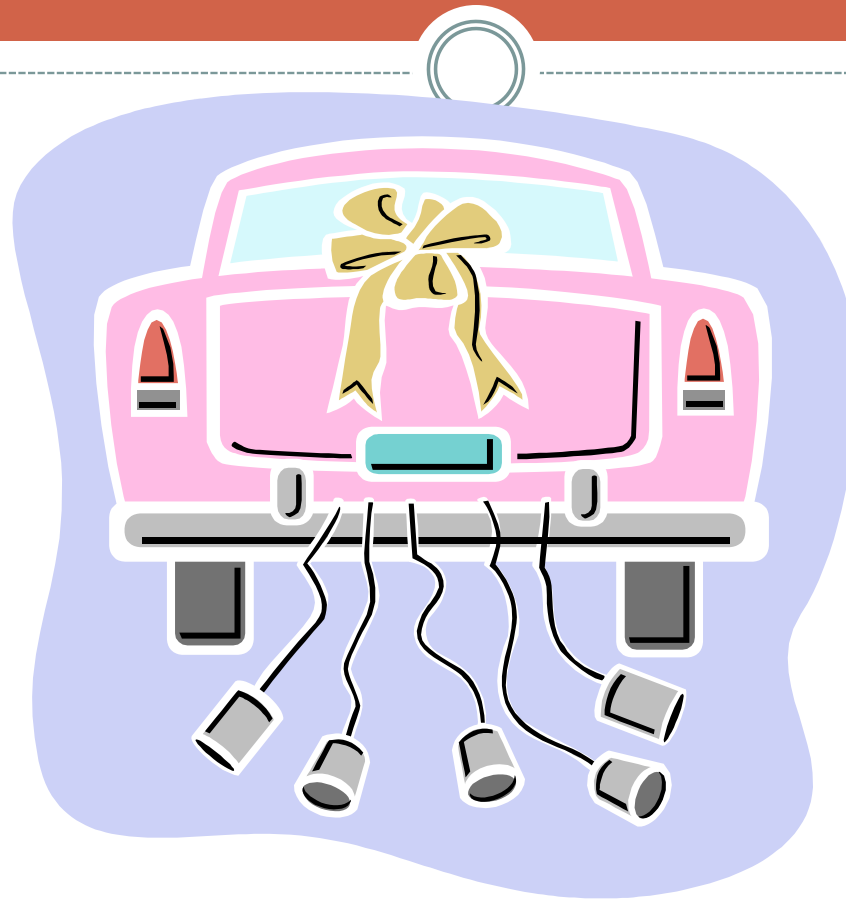


MOVING HEAT WITH WATER

The perfect marriage



UNLESS YOU DO IT WRONG



We're moving BTU's here.

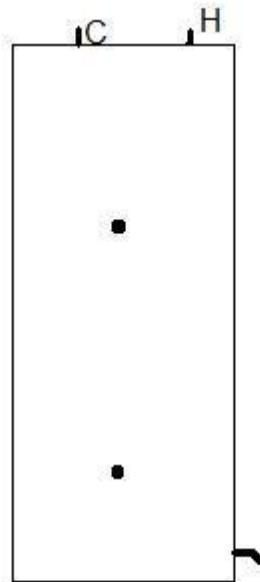
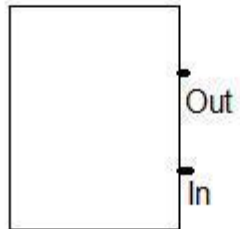
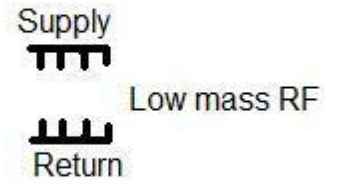
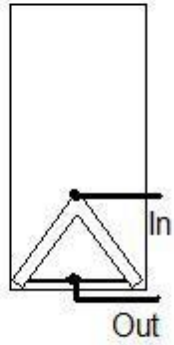


- So what is a BTU?
- A BTU is the amount of heat to move one pound of water 1 degree F.
- About the amount of heat in a match.

There are lots of ways to do this.....



- Not all of them are wrong.
- Plbg Diagrams do not show all parts, for the reason of clarity.
- Components should be added to isolate for future service.
- Be aware of the potential for thermo siphon.
- Cold lines will need to be insulated, to eliminate condensation.
- All Hydronic lines should be copper or Oxygen Barrier Pex Tubing, CAUTION watch the size.



What are we trying to do?



- Design for the highest COP: Get the coolest water to the heat pump (in heating mode) which will maximize COP.
- Thoughtful plumbing will help us accomplish that.

Buffer Tank



- This is a critical part of the heat pump system, because we need to move the heat away from the heat pump.
- Depending on the system design, we recommend between 6 and 10 gallon capacity per ton.
- There can be designs where a primary loop, if big enough, can act as the buffer tank.
- If there is only one zone and it matches the heat pump, no tank is required.

Supply



Low mass RF



Return

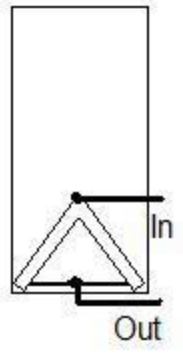
Supply



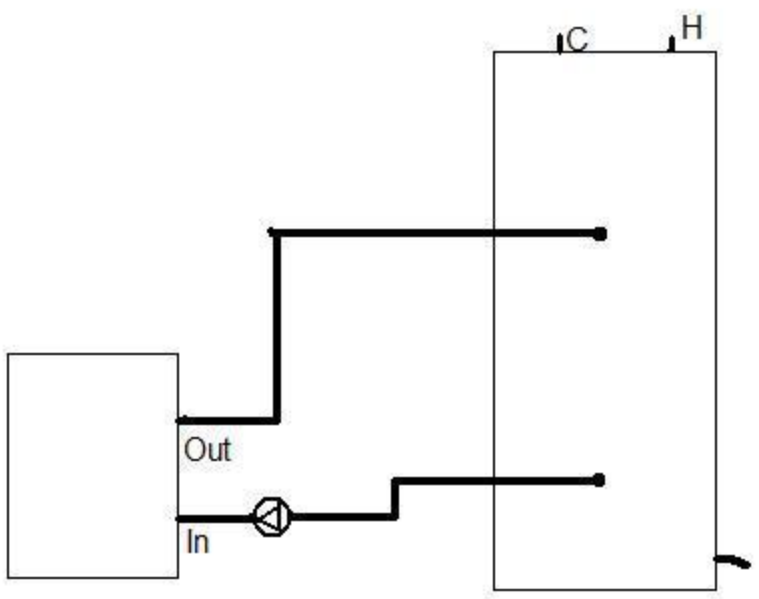
High Mass RF



Return



\downarrow Z



Hose Kits



- Hose Kits are available for the Hydronic side of the heat pump.
- Isolates the heat pump, reduces resistance and has P/T ports for measuring temperature and pressure differential.
- 1" hose for the 3-5 ton units.
- 1 1/4" hose for the 6-10 ton units.

Hydronic Installation Concerns Cont.



- Size piping and pumps to the expected flows and pressure drops
- Flow = BTU'S.
- Limit number of fittings, to limit pressure drop.
- 1" piping on 3-5 ton units.
- 1 1/4" on 6-10 ton units.
- 40' or less piping between Tank & Heat Pump

Connecting the Fan Coil



- We need the hottest water in the heating mode and the coldest water in the cooling mode to go to the fan coil
- This will maximize comfort in both modes.
- More importantly, it will maximize dehumidification in cooling mode.

Supply



Low mass RF



Return

Supply

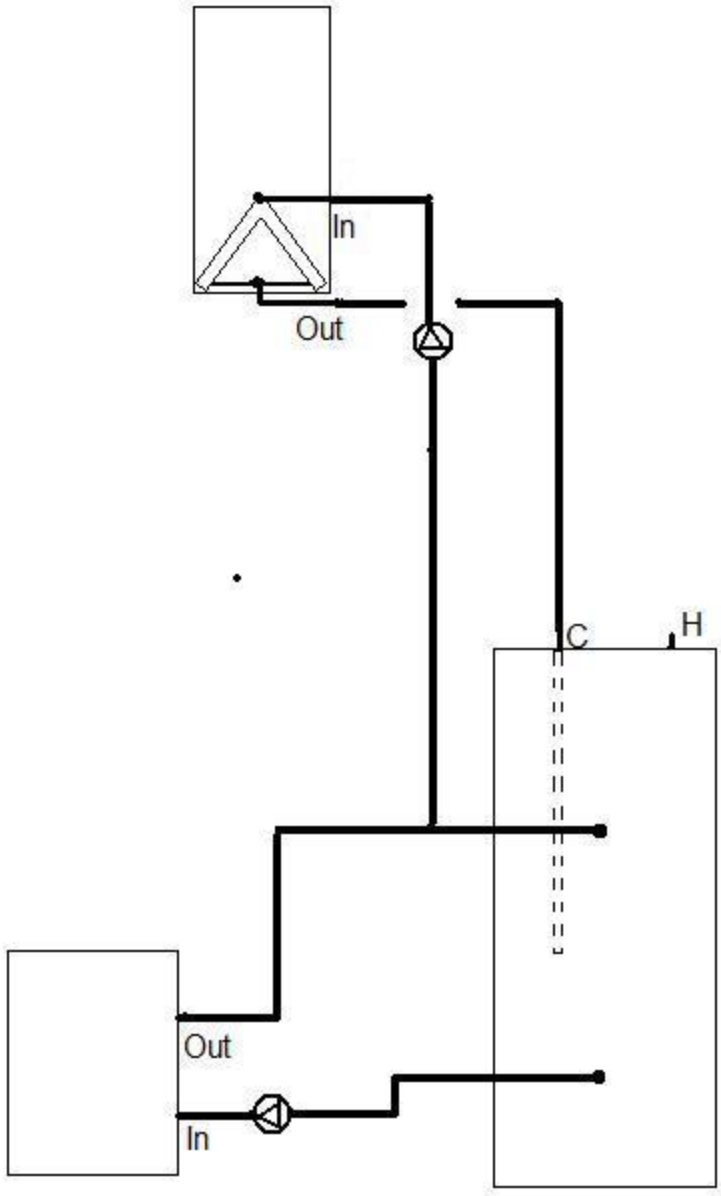


High Mass RF



Return

↑Σ



The Formula



- $\text{BTU/h} = \text{GPM} \times \text{Delta T} \times 500$
- Why the 500? It converts GPM to pounds of water per hour.
- Where $500 = 8.33 \text{ lbs per gallon} \times 60 \text{ minutes/hour}$
- Example: $12 \text{ GPM} \times 10 \text{ degrees Delta T} \times 500 = 60,000 \text{ BTU/h}$

Applying the formula



- If we had a hydronic heat pump that produces 50,000 BTU/h and we seek a 10° ΔT across the heat pump, what would our flow rate need to be?
- $50,000 = \text{GPM} \times \Delta T \times 500$
- $\text{GPM} = 50,000 / (\Delta T \times 500)$
- $\text{GPM} = 10$
- What about a 5° ΔT ?

Connect High Mass Radiant Floor

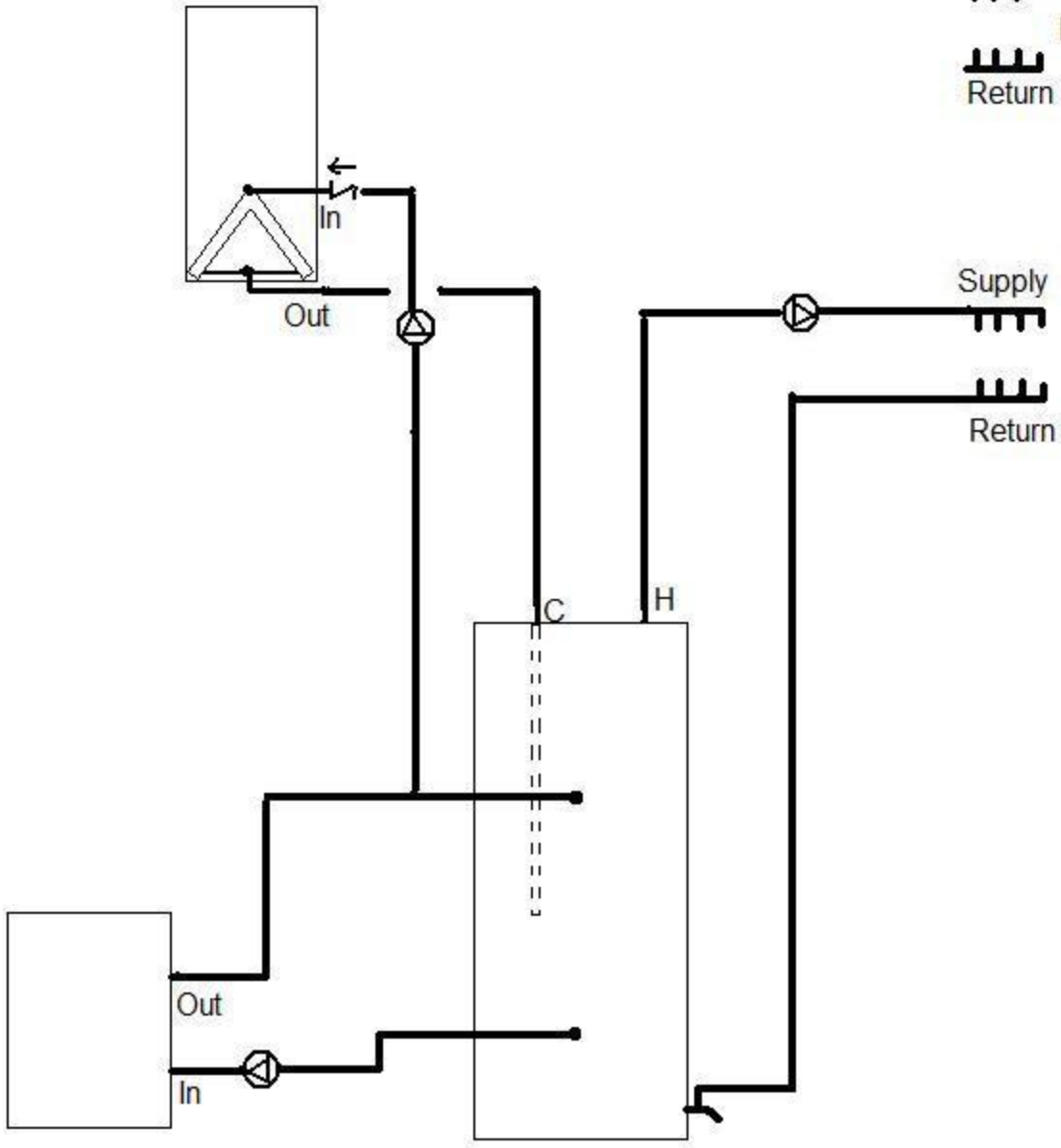


- High mass means it weighs a lot and the temperature change occurs slowly. (barge, not a speed boat)
- Typically a basement or garage.
- It requires 10 BTU/s per sq ft to move a 4” concrete slab 1 degree.
- Maximize insulation under and around the perimeter
- Minimize insulation on top. (carpet)
- Typically does not require water over 85-90 degrees.
- Garages even less

