydronic system flow rates. For example, a 3 ton water-to-water heat pump typically requires about 9 GPM (34 l/min) for the ground loop (“source” heat exchanger) and for the hydronic side (“load” heat exchanger). Dropping below 7 GPM (26 l/min) could cause refrigeration circuit problems. However, the hydronic heating or cooling system connected to the load heat exchanger may require much less flow, especially multi-zone systems like radiant floor heating, where a signal zone using 1/2” (13mm) PEX piping may require only 1.5 GPM (6 l/min).

Modulating-condensing boilers can also benefit from a buffer tank to reduce short cycling. For example, when a mod-con has a 150,000 BTU/hour (44 kW) capacity with a 5:1 turn down ratio, it could be firing at 30,000 BTU/hour (9 kW) to satisfy a load of just 10,000 BTU/hour (3 kW) when the heat loss is lower at warmer outdoor temperatures (or when only one radiant zone is calling), causing the boiler to short cycle. The two worst times in the combustion cycle are startup and shutdown, when the flue gas is at its dirtiest. The boiler will burn more fuel and create wear and tear on all components, shortening the life expectancy of the heat exchanger when installed without a buffer tank.

The HCT buffer tanks are of composite construction consisting of a fiberglass reinforced polypropylene tank that is lightweight and will not corrode. The tank is insulated with closed-cell foam for a high R-value, and finished with a durable polypropylene shell that resists scratches and dents, and will not rust. The HCT buffer tanks ship standard with union connections installed into the tank, an auto air vent and vacuum breaker assembly, a drain valve with garden hose connection, and a thermal well (except for HCT-R2).

Figure 1. HCT Buffer tank components.



Models

Model PN	Volume Gal	Thermal Well	Weight Lbs
HCT-R2-000-NM	22	NO	50
HCT-R4-000-NM	40	YES	65
HCT-R5-000-NM	55	YES	85
HCT-R8-000-NM	80	YES	124
HCT-R9-000-NM	119	YES	145