Supply
Return
Low mass RF

Supply
Return
High Mass RF

↑Σ
⊗



Connect Low Mass Radiant Floor



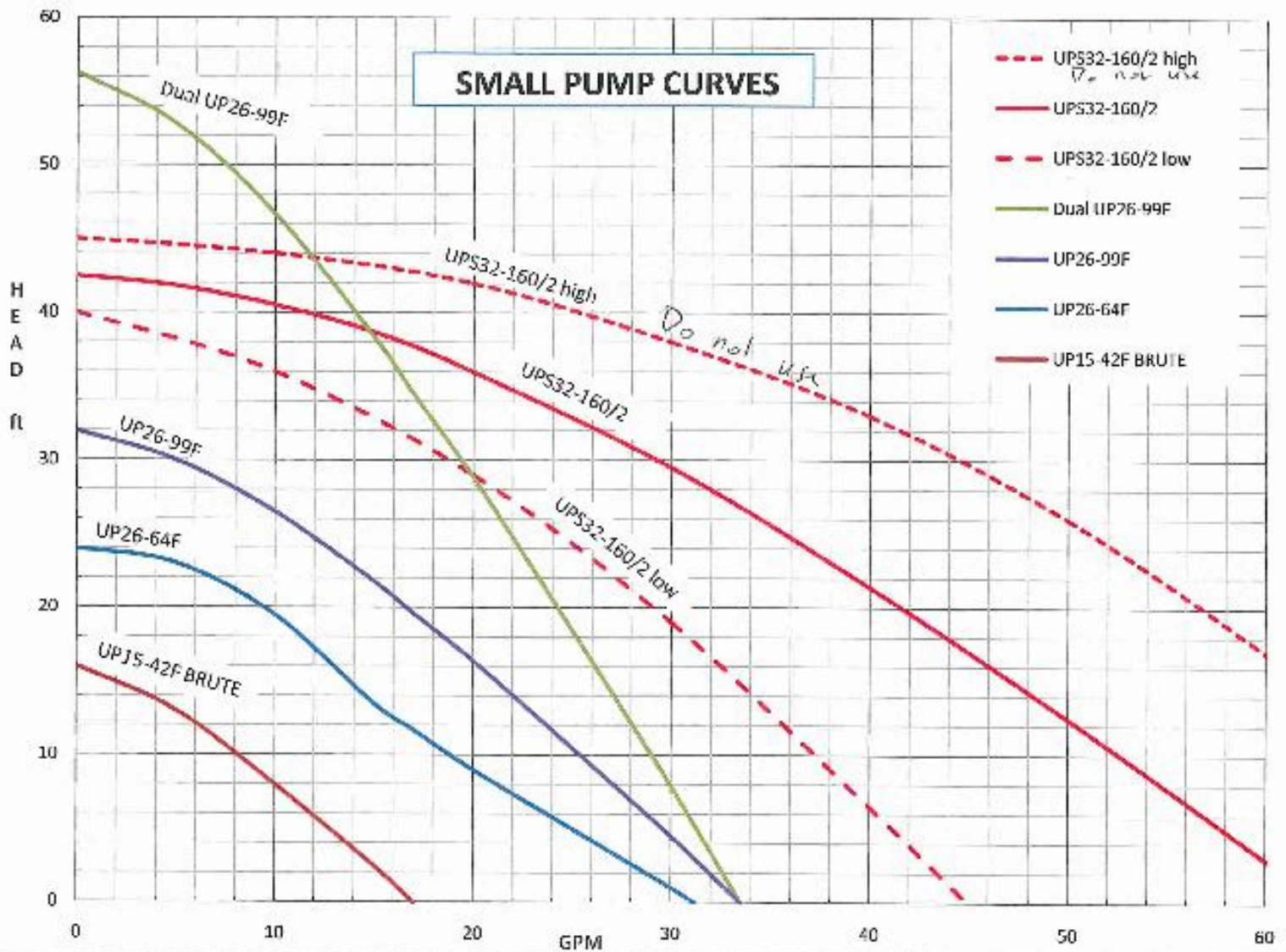
- Low mass is joist pocket heating, Warmboard, quicktrac, etc.
- Needs hotter water temp.
- Probably still won't heat the room under certain conditions like great rooms, lots of glass, carpeted floors.
- Watch out for wood floor maximum temperatures.

Pump Selection

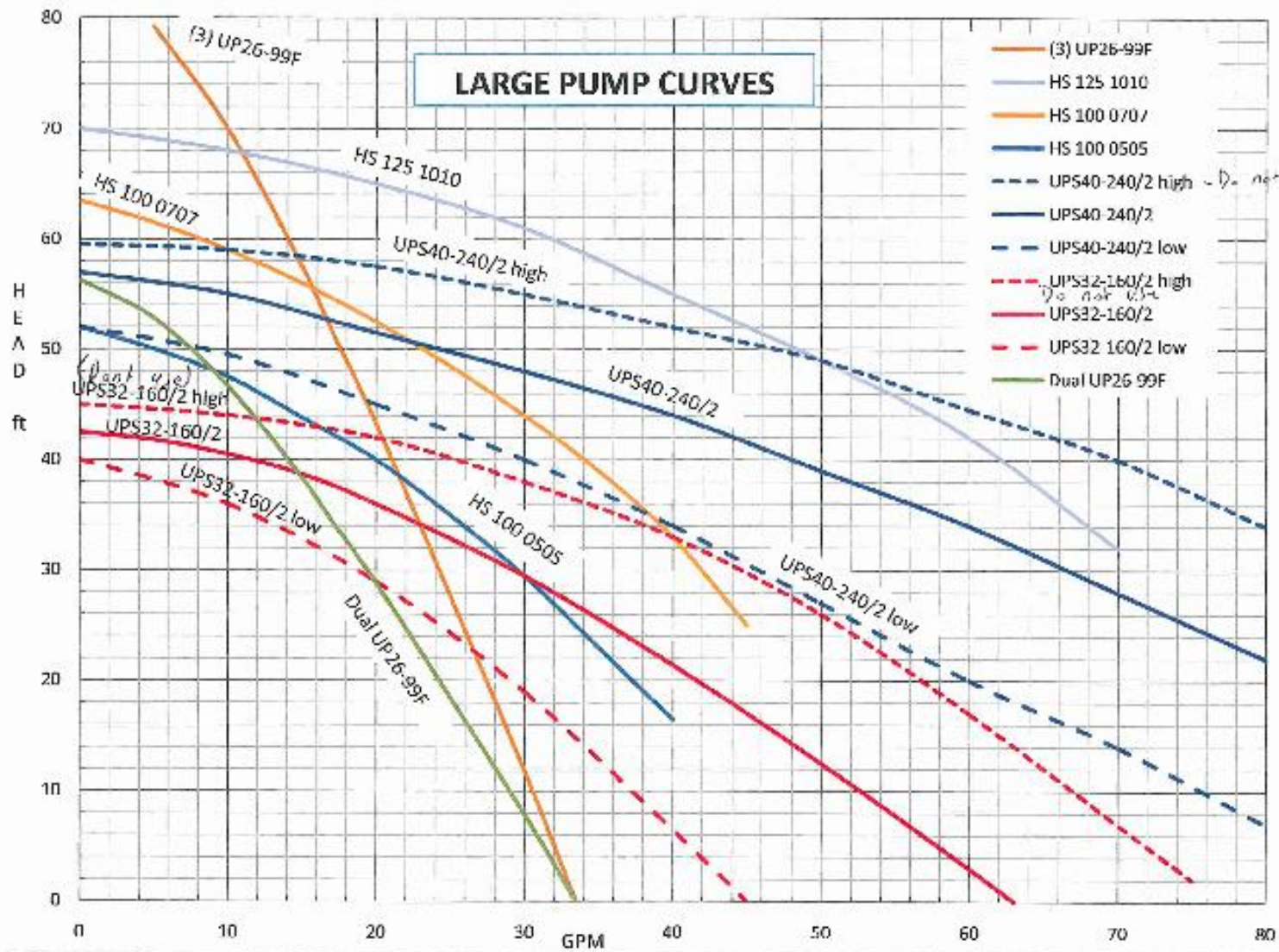


- Determine the desired flow rate.
- Calculate the load (ft of head) with manufacturer engineering tables at that flow rate.
- Choose a pump that will pump the load.
- Foam insulated pumps packs are recommended for use on the hydronic side of the heat pump.

SMALL PUMP CURVES



LARGE PUMP CURVES



Pump Installation



- Mount the pumps correctly. (motor mounting & pumping direction, up, horizontal and down)
- If there is any concern about added resistance in the Plbg of a system, increase the tubing size that you are using.
- Watch out for building air traps ahead of pumps.

Hydronic Installation Concerns Cont.



- Fan Coils
- Provide forced air heating and cooling.
- 1 stage heating and cooling is done with a water coil & circulating pump.
- 2 nd stage is electric heat.

Hydronic Installation Concerns Cont.

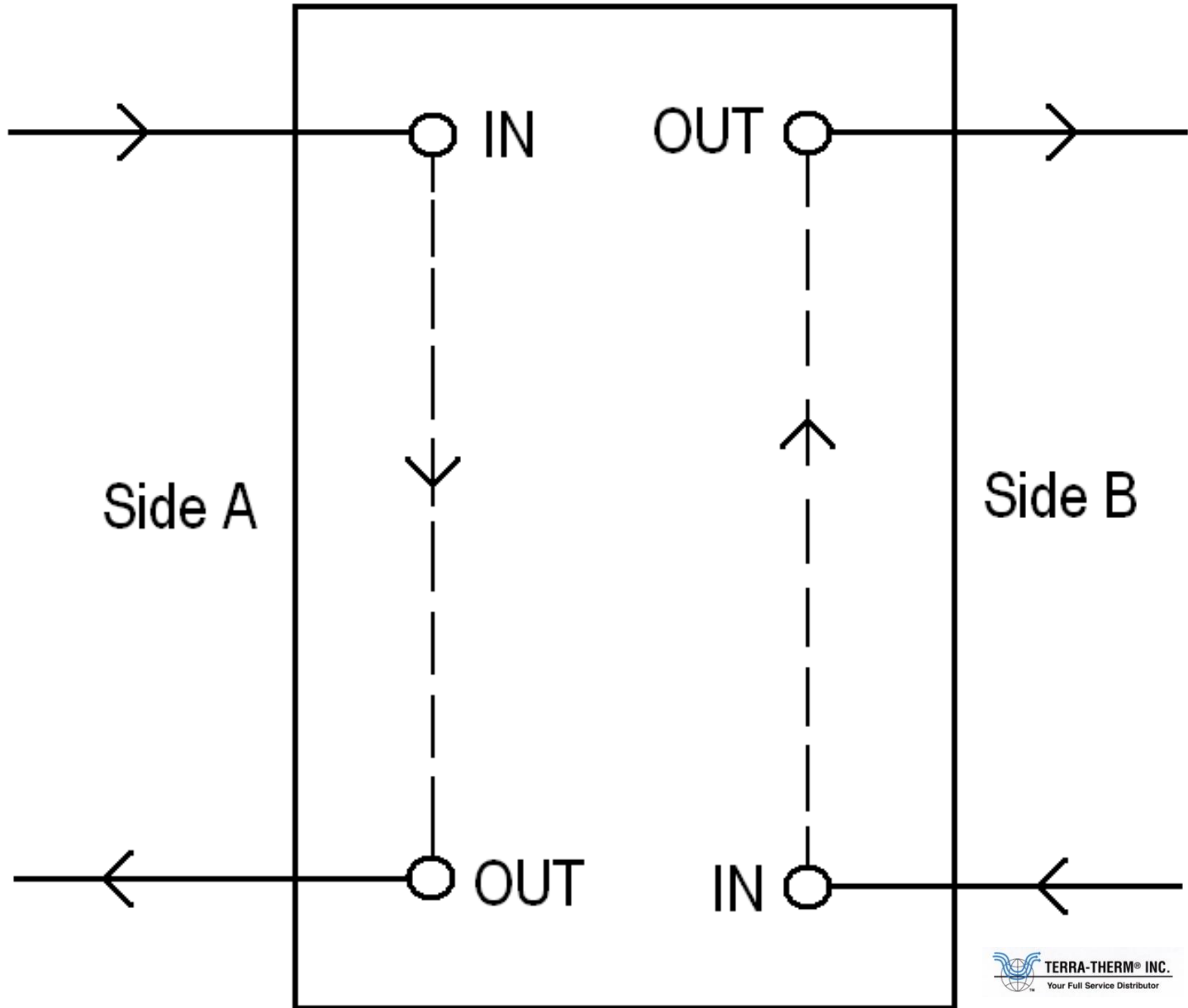


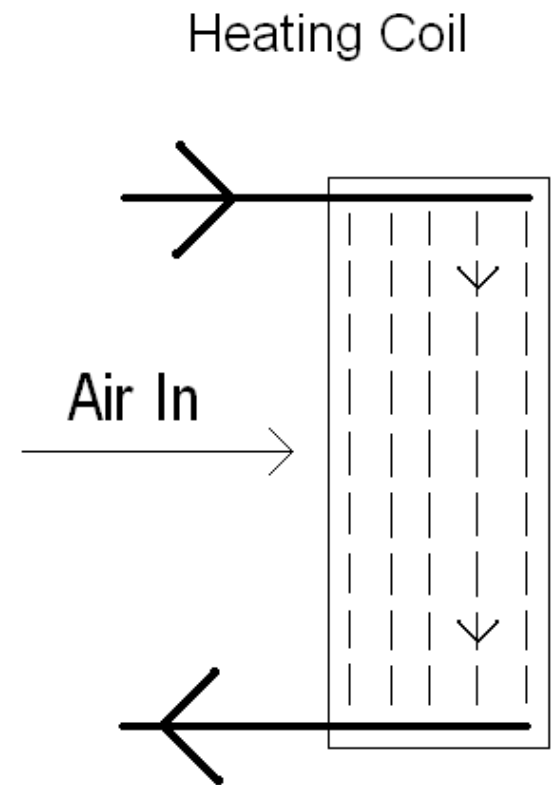
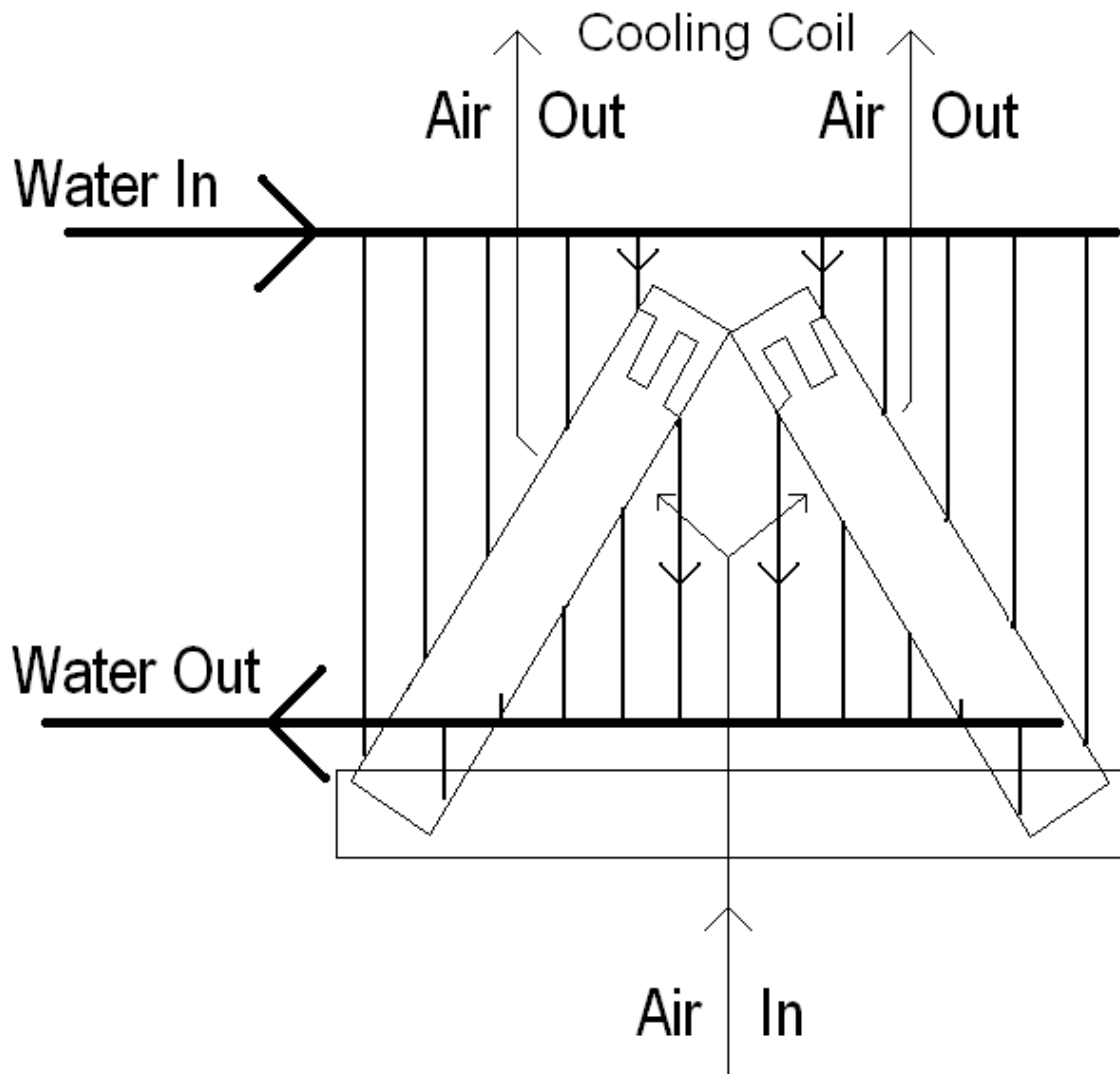
- The fan coil should get the hottest water for heating and the coldest water for cooling. We insure this by the way that it is plumbed.
- 208-240V, 1 ph.
- Need to plan for a condensate drain from the fan coil.

Hydronic Installation Concerns Cont.



- Make sure you are using a cooling type coil if you are trying to cool.
- Make sure that the water is flowing the correct direction through the water coil.
- The water flow has to be counter flow to the Air flow. (Diagram)
- Make sure your fan coil is capacity rated for the temperature water you are using.





To Measure the Output of a Fan Coil



APPLY THE FORMULA!

GPM X DELTA T X 500 = BTU

MEASURE GPM

MEASURE DELTA T

CALCULATE THE BTU

EXAMPLE



- Fan coil has $10 \text{ GPM} \times 10\text{F Delta T} \times 500 = 50,000 \text{ BTU/h}$
- This works in heating mode and cooling mode but watch out for latent heat in cooling. Not all energy moved is sensible (what a thermometer measures).

Measure Fan Coil Output with Air Flow



- Verify CFM.
- Check airstream Delta T
- $\text{BTU/h} = \text{CFM} \times \text{Delta T} \times 1.08$
- $\text{BTU/h} = 1800 \times 25 \text{ degrees} \times 1.08$
- $\text{BTU/h} = 48,600$
- Very close to what we measured on the water side.

Hydronic Installation Concerns Cont.



- **Radiant floor System**
- A thermostat activates the circulating pump to push hot water through the radiant floor.
- We normally use pumps and check valves.
- Zone valves and actuators can also be used
- There are 2 types of thermostats for radiant floor.

Hydronic Installation Concerns Cont.



- AIR SENSING thermostats are used where there is only one type of heat. (Do not position under ductwork in basement.)
- It automatically adjust to changing outside conditions.
- SLAB SENSING thermostat are used where there are two types of heat or where the thermostat can be affected by door openings.
- May need to be adjusted as the outside air temperature changes.

Hydronic Installation Concerns Cont.

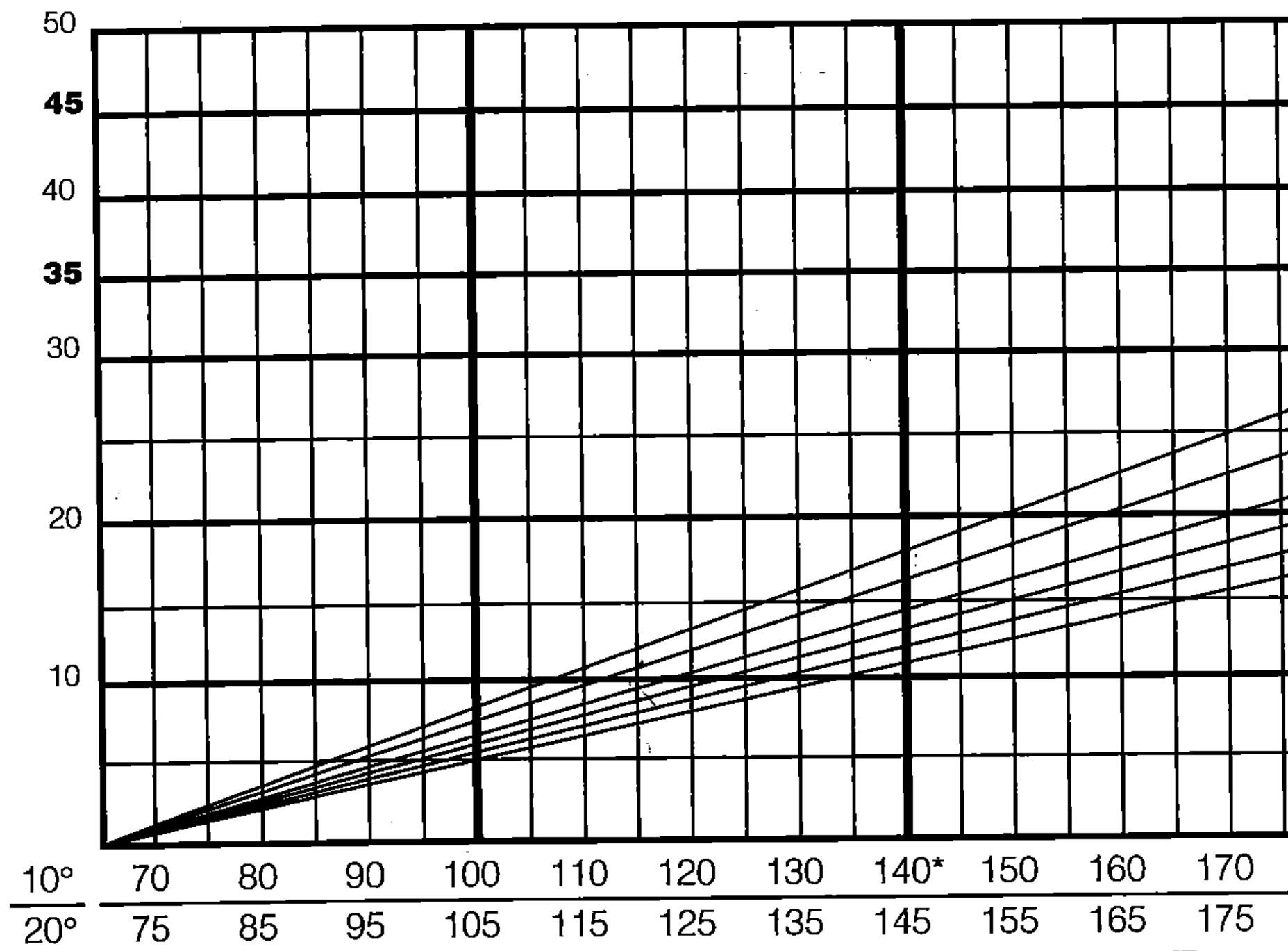


- 2 Types of Radiant floors.
- HIGH MASS is 4” to 6” of Concrete. (basements & garages)
- Usually does not require as hot of water, 85-95 or less.
- LOW MASS is Gypcrete’s, Quick track’s & Joist pocket heating, Warmboard. (main and second levels)
- Usually requires hotter water temperatures, 110-120.