Technical Specifications

Tank: Fiberglass reinforced Polypropylene

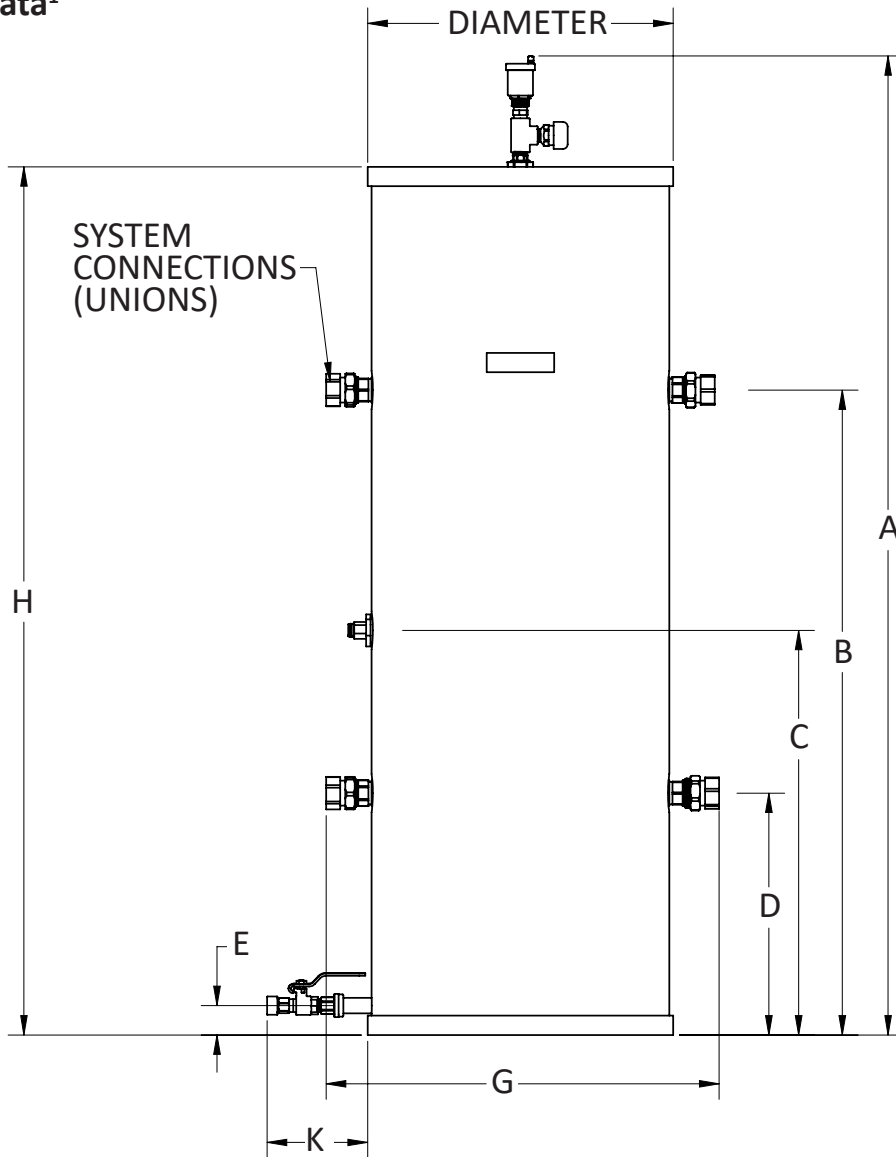
Maximum Working Pressure: 100 PSI

Shell: Polypropylene

Maximum Working Temperature: 180°F

R-Value: 15

Dimensional Data¹



Model PN	Diameter	Height A	Port Height				G	K	System Connections
			B	C	D	E			
HCT-R2-000-NM	20"	42-1/2"	24"	N/A	14"	1-7/8"	26"	7"	1-1/4"
HCT-R4-000-NM	20"	63-1/2"	41-5/8"	26-1/8"	15-5/8"	1-7/8"	26"		1-1/4"
HCT-R5-000-NM	20"	78-5/8"	59-1/8"	33-1/4"	15-5/8"	1-7/8"	26"		1-1/4"
HCT-R8-000-NM	29"	58-7/8"	38-1/8"	26-5/8"	17-1/8"	2-5/8"	35"		2"
HCT-R9-000-NM	29"	81-1/2"	57-3/8"	33-7/8"	18-3/8"	2-5/8"	35"		2"

1. Dimensional data provided for informational purposes and is rounded to nearest 1/8"

Buffer Tank Sizing

The Geo-Flo Hydro-Connect buffer tank (HCT) is available in five sizes to accommodate a variety of heat pump and boiler/chiller applications. Table 1 below provides general sizing recommendations for heat pump applications. However, it is good design practice to verify the tank is properly sized for each application. Geo-Flo has an online buffer tank sizing Calculator available at www.geo-flo.com which is based on John Siegenthaler’s Modern Hydronics, and is explained below. Note that a larger tank is not harmful to a system, but too small of tank could lead to unit short-cycling and equipment issues as discussed previously.

Heat Pump nominal capacity (Tons)	2 Ton		3 Ton		4 Ton		5 Ton		6 Ton	
	Single Stage	Two Stage	Single Stage	Two Stage	Single Stage	Two Stage	Single Stage	Two Stage	Single Stage	Two Stage
Hot Water Only	HCT-R4	HCT-R2	HCT-R4	HCT-R4	HCT-R5	HCT-R4	HCT-R8	HCT-R4	HCT-R8	HCT-R5
Chilled Water	HCT-R4	HCT-R4	HCT-R5	HCT-R4	HCT-R8	HCT-R5	HCT-R9	HCT-R5	HCT-R9	HCT-R8

Heat Pump nominal capacity (Tons)	7 Ton		8 Ton		10 Ton		15 Ton		20 Ton	
	Single Stage	Two Stage	Single Stage	Two Stage	Single Stage	Two Stage	Single Stage	Two Stage	Single Stage	Two Stage
Hot Water Only	HCT-R9	HCT-R5	HCT-R9	HCT-R8	HCT-R9	HCT-R8	See Note 2	HCT-R9	See Note 2	See Note 2
Chilled Water	HCT-R9	HCT-R8	See Note 2	HCT-R9	See Note 2	HCT-R9	See Note 2	See Note 2	See Note 2	See Note 2

Table 1. Recommended tank sizing for heat pumps.