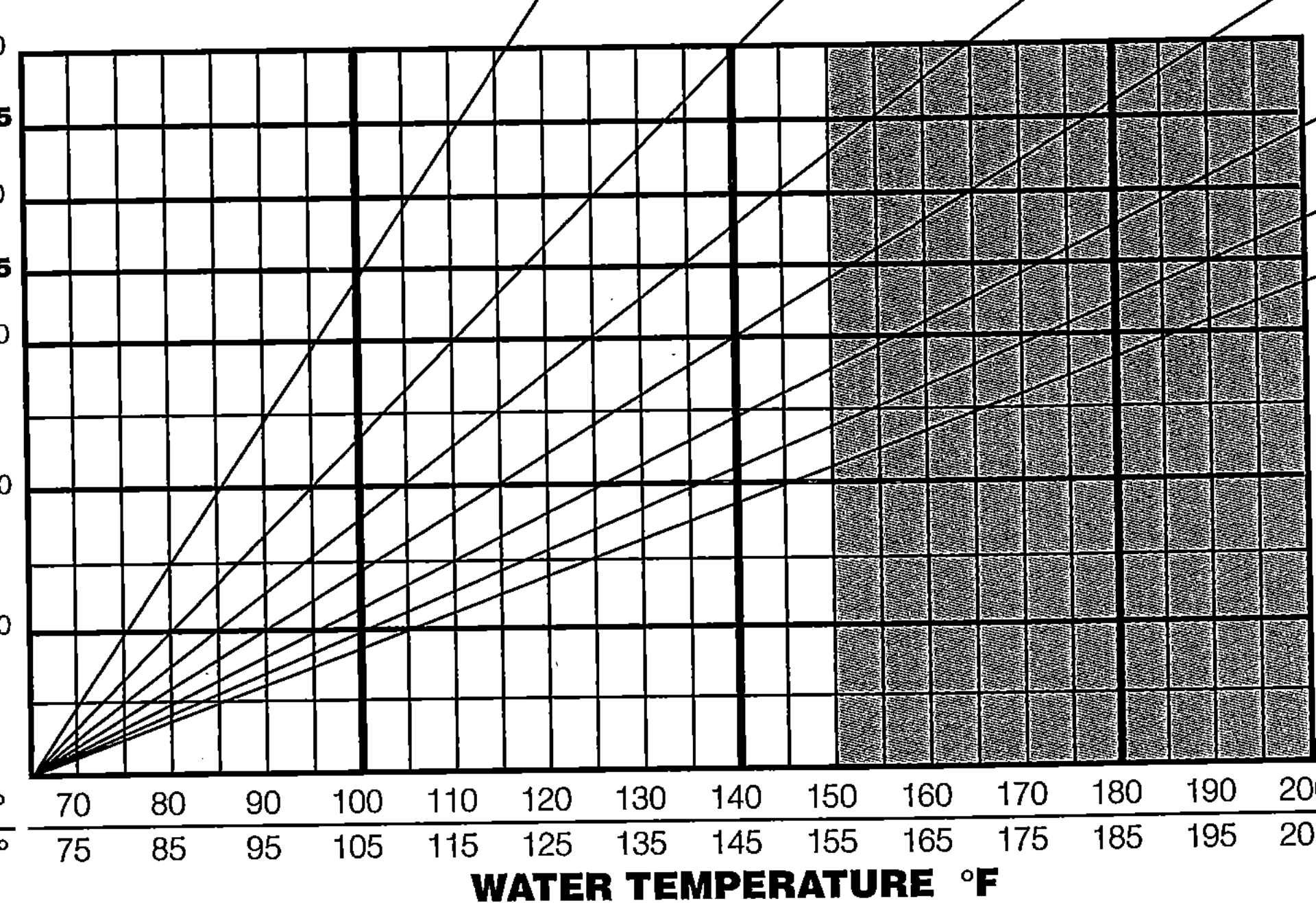
Hydronic Installation Concerns Cont.



- Most of the time radiant floor systems do not need as hot of water as fan coils.
- It is important that the radiant floor is disabled in the summer time.



WATER TEMPERATURE °F



ded maximum fluid temperature for all concrete applications is 150°F, in accordance with
 de. This data assumes negligible downward loss in accordance with good insulation p

Hydronic Installation Concerns Cont.



- **Water Quality**
- It is very important to fill the hydronic system with good quality water.
- Poor water quality can have bacteria or algae growth.
- This can reduce the efficiency and capacity.
- Cause lockouts.

Hydronic Installation Concerns Cont.



- Fill with 100-PPM grains of hardness or less.
- Types of water starting with lowest to highest, softened water, bottled water, reverse osmosis water and distilled water.
- Use hydronic system cleaners to clean up the pipes before filling & antifreezing the system.
- Adding 2 ounces of bleach for each 10 gallons of fluid or boiler system conditioner can reduce the possibility of a problem.

Hydronic Installation Concerns Cont.



- **Antifreeze Protection:**
- **Know the concentration of your antifreeze!**
- EnviroGard Ultra HD Antifreeze, 95% Propylene Glycol & 5% Inhibitors.
- Antifreezing is required on the hydronic side of the heat pump, fan coils in the attic and garage radiant floors
- We are shooting for a 23% of Propylene Glycol or 18 deg protection level.

Hydronic Installation Concerns Cont.



- After the antifreeze is added it is important that you verify the antifreeze mixture is correct. Wait a week to check. Over antifreezing the system is bad.

Hydronic Installation Concerns Cont.



- **System Design**
- We are selling efficiency so design for efficiency and use lower water temps in the design of the system (100 deg).
- No need for outdoor reset.
- Over size the fan coils. (benefits)
- Heat pump efficiency COP & KW. (Engineering Specs)

GW 570 and GW 571 Heating Performance Data

| GROUND | | | | Hyd LWT °F |
|-----------|-----|------------|----------|------------------|
| EWT °F | GPM | dP psig | dP ft | |
| 25 | 15 | 2.9 | 6.7 | 115 |
| | | | | 100 |
| | | | | 85 |
| | | | | 70 |
| 30 | 15 | 2.9 | 6.7 | 115 |
| | | | | 100 |
| | | | | 85 |
| | | | | 70 |
| 35 | 15 | 2.9 | 6.7 | 115 |
| | | | | 100 |
| | | | | 85 |
| | | | | 70 |
| 13 | 24 | 4.0 | 10.0 | 115 |
| | | | | 100 |

| HYDRONIC FLOW - 12 GPM 2.1 PSIG dP, 4.8 FT dP | | | | |
|--|---------------|-----------|-----|--------------|
| TEMP RISE | CAP kBTU/h | PWR kW | COP | HE kBTU/h |
| 7.3 | 43.9 | 5.1 | 2.5 | 26.5 |
| 7.6 | 45.5 | 4.4 | 3.1 | 30.6 |
| 7.9 | 47.1 | 3.6 | 3.8 | 34.7 |
| 8.1 | 48.7 | 2.9 | 4.9 | 38.7 |
| 7.8 | 46.8 | 5.1 | 2.7 | 29.3 |
| 8.1 | 48.6 | 4.4 | 3.2 | 33.6 |
| 8.4 | 50.4 | 3.7 | 4.0 | 37.9 |
| 8.7 | 52.2 | 2.9 | 5.2 | 42.2 |
| 8.3 | 49.8 | 5.2 | 2.8 | 32.1 |
| 8.6 | 51.7 | 4.4 | 3.4 | 36.6 |
| 8.9 | 53.7 | 3.7 | 4.3 | 41.1 |
| 9.3 | 55.6 | 2.9 | 5.5 | 45.6 |
| 8.6 | 51.6 | 5.2 | 2.9 | 33.9 |
| 8.9 | 53.6 | 4.4 | 3.5 | 38.5 |

| HYDRONIC FLOW - 15 GPM 2.9 PSIG dP, 6.7 FT dP | | | | |
|--|---------------|-----------|-----|--------------|
| TEMP RISE | CAP kBTU/h | PWR kW | COP | HE kBTU/h |
| 5.9 | 44.0 | 5.0 | 2.6 | 27.1 |
| 6.1 | 45.7 | 4.3 | 3.1 | 31.1 |
| 6.3 | 47.3 | 3.6 | 3.9 | 35.2 |
| 6.5 | 48.9 | 2.9 | 5.0 | 39.2 |
| 6.3 | 47.0 | 5.0 | 2.8 | 29.9 |
| 6.5 | 48.8 | 4.3 | 3.3 | 34.2 |
| 6.7 | 50.6 | 3.6 | 4.1 | 38.4 |
| 7.0 | 52.4 | 2.9 | 5.4 | 42.6 |
| 6.7 | 50.0 | 5.1 | 2.9 | 32.8 |
| 6.9 | 52.0 | 4.3 | 3.5 | 37.2 |
| 7.2 | 53.9 | 3.6 | 4.4 | 41.6 |
| 7.4 | 55.8 | 2.9 | 5.7 | 46.0 |
| 6.9 | 51.8 | 5.0 | 3.0 | 34.6 |
| 7.2 | 53.8 | 4.3 | 3.7 | 39.1 |

GW 37 - GW 110 Hydronic Residential Plumbing Recommendations

| Heat Pump Model | Heat Exchanger Plumbing | Hydronic Loop GPM | Min. Copper Pipe Size | Recommended Buffer Tank | TTI Hydronic Loop Pump | TTI Hose Kit | Adapters TTI part # | EnviroGard Ultra HD Glycol Tank & Heat Pump Circuit |
|-----------------|-------------------------|-------------------|-----------------------|-------------------------|-------------------------|----------------------------|-----------------------------|---|
| GW 37 | 1" FPT | 9 GPM | 1" | M2-0301 62 Gallon | L3-0019A Single Pump | L3-0015B 1" Hose Kit | N/A | 13 Gallons |
| GW 47 | 1" FPT | 12 GPM | 1" | M2-0301 62 Gallon | L3-0019A Single Pump | L3-0015B 1" Hose Kit | N/A | 13 Gallons |
| ** GW 57 | 1-1/4" MPT | 15 GPM | 1" | M2-0301 62 Gallon | L3-0019A Single Pump | L3-0015B 1" Hose Kit | 30118-00126-100 2 needed | 13 Gallons |
| ** GW 57 | 1-1/4" MPT | 15 GPM | 1" | M2-0301 62 Gallon | L3-0019C Single Pump | L3-0014 1-1/4" Hose Kit | 30118-00126-100 2 needed | 13 Gallons |
| GW77 | 1-1/4" MPT | 18 GPM | 1-1/4" | M2-0304 80 Gallon | L3-0019C Single Pump | L3-0014 1-1/4" Hose Kit | N/A | 20 Gallons |
| GW 87 | 1-1/4" MPT | 20 GPM | 1-1/4" | M2-0304 80 Gallon | L3-0019C Single Pump | L3-0014 1-1/4" Hose Kit | N/A | 20 Gallons |
| GW 110 | 1-1/4" MPT | 20 GPM | 1-1/4" | M2-0304 80 Gallon | L3-0019C Single Pump | L3-0014 1-1/4" Hose Kit | N/A | 20 Gallons |

NOTE: The above table should only be used when designing systems with a single heat pump in a residential application. When designing other systems contact Terra-Therm's Technical Support team. (507) 463-3213

Additional Antifreeze Calculations: see below or use the TTI's antifreeze calculator to determine system requirements

TTI's Antifreeze Calculator is a Microsoft Excel File available from Terra Therm Inc.

Water Volume per 100' pipe:

Radiant Floor 1/2" pex = 0.92 gal. ~ 5/8" pex = 1.38 gal.

Plumbing 1-1/4" pex = 4.45 gal. ~ 1" copper = 4.54 gal ~ 1-1/4" copper = 6.8 gal ~ 1-1/2" copper = 9.51 gal ~ 2" copper = 16.47 gal

Average Water Coil Capacity = 2.5 gal.

Total antifreeze needed: (Tank Capacity ____ gal. + Fan Coil and Pipe Capacity ____ gal.) X .23 = ____ gal. EnviroGard Ultra HD

23 % EnviroGard Ultra HD Glycol provides freeze protection to 18° F.

Add 2 oz of Hilex/Clorox bleach for each 10 gallons of total volume.

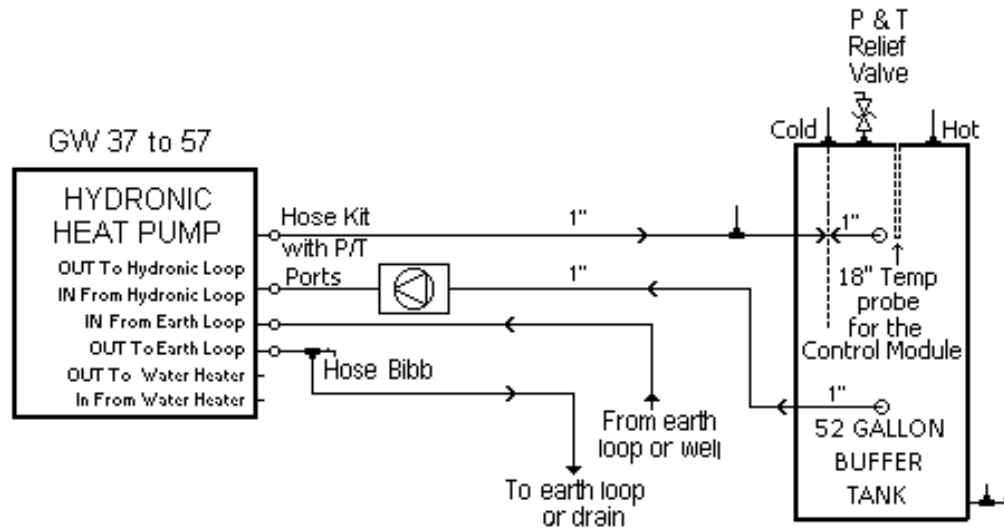
** GW 57 - 1" hose kit does not have isolation valves - circulator has 1" flanges - need 2 ea. 1-1/4" to 1" reducers at the heat pump

** GW 57 - 1-1/4" hose kit has union ball valves at the heat pump - circulator will have 1-1/4" flanges - need 2 ea 1-1/4" to 1" reducers at the tank.

L3-0019A - Single 26-99 230V Foam Pump Pack with 1" X 1" flange ball valves

L3-0019C - Single 26-99 230V Foam Pump Pack with 1-1/4" X 1-1/4" flange ball valves

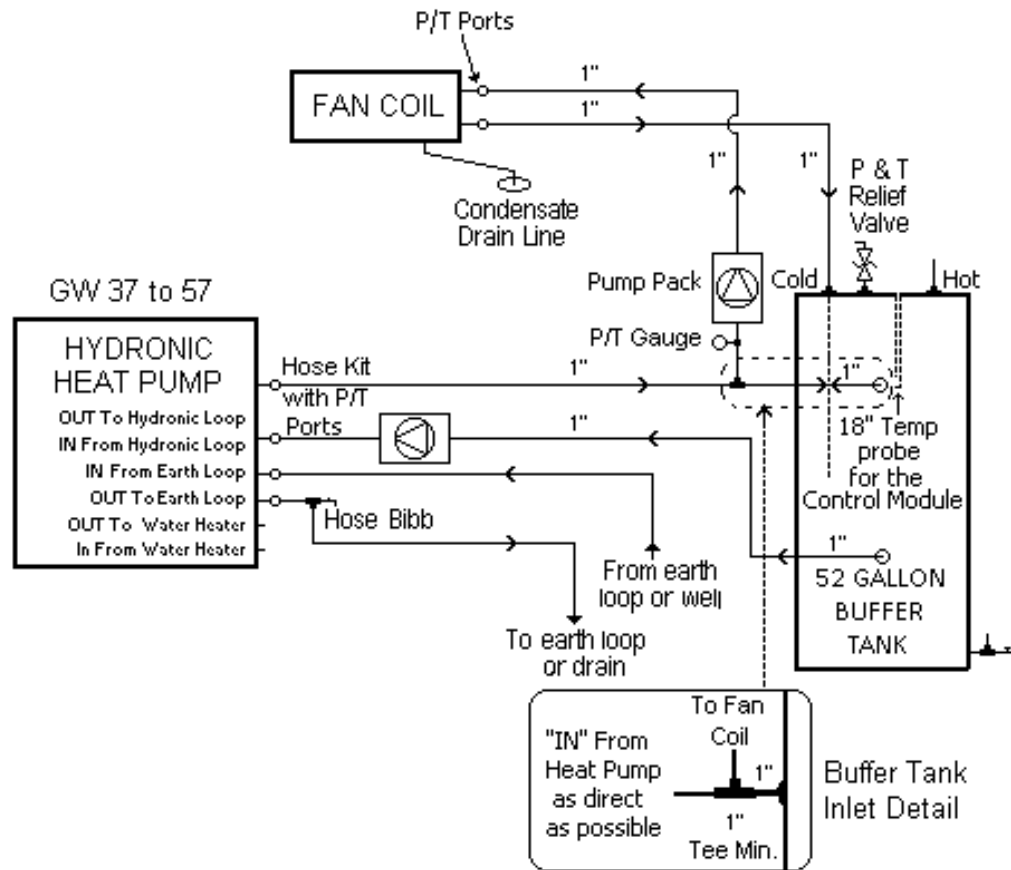
Heat Pump



School 2009 #1

TERRA-THERM, INC.
Revised 3/22/10

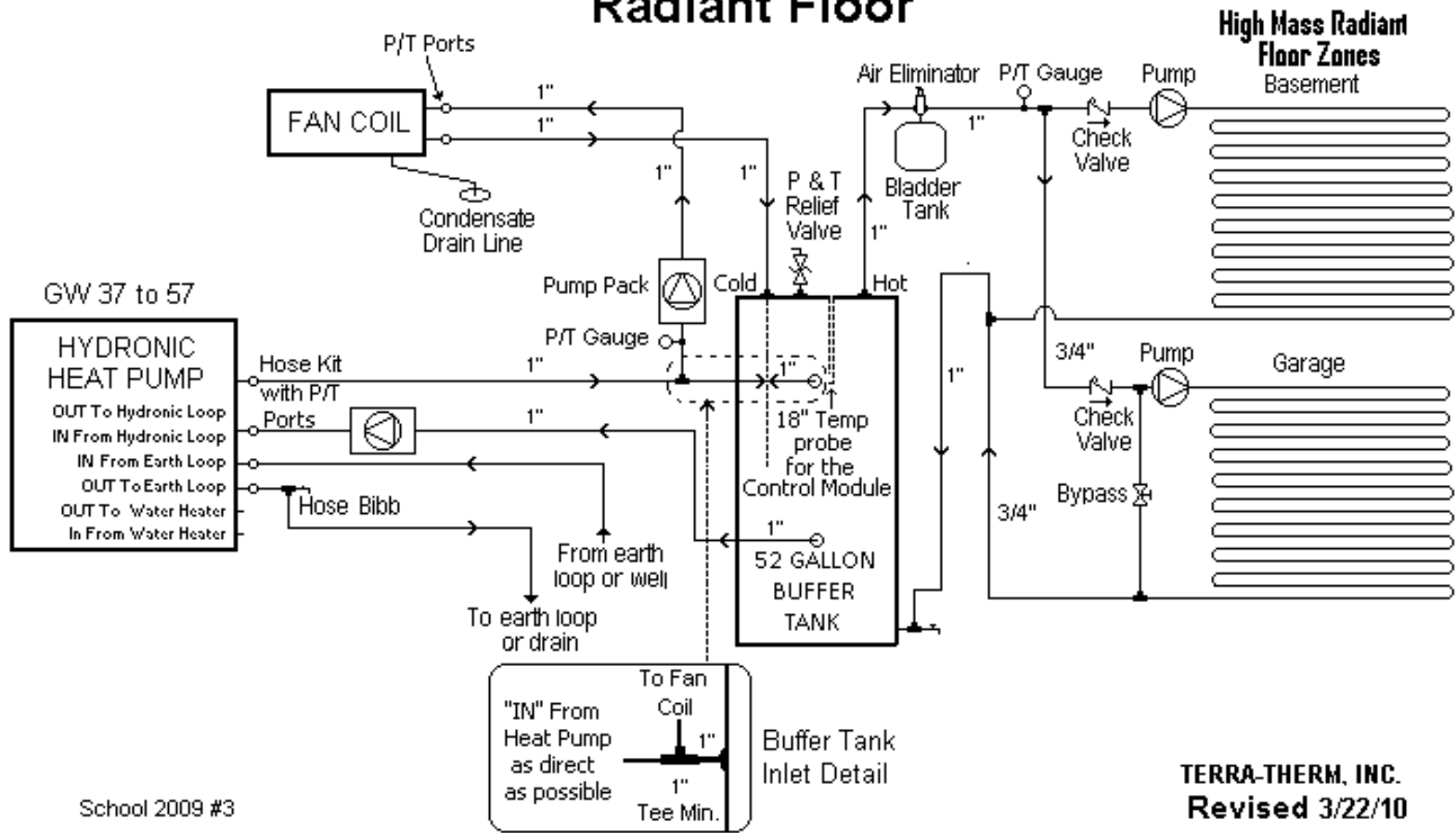
Fan Coil



School 2009 #2

TERRA-THERM, INC.
Revised 3/22/10

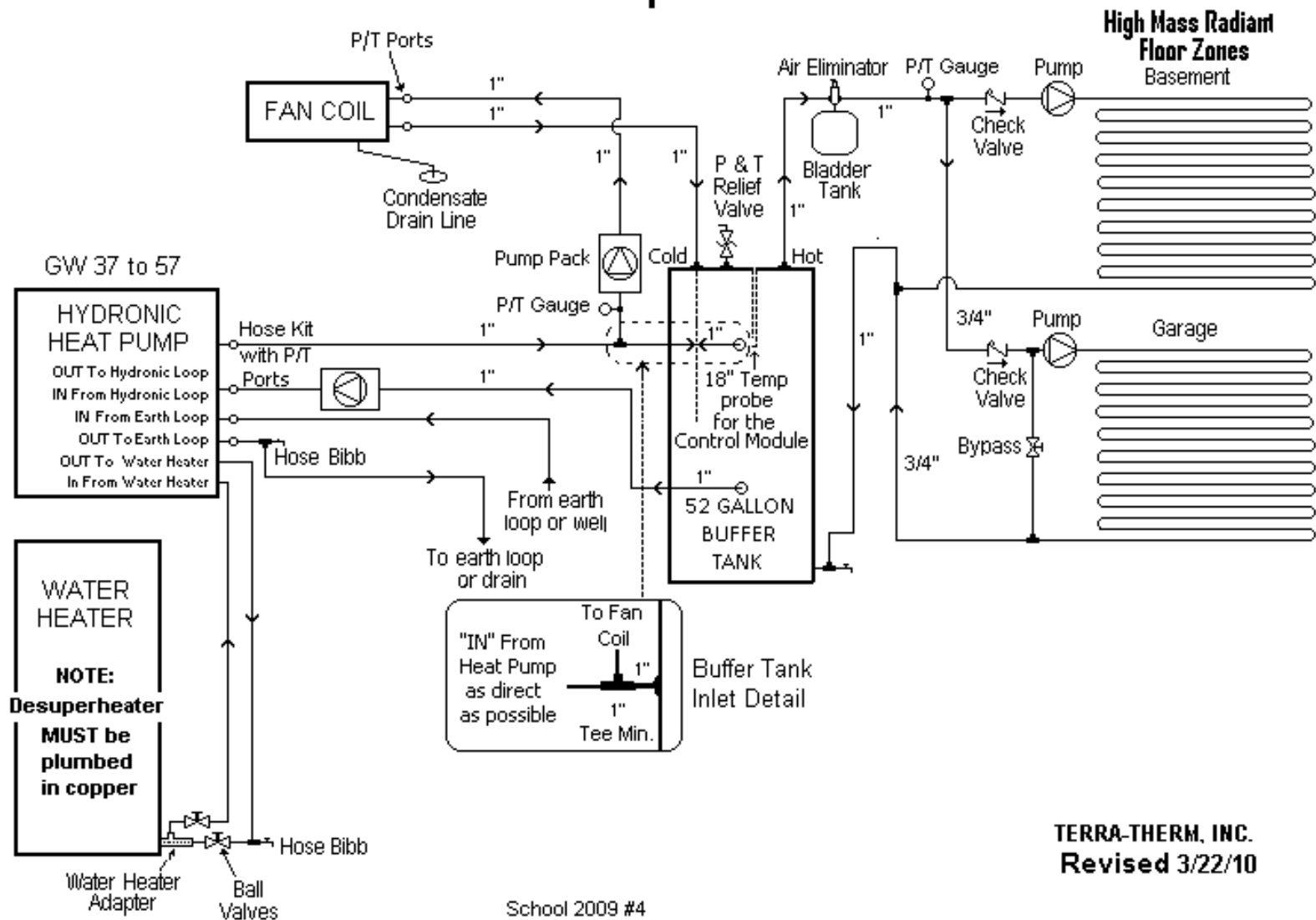
Radiant Floor



TERRA-THERM, INC.
Revised 3/22/10

School 2009 #3

Desuperheater



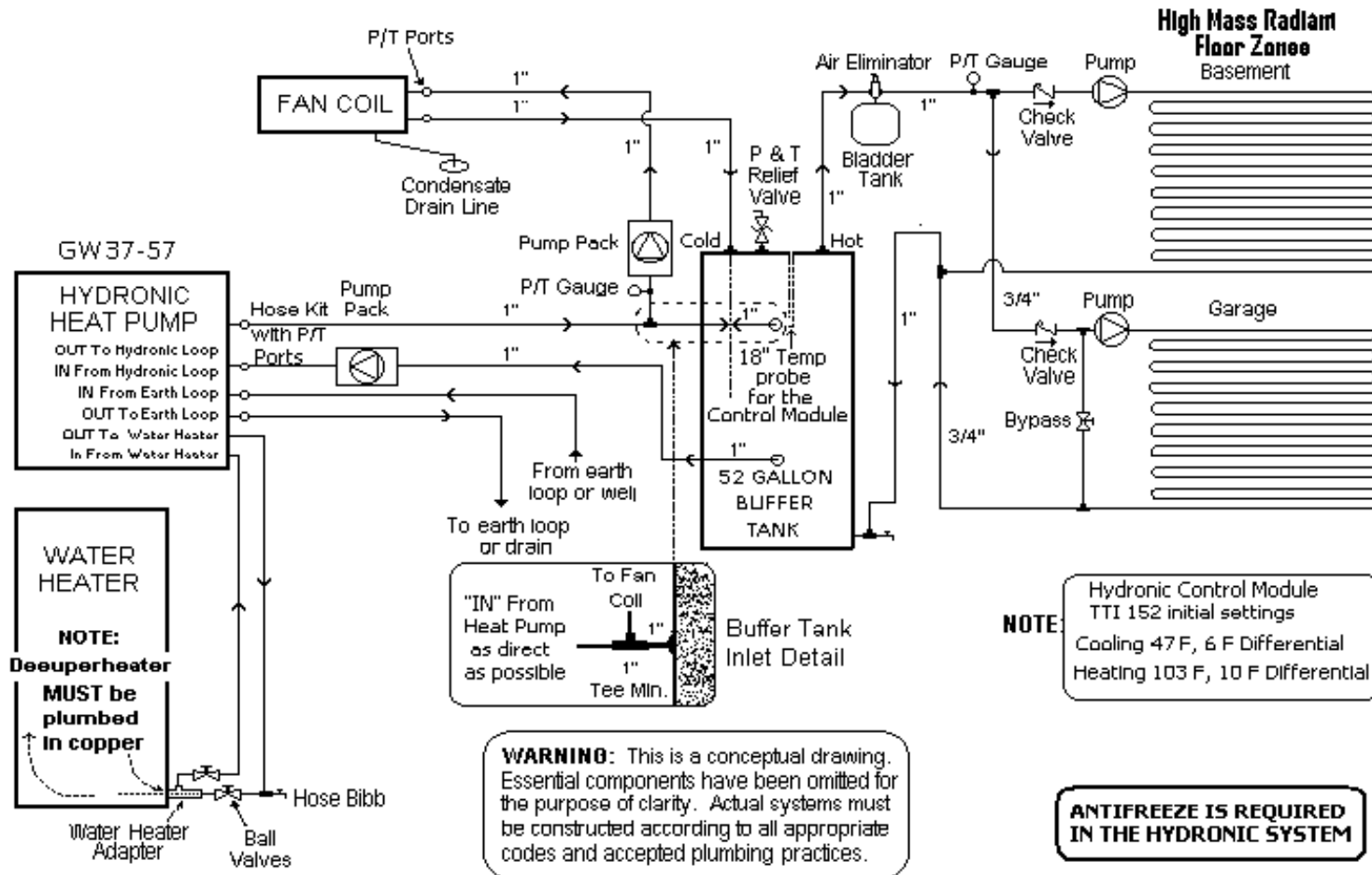