1. Tank sizing is based on the following assumptions: minimum heat pump run time is 10 minutes , heat of extraction ratio is 50% and heat of rejection rate is 45%, and delta-T= 10 F in heating and 8 F in cooling. Other assumptions may yield different results, and are not necessarily incorrect.
2. Tank size is larger than available from Geo-Flo in this line of HCT tanks. Use two tanks, or provide a larger tank from another line of tanks. Contact Geo-Flo for more information.

Buffer Tank Sizing Calculator
Version 1.1

Instructions: Use this calculator to determine the volume required for a **Geo-Flo Hydro-Connect** buffer tank used with a water-to-water or combination heat pump. Enter the heat pump and system information below.

IMPORTANT: Geo-Flo recommends Chrome or Firefox browsers. This Calculator may not operate properly with Safari or Edge, and in some cases with Internet Explorer.

Buffer Tank Sizing for Hot Water (Heating):

1 Minimum heat pump run time (typically 5 minutes) minutes
(heat pump manufacturer guidelines supercede this recommendation)

2 Heat pump maximum heating capacity at the lowest stage* Btu/hr
(typically at 50F EST [Entering Source Temp] and 100F ELT [Entering Load Temp])
*Example: Enter the heating capacity at part load for a two-stage heat pump.
Maximum flow through the tank should be limited to 40 to 45 U.S. GPM.
NOTE: Maximum flow to the tank of 45 GPM based on limiting flow velocity noise through fluid connections. Proper plumbing practices should be implemented to limit velocity-dependent noise.

3 Rate of heat extraction from buffer tank at maximum heat pump capacity %
(typically 50%)
Example: 90,000 Btu/hr heat loss at 0F outside (70F inside). If EST is 50F, the outdoor air temperature is probably closer to 35F. The heat loss at 35F outside is 45,000 Btu/hr, which is 1/2 of the design heat loss.

4 ΔT for heat pump heating control (typically 10 deg F) deg F
(the difference between the heat pump on temperature and off temperature)
Example: The control tank setpoint is 105F. Therefore, it brings the heat pump on at 100F tank temperature (5F below set point), and turns off the heat pump when the tank temperature is 110F (5F above set point), creating a 10F ΔT.
NOTE: Use the total ΔT (some controllers have a 1st stage and 2nd stage ΔT).
For example, if 1st stage has a 5F ΔT and 2nd stage has a 5F ΔT, enter 10F.

Minimum buffer tank sizing for heating = 12 U.S. gallons

Figure 2. Example buffer tank sizing for heating with online Calculator

Buffer tank volume is based upon four factors, namely:

1. Minimum “on” time (t): Most heat pump controls have a built-in five minute anti-short cycle timer to keep the compressor from restarting more often than every five minutes. However, most do not have a min. run time setting. For practical purposes, assuming a 10 minute minimum run time for tank sizing is reasonable. This will prevent a situation where the system is calling for heating or cooling, but the heat pump will not start due to the anti-short cycle timer. Using a lower minimum run time such as 5 minutes may result in a smaller tank and may work well in a specific system design, but the heat pump manufacturer’s guidelines for minimum run time should be verified before using a lower minimum run time.

2. Output capacity of heat pump/boiler in heating or heat pump/chiller in cooling (Q) -- input to the tank:

Buffer tank selection for heating is based upon the heat pump capacity at the maximum entering source water temperature (EST) and the minimum entering load water temperature (ELT), the point at which the water-to-water unit has the highest heating capacity, usually 50-70°F EST and 90-100°F ELT. In cooling, the tank is sized at the minimum EST and the maximum ELT, the point at which the water-to-water unit has the highest cooling capacity, usually 50-70°F EST and 50-60°F ELT. Select the tank based upon the larger of the calculations (heating or cooling). Using the highest heat pump capacity for buffer tank sizing will ensure that the heat pump will not short cycle when the heat loss/heat gain is less than design conditions. At design conditions buffer tank sizing is much less critical, as the heat pump will require longer operation time to maintain tank temperature.

INSTALLATION/DESIGN TIP

When determining the heat pump capacity, use the minimum heat pump stage. For example, a two-stage heat pump needs a smaller buffer tank than a single speed heat pump of the same capacity. Likewise, two 5 ton heat pumps connected to a single buffer tank requires sizing for 5 tons of capacity, whereas a single speed 10 ton heat pump must be sized for 10 tons of capacity. Although a larger tank will not adversely affect the system, it may add unnecessary cost.

3. The heat removed from (heating mode) or rejected to (cooling mode) the tank (q): The heat removed/rejected should be considered when the heat pump is at its maximum capacity, as this will be the point where short cycling could most likely occur. As stated in item #2, above, the heat pump maximum capacity is at the mildest ground loop temperatures, which generally occur in the Spring or Fall when the building load is lower than design conditions. A value of 50% is typical for heating at this condition. However, some buildings may be slightly different, depending upon infiltration, passive/active design, solar gain, and other construction factors. In cooling, 40% to 50% is typical, and is also dependent upon construction factors.

4. Temperature difference (ΔT): The temperature difference (in °F) is the difference between the tank temperature when the hot water/chilled water source (e.g. water-to-water heat pump) is turned on and when it is turned off. A value of 10 °F is typical for most control systems. A temperature difference setting that is too low can require a much larger tank and/or potentially cause the heat pump to short cycle. However, a temperature difference that is too high could create comfort issues. **NOTE: Controller set point must be considered as well as temperature difference to avoid a condition that could result in water temperature returning to the heat pump that is hotter than allowed by the heat pump manufacturer.**

BUFFER TANK SIZING FORMULA:

$$V = \frac{t \times (Q-q)}{(500 \times \Delta T)}$$

where:

- V = volume (U.S. gallons)
 t = minimum "on" cycle (minutes)
 Q = output of heat source or chilled water source (Btu/hr)
 q = rate of Heat of Extraction or Heat of Rejection (Btu/hr)
 ΔT = temperature difference from when heat/chilled water source is turned on to when turned off (deg. F)

Installation

NOTE: The HCT composite buffer tank must be installed following all local and national pumping codes.



WARNING: Fluid temperature should not exceed 180 F. Pressure should not exceed 100 PSI. A properly sized pressure relief valve must be installed (not included).



WARNING: The HCT vacuum breaker must be installed on the tank, and must remain on the tank at all times, to prevent sub-atmospheric pressure (i.e. a vacuum) inside the tank. The tank's construction allows for a 100 PSI maximum pressure, but the tank will implode under vacuum.

1. Position the tank on a level surface in an area not subject to freezing.

Note: When installed in an area that may be damaged from leaks, extreme caution dictates installing the tank in a drain pan plumbed to a sump well or other safe location.



WARNING: The fittings attached to the tank have been factory torqued to 40 +/-10 ft-Lbs, and uses a Loctite anaerobic thread sealant. Torque on these fittings should not exceed 50 ft-lbs. When assembling union connections to these tank connections, be sure that the torque transmitted to the tank fittings does not exceed 50 ft-lbs. When in doubt, use a back-up wrench on the tank fittings to prevent over-tightening

2. Assemble air vent and vacuum breaker assembly (shipped uninstalled to prevent damage) to the top of the tank. The union connection seal/O-ring is zip-tied to the assembly, and should be removed and installed (Figure 3). Be sure the O-ring gland and mating face are clean. Do not apply thread sealant to the threads of the union fitting; it is not useful or required since this connection is a face-seal. Only a small amount of torque needs to be applied to the union nut to squeeze the O-ring and seal the connection. The union nut should be hand-tightened plus approximately ¼ turn.