TERRA-THERM, INC.
Revised 3/22/10

School 2009 #4

CONCEPTUAL PLUMBING DIAGRAM

GeoSource Ultra Hydronic Heat Pump with Desuperheater

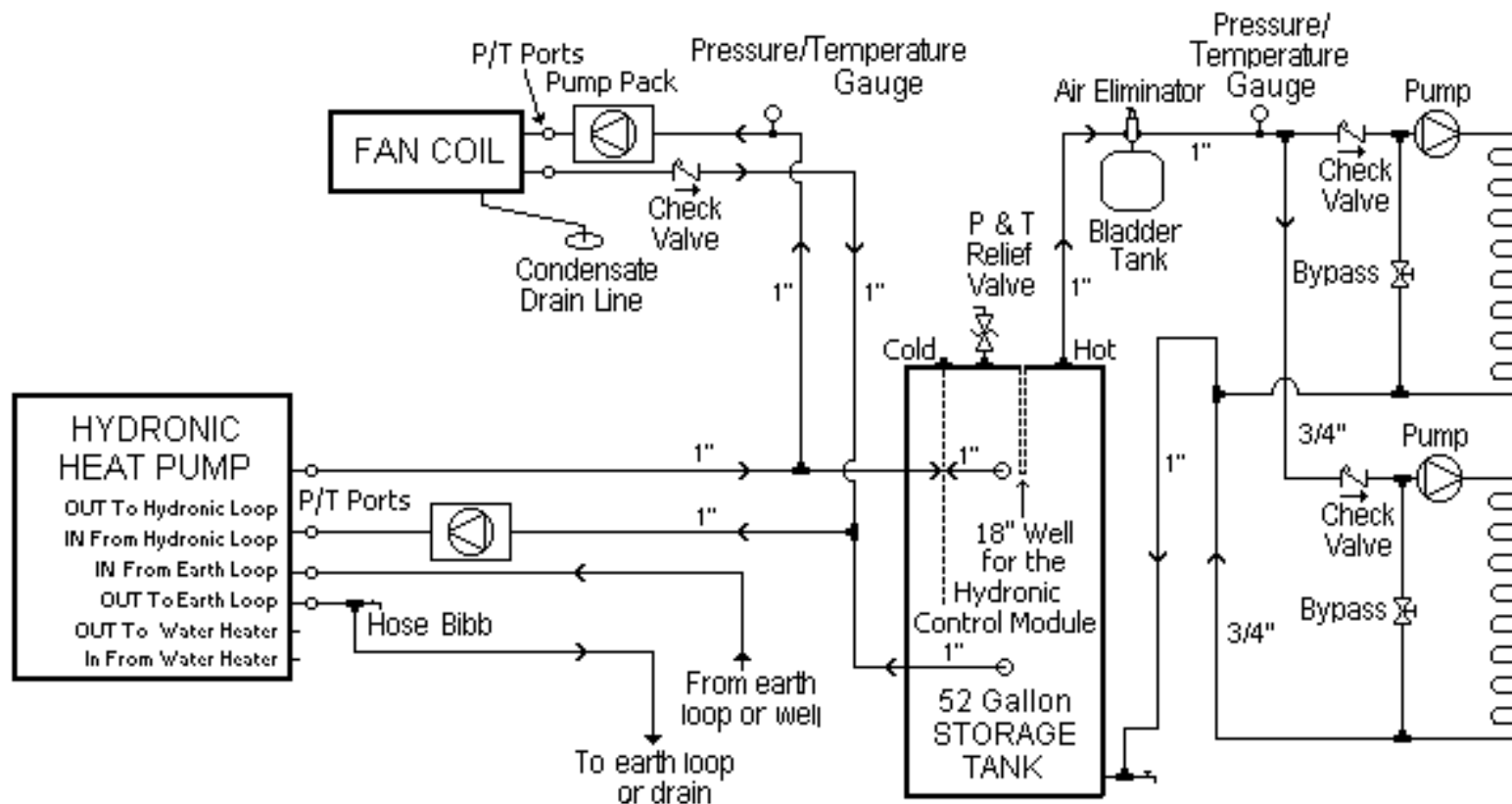
Fan Coil Heating and Air Conditioning and Hydronic Radiant Floor Heating



Common/Dealer Manual/Hydronics Plumbing Diagrams/1HP,1FC,2Z RFH

TERRA-THERM, INC.
 revised: 3/5/10

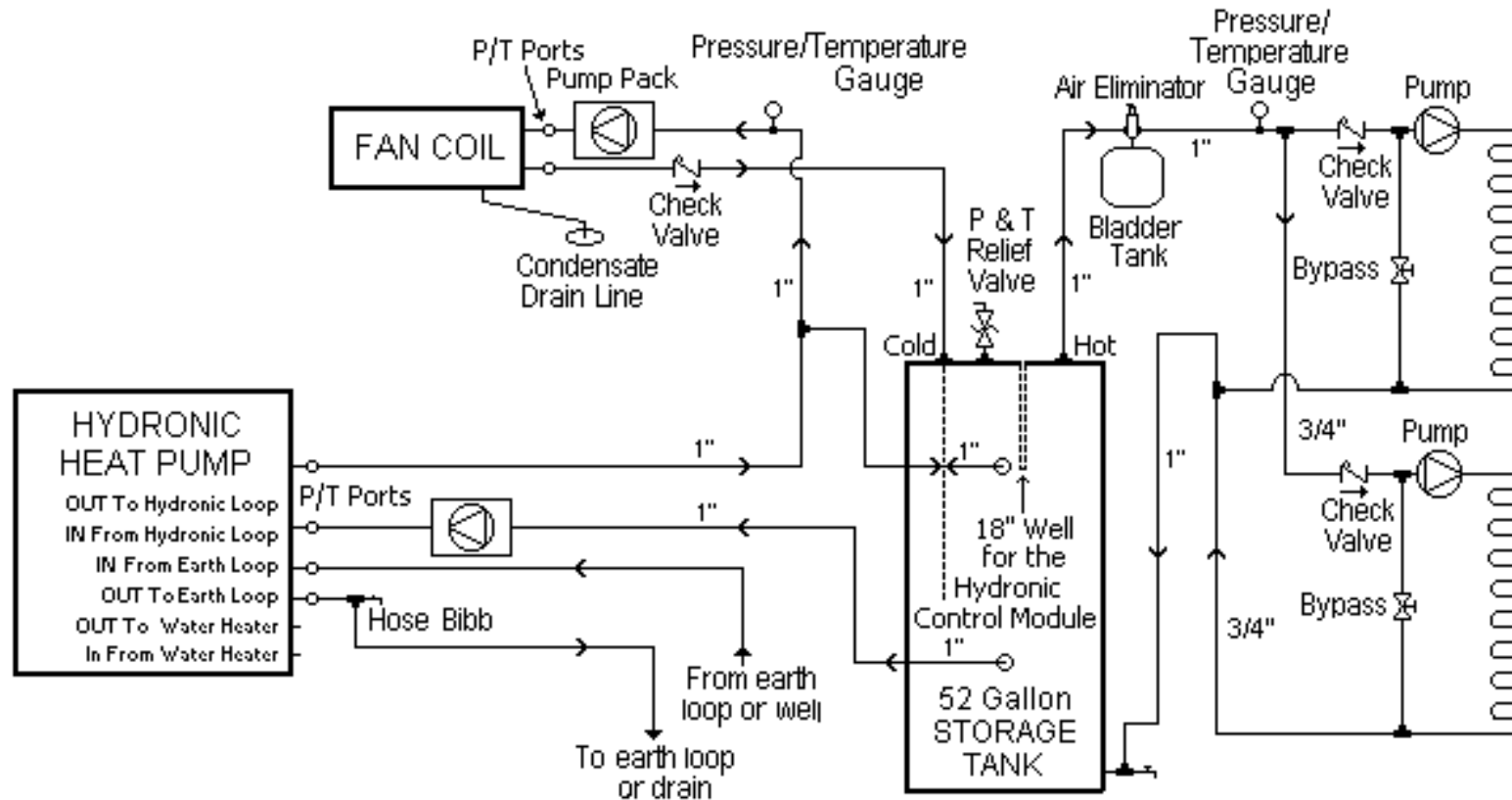
Bypass (Wrong)



School #7

Terra Therm Inc
3/22/10

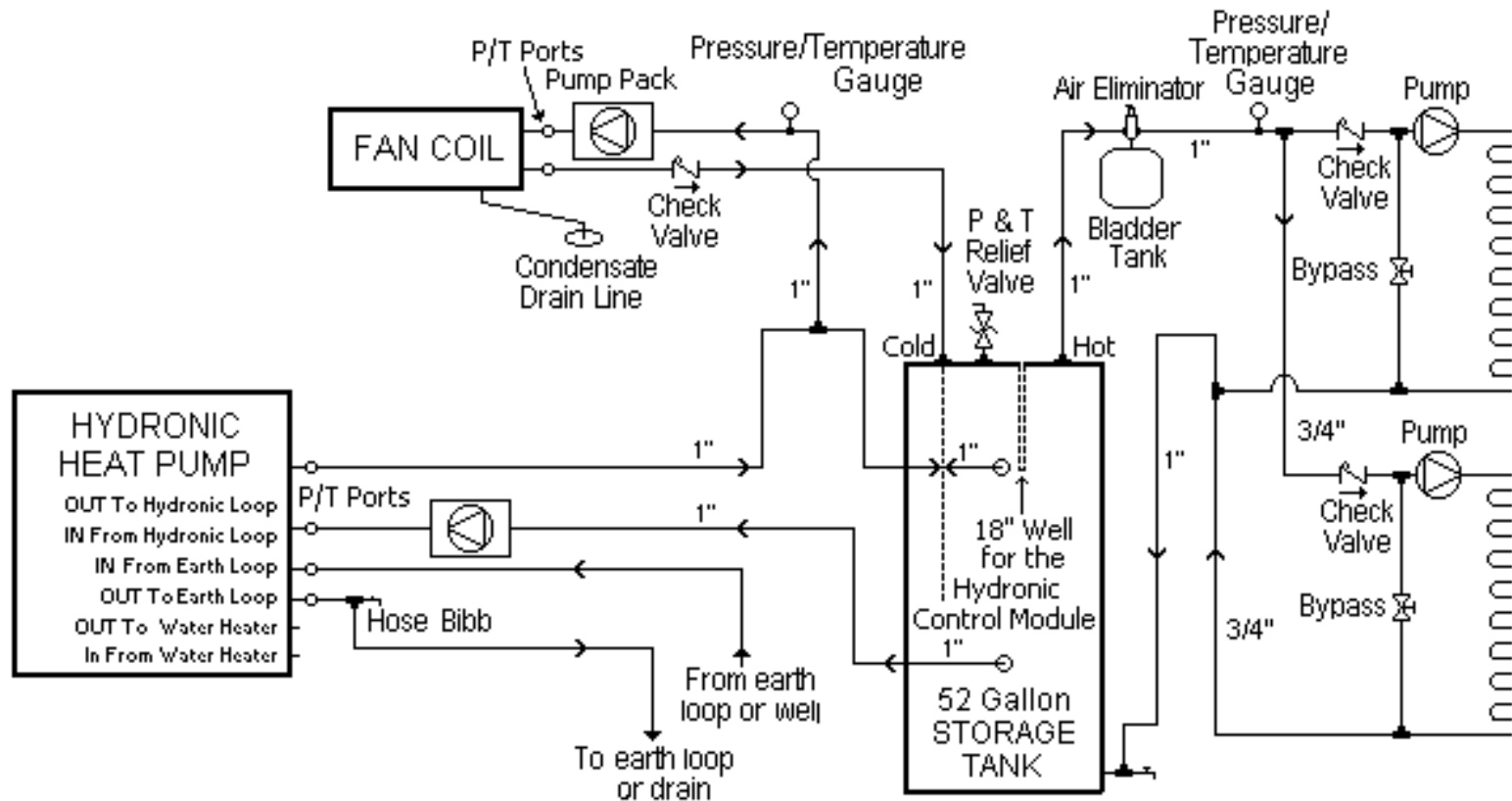
Path of Least Resistance (Wrong)