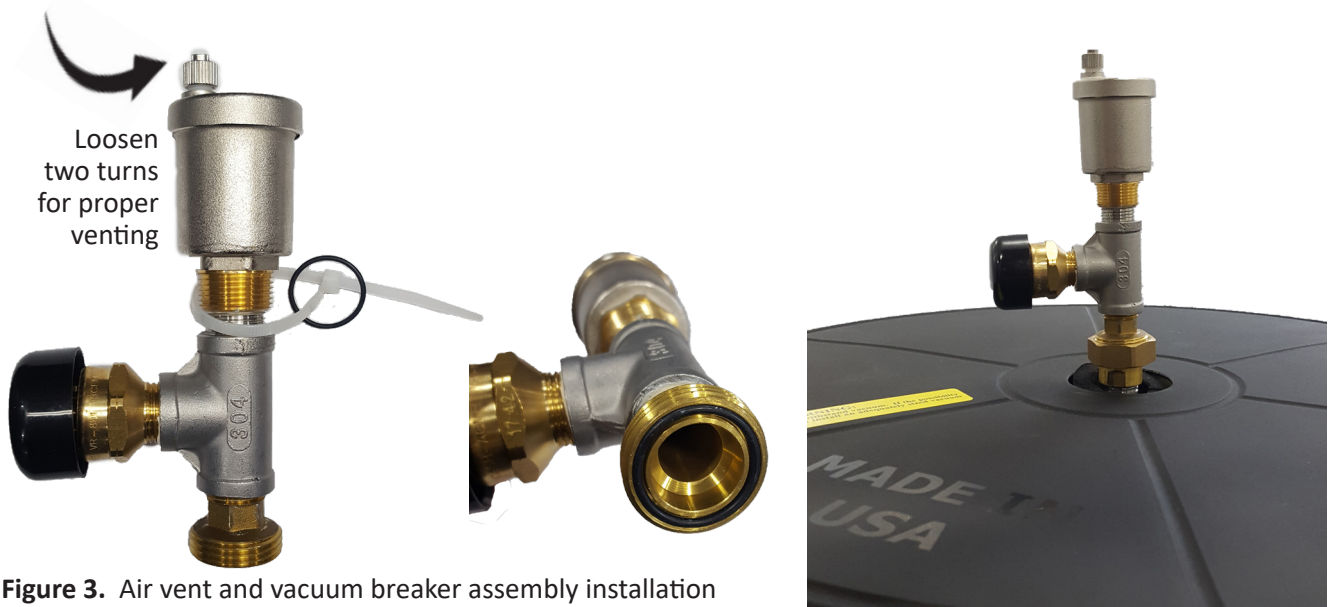


Figure 3. Air vent and vacuum breaker assembly installation

3. Ensure that the air vent assembly is open (vent should ship in the open position). The vent must remain open during operation.

4. Assemble drain valve assembly (shipped separately to prevent damage) to the ½” nipple (Figure 4). Do not apply thread sealant to the threads of the pipe nipple; it is not useful or required since this connection is a face-seal. Only a small amount of torque needs to be applied to the swivel union nut to squeeze the gasket and seal the connection. The swivel union nut should be hand-tightened plus approximately ¼ turn.



Figure 4. Drain valve assembly installation

WARNING: The fittings attached to the tank have been factory torqued to 40 +/-10 ft-Lbs, and uses a Loctite anaerobic thread sealant. Torque on these fittings should not exceed 50 ft-lbs.



When assembling union connections to these tank connections, be sure that the torque transmitted to the tank fittings does not exceed 50 ft-lbs. When in doubt, use a back-up wrench on the tank fittings to prevent over-tightening

5. Complete the plumbing to the heat pump and circuit headers to the remaining tank connections. Figures 5 and 6 below show typical plumbing for zoning with circulators or zone valves. See Appendix A for plumbing material considerations. Note that the four system connections utilize union fittings with O-ring face seals. All four O-rings are zip-tied to the upper right connection (see Figure 5.). These O-ring must be installed to seal the union connections (Figure 6). Be sure that the O-ring gland and mating face are clean. Only a small amount of torque needs to be applied to the union nut to squeeze the O-ring and seal the connection. The union nut should be hand-tightened plus approximately ¼ turn. When torquing these union nuts, care must be taken to not transmit the torque to the tank fitting (see Warning on previous page).



Figure 5. O-rings zip-tied to upper right connection on tank



Figure 6. O-ring installed on union fitting

NOTE: In many cases, the header, circulators, and controls will be mounted to a wall behind the tank. It may be useful to use an elbow as show in Figure 7 to direct the plumbing toward the wall. A 1-1/4" or 2" MPT X FPT elbow with 1/4" FPT port is a useful way to achieve this while also allowing the installation of a PT plug, or temperature gauge. These elbows are not included but can be purchased separately.

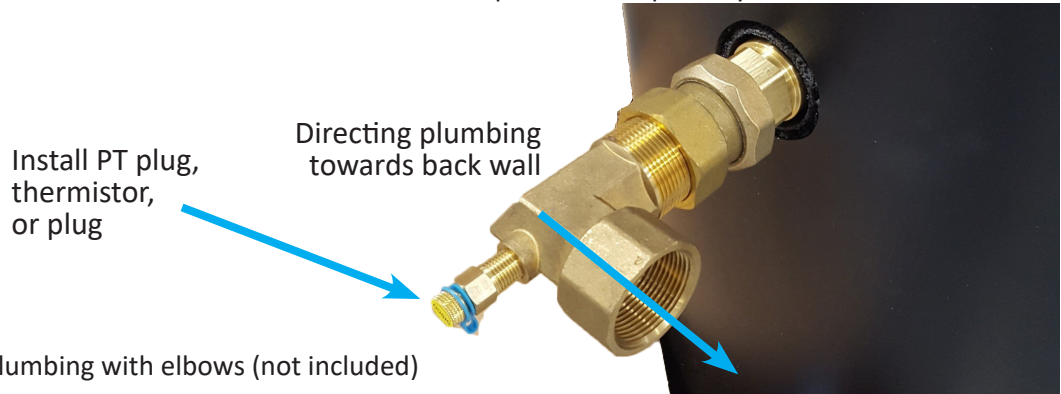


Figure 7. Redirected plumbing with elbows (not included)