School # 8

Terra Therm Inc
3/22/10

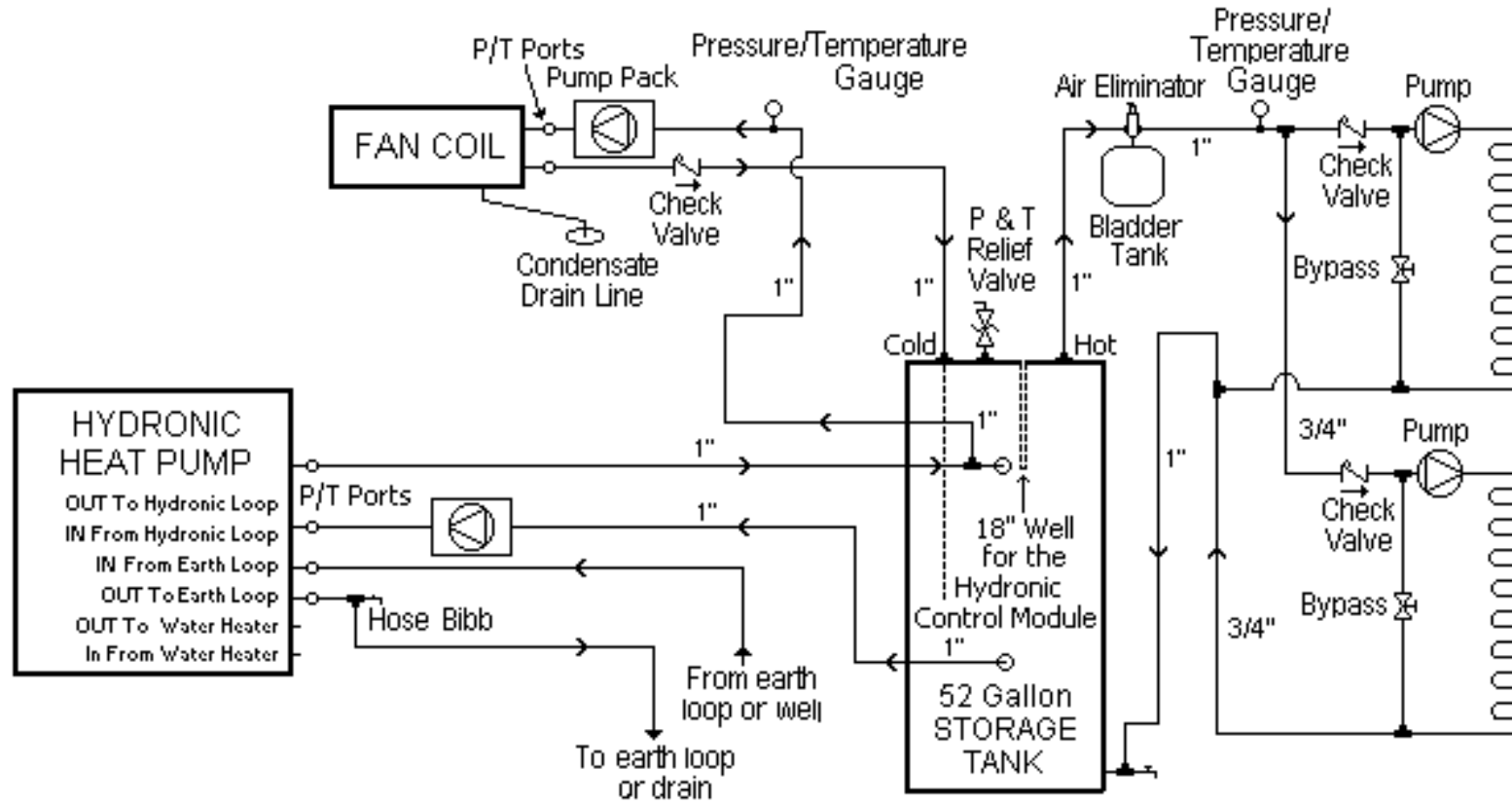
Path of Least Resistance (Wrong)



School #9

Terra Therm Inc
3/22/10

Correct

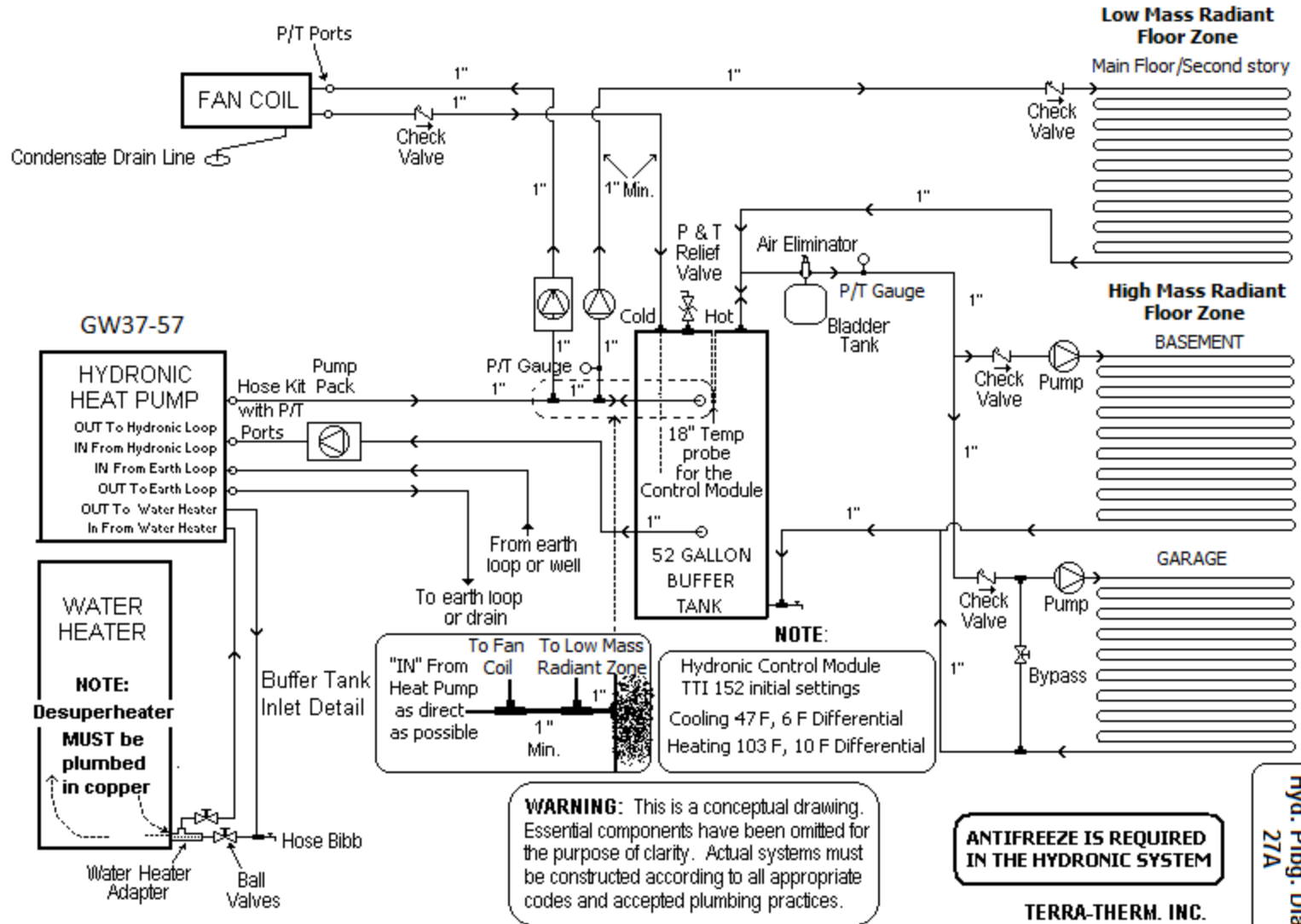


School # 10

Terra Therm Inc
3/22/10

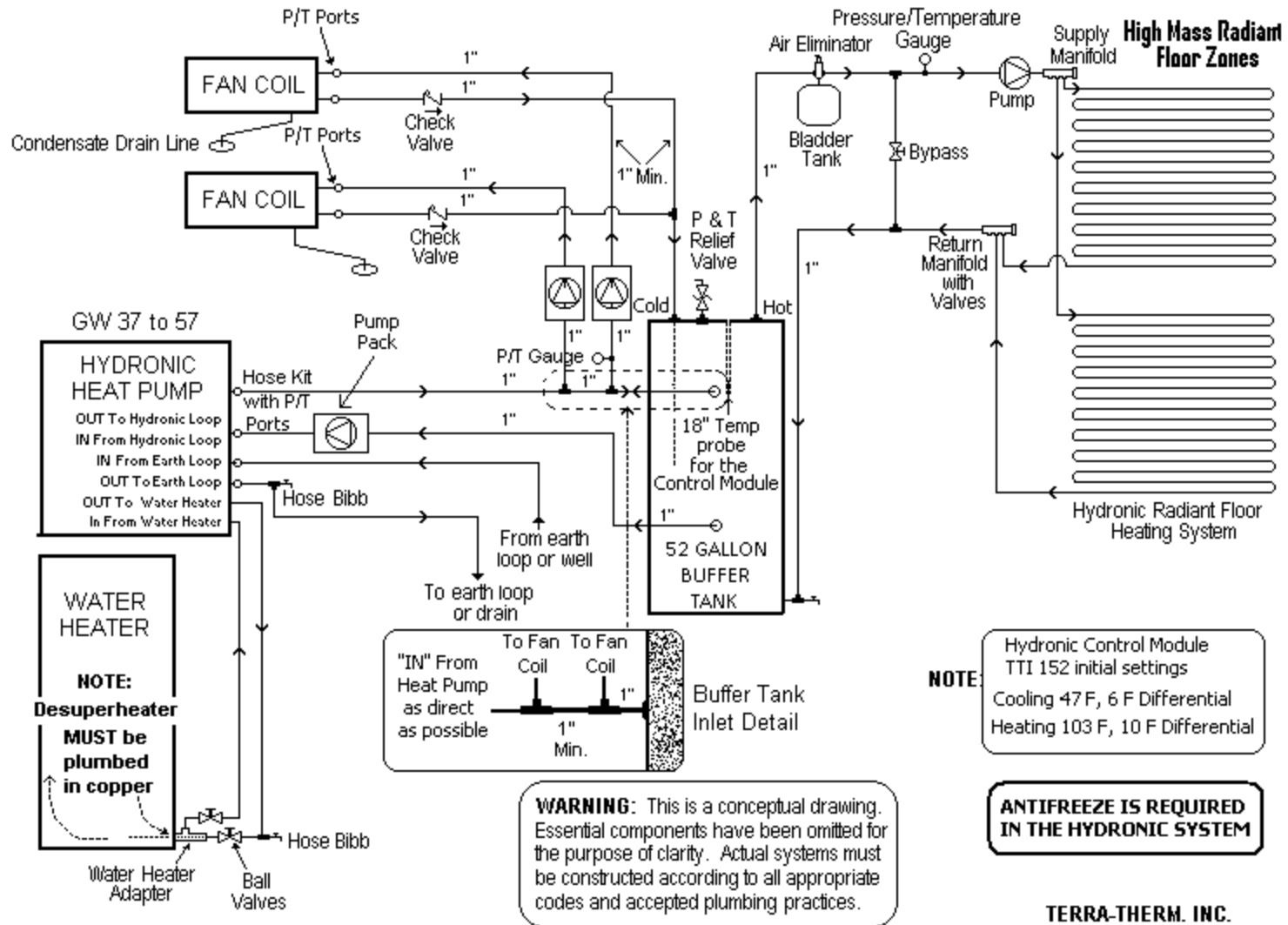
CONCEPTUAL PLUMBING DIAGRAM

GeoSource Ultra Hydronic Heat Pump with Desuperheater Fan Coil Heating and Air Conditioning and Hydronic Radiant Floor Heating



CONCEPTUAL PLUMBING DIAGRAM

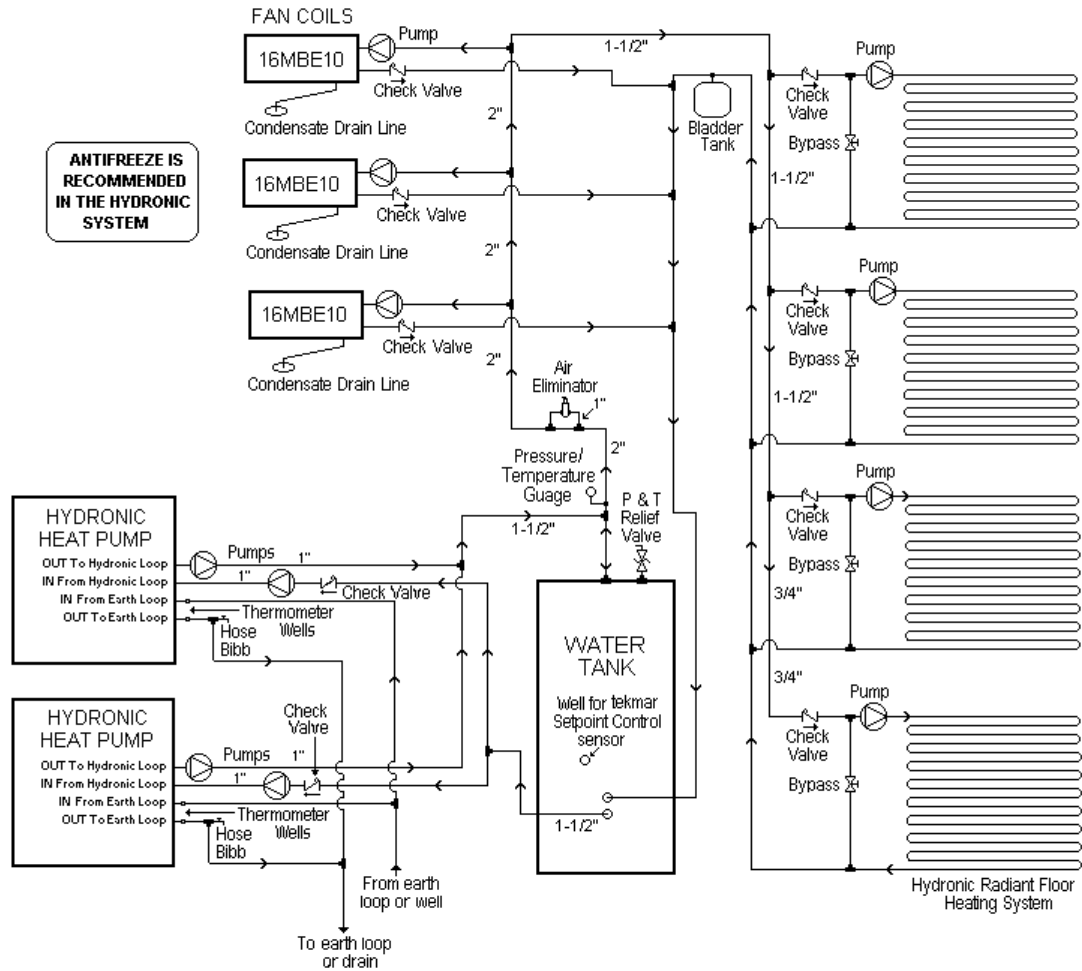
GeoSource Ultra Hydronic Heat Pump with Desuperheater Fan Coil Heating and Air Conditioning and Hydronic Radiant Floor Heating



CONCEPTUAL PLUMBING DIAGRAM

GeoSource 2000 Hydronic Heat Pumps with Fan Coil Heating and Air Conditioning and WIRSBO Hydronic Radiant Floor Heating

Incorrect



ANTIFREEZE IS RECOMMENDED IN THE HYDRONIC SYSTEM

WARNING: This is a conceptual drawing. Essential components have been omitted for the purpose of clarity. Actual systems must be constructed according to all appropriate codes and accepted plumbing practices.