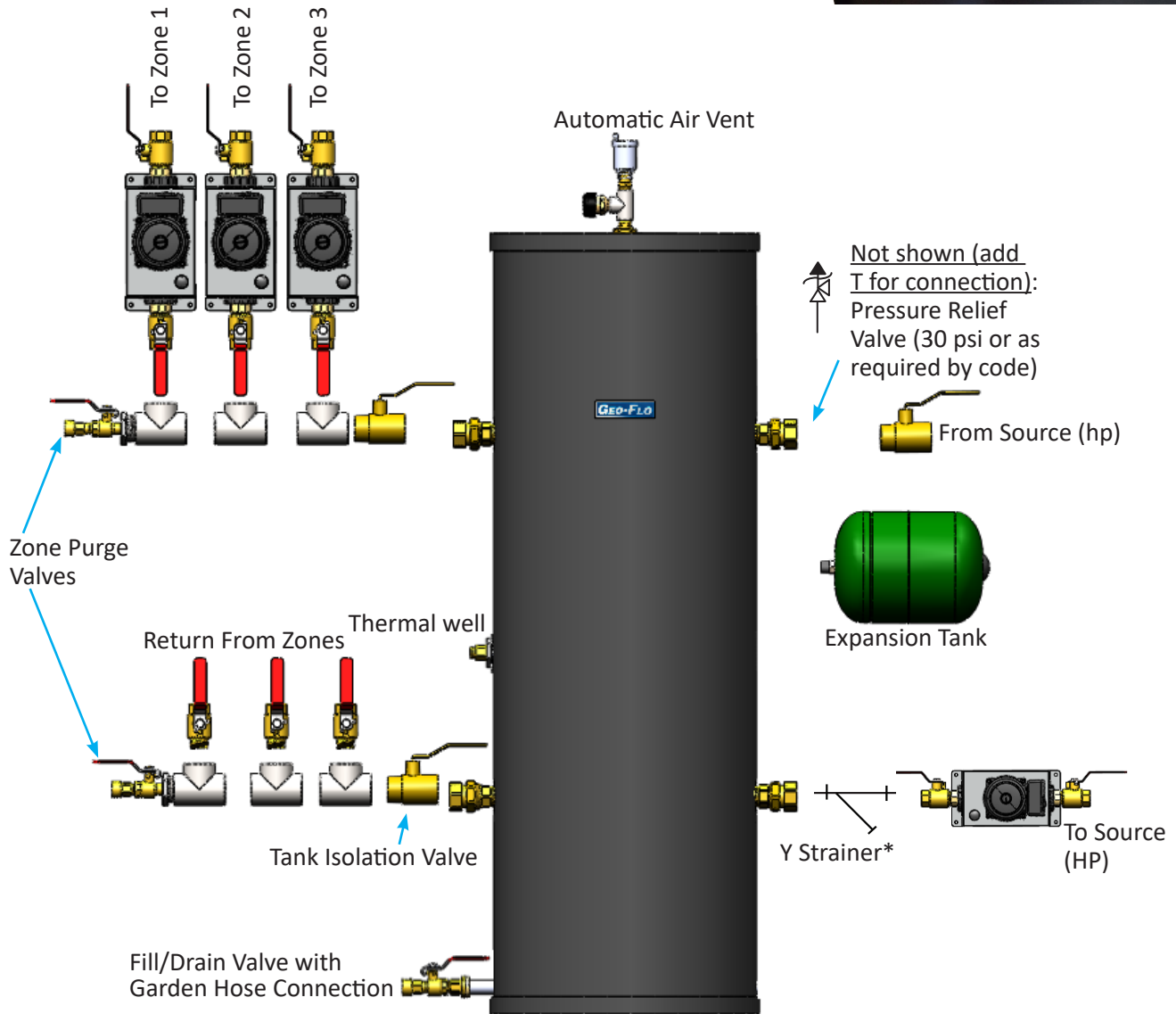


Figure 8. Typical plumbing arrangement when zoning with pumps

*Consult heat pump manufacturer literature for requirements if applicable.

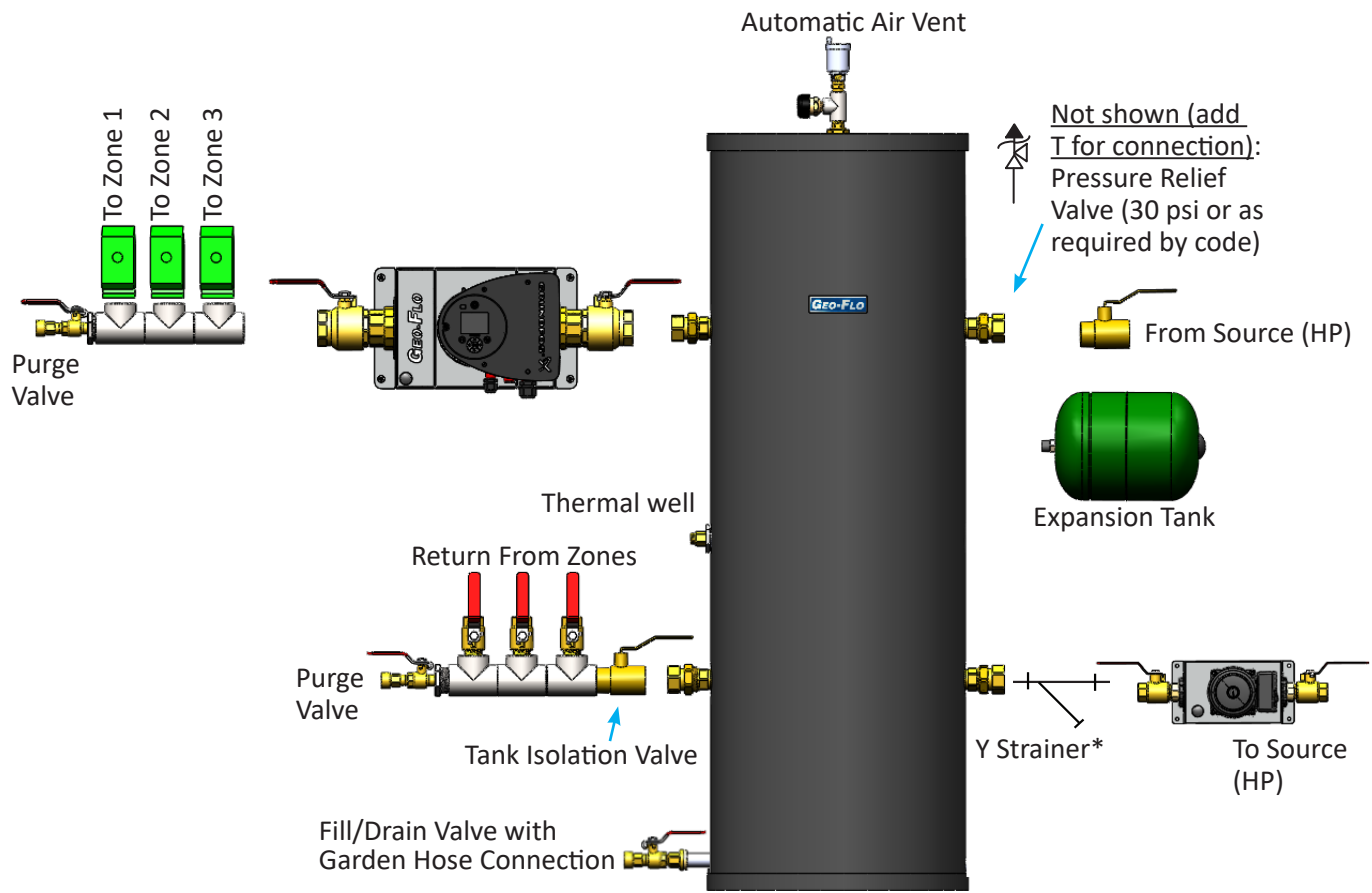


Figure 9. Typical plumbing arrangement when zoning with valves

6. Fill flush and fill the system using appropriate equipment and filtering. The tank should be bypassed during high velocity/pressure flushing. The tank may be filled by connecting the water source to the garden hose fitting at the bottom of the tank. Air will exit through the air vent at the top of the tank as the tank fills.

7. Install sensor/thermistor or aquastat into the thermal well. Thermal paste may be used to improve contact with the well. The sensor may be secured with a zip-tie, or field supplied thermowell clamp.

NOTE: The HCT-R2 (20 gallon tank) does not have a thermal well due to its size. If a sensor/ thermistor is required for this tank, you may install a 1/4" MPT immersion style thermistor to a fitting that includes a 1/4" FPT port. See figure 7 for example.

8. Insulate all exposed piping including the thermal well entry point. This is particularly important if the buffer tank will be used with chilled water to prevent condensation.

*Consult heat pump manufacturer literature for requirements if applicable.

Maintenance

Regular maintenance is not required on the buffer tank itself. In some cases, fluid may need to be removed or added to the system. Fluid may be added or removed from the drain/fill valve at the base of the tank. When removing fluid, caution must be taken to prevent vacuum in the tank. The vacuum breaker in the top must be present and functioning to prevent a vacuum in the tank and tank collapse.

Appendix A: Plumbing Materials

Plumbing Materials

The following factors should be considered when selecting material for piping:

- Code requirements
- Working fluid in the pipe
- Pressure and temperature of the fluid
- External environment of the pipe
- Installation cost

Table 2 lists materials used for heating and air-conditioning piping. The pressure and temperature rating of each component selected must be considered; the lowest rating establishes the operating limits of the system.

Pipe Material	Weight	Joint Type	Fitting Material	Max. Temp., ¹ °F	Max. System Press. at Temp., ^{1,2} psig
Steel	Standard	Thread	Cast iron	250	125
Copper, hard	Type L	Braze or silver solder ³	Wrought copper	250	200
PVC	SCH 40/80	Solvent	PVC	75	166/243 ⁴
CPVC	SCH 40/80	Solvent	CPVC	150	275/400 ⁵
HDPE	SDR 11	Fusion	HDPE	140	160/80 ⁶
PEX	CTS	Mechanical ⁷	Varies ⁷	210	160/100/80 ⁸

Table 2: Application of Pipe, Fittings, and Valves for Heating and Air Conditioning for piping 2" and Smaller

- 1 Data for steel, copper, PVC, and CPVC from *2012 ASHRAE Handbook—HVAC Systems and Equipment*; data for HDPE from PPI (Plastics Pipe Institute) *Handbook of Polyethylene Piping*, 2nd Edition; data for PEX piping from PPI *Design Guide, Residential PEX Water Supply Plumbing Systems*, 2nd Edition.
- 2 Maximum allowable working pressures have been derated in this table. Higher system pressures can be used for lower temperatures and smaller pipe sizes. Pipe, fittings, joints, and valves must all be considered.
- 3 Lead- and antimony-based solders should not be used for potable-water systems. Brazing and silver solders should be used.
- 4 166 psig for 2" SCH 40 and 243 psig for 2" SCH 80 (higher for smaller sizes) at 73.4°F
- 5 275 psig for 2" SCH 40 and 400 psig for 2" SCH 80 (higher for smaller sizes) at 73.4°F. At 140°F, the strength is derated to approximately 20% of the strength at 73.4°F.
- 6 160 psig at 73.4°F; 80 psig at 140°F
- 7 All PEX pipe is joined with mechanical fittings; type varies by piping manufacturer. Cold expansion fittings with PEX reinforced rings, cold expansion fittings with metal compression sleeves, metal or plastic insert fittings, and push type fittings are common types of mechanical joining methods.
- 8 160 psig at 73.4°F; 100 psig at 180°F; 80 psig at 200°F

Manual Updates Table

Date	Description of Changes	Pages
29AUG2019	First published	All



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