TERRA-THERM, INC.
3/22/10

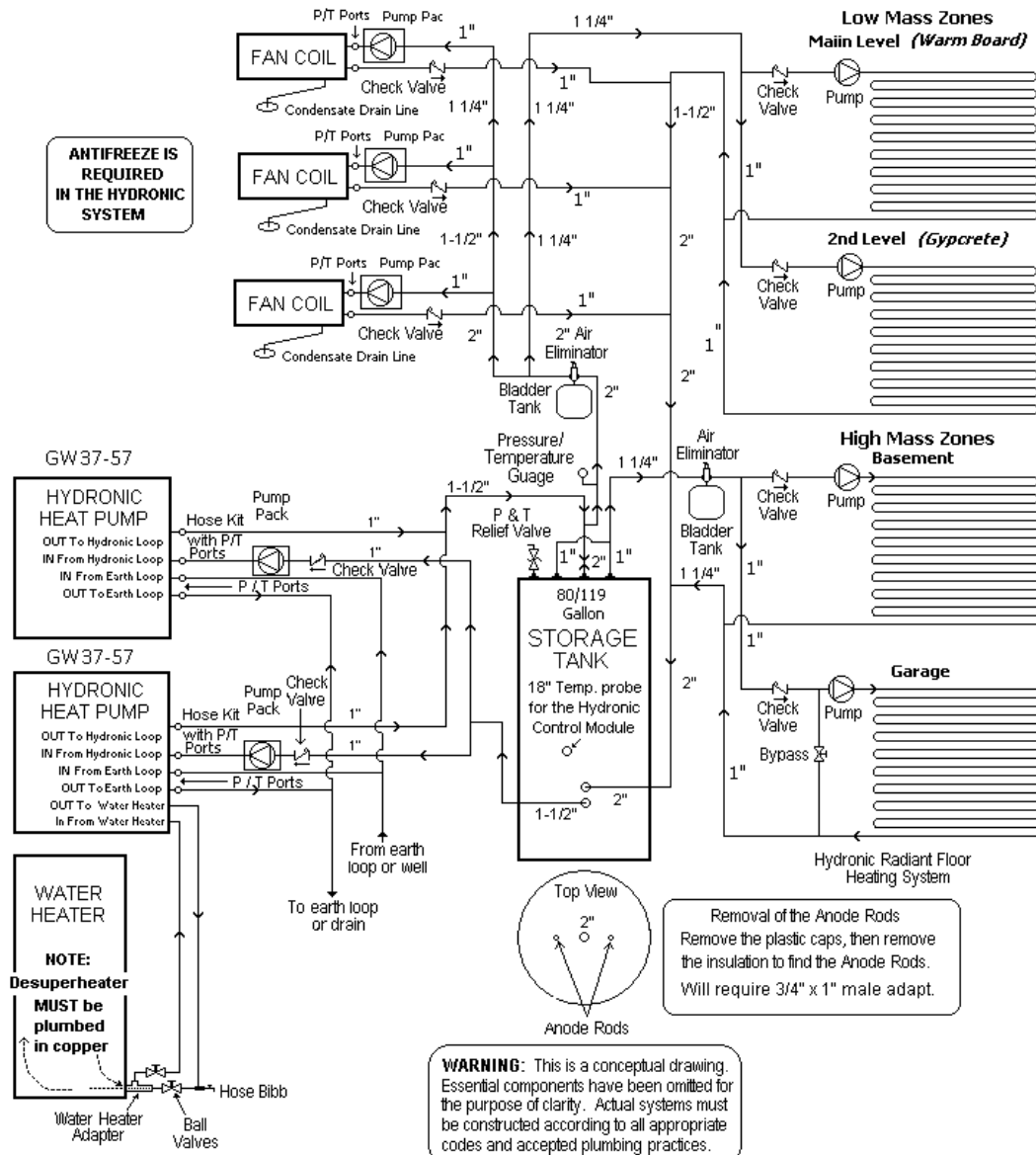
CONCEPTUAL PLUMBING DIAGRAM

GeoSource Ultra Hydronic Heat Pump with Desuperheater

Fan Coil Heating and Air Conditioning, Both High and Low Mass

Hydronic Radiant Floor Heating

Hyd. Plbg. Dia.
30A



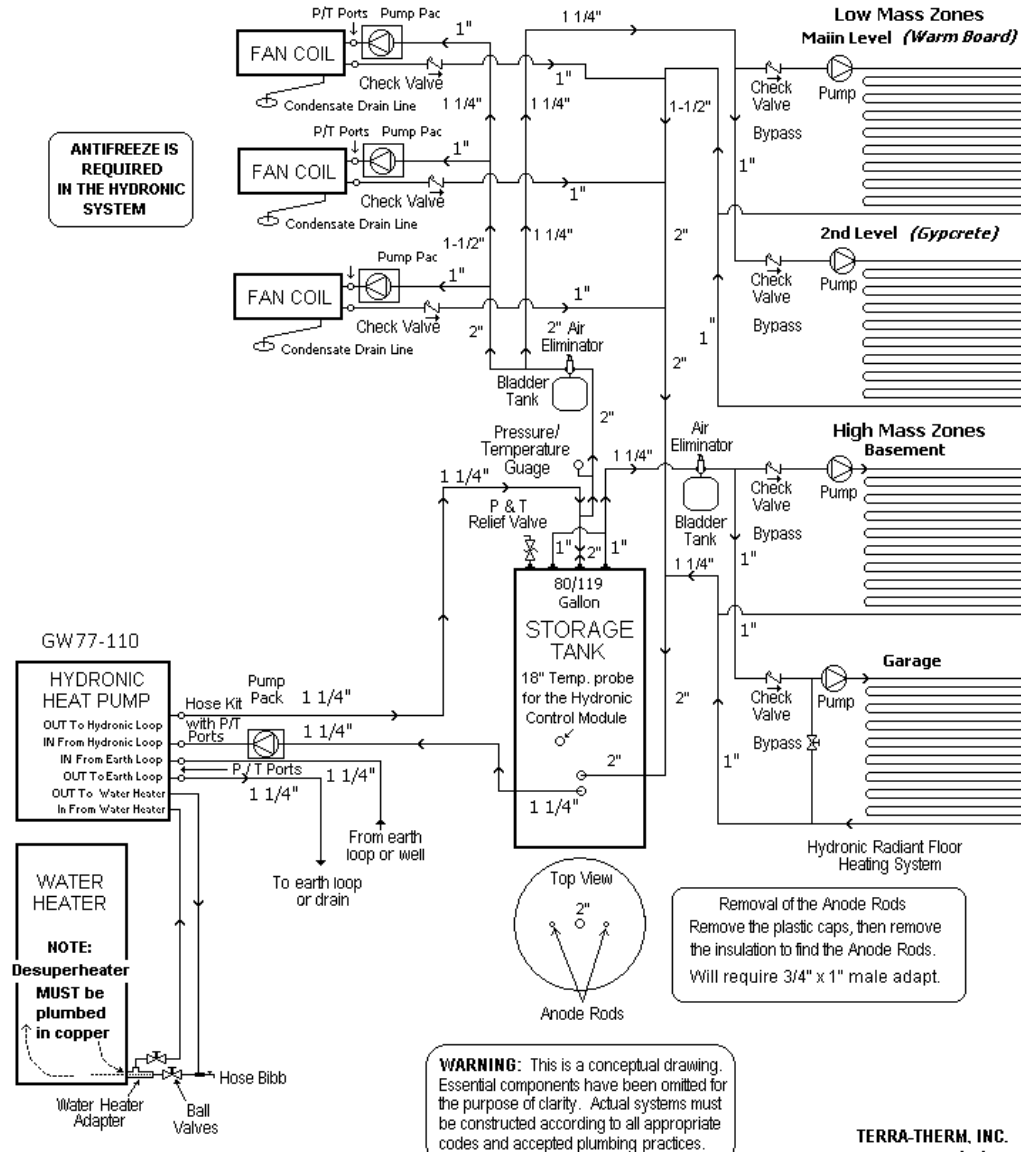
CONCEPTUAL PLUMBING DIAGRAM

GeoSource Ultra Hydronic Heat Pump with Desuperheater

Fan Coil Heating and Air Conditioning, Both High and Low Mass

Hydronic Radiant Floor Heating

Hyd. Plbg. Dia.
35A



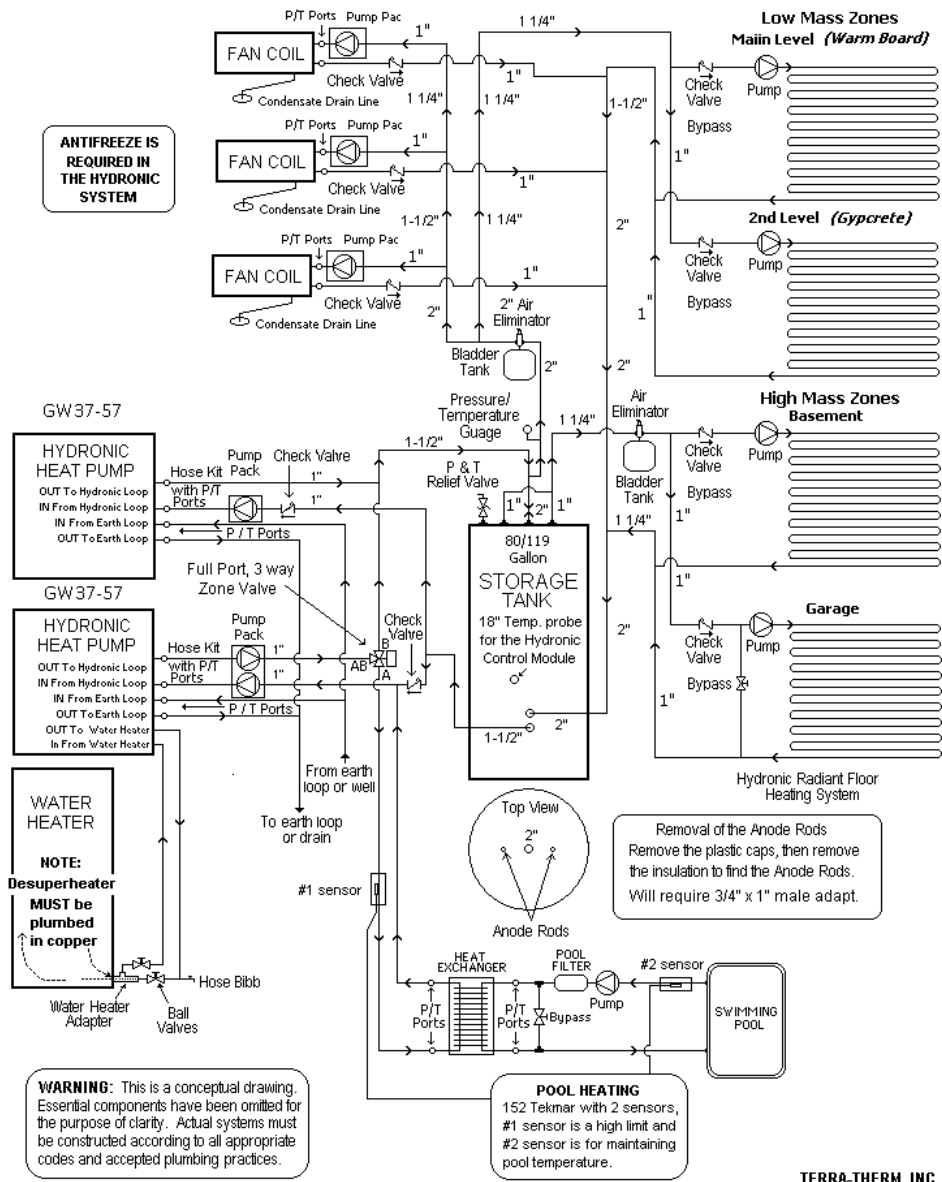
CONCEPTUAL PLUMBING DIAGRAM

GeoSource Ultra Hydronic Heat Pump with Desuperheater

Fan Coil Heating and Air Conditioning, Both High and Low Mass

Hydronic Radiant Floor Heating and Pool Heating

Hyd. Pibg. Dia.
40A



ANTIFREEZE IS REQUIRED IN THE HYDRONIC SYSTEM

GW37-57
HYDRONIC HEAT PUMP
OUT To Hydronic Loop
IN From Hydronic Loop
IN From Earth Loop
OUT To Earth Loop

GW37-57
HYDRONIC HEAT PUMP
OUT To Hydronic Loop
IN From Hydronic Loop
IN From Earth Loop
OUT To Earth Loop
OUT To Water Heater
IN From Water Heater

WATER HEATER
NOTE:
Desuperheater **MUST** be plumbed in copper

Removal of the Anode Rods
Remove the plastic caps, then remove the insulation to find the Anode Rods. Will require 3/4" x 1" male adapt.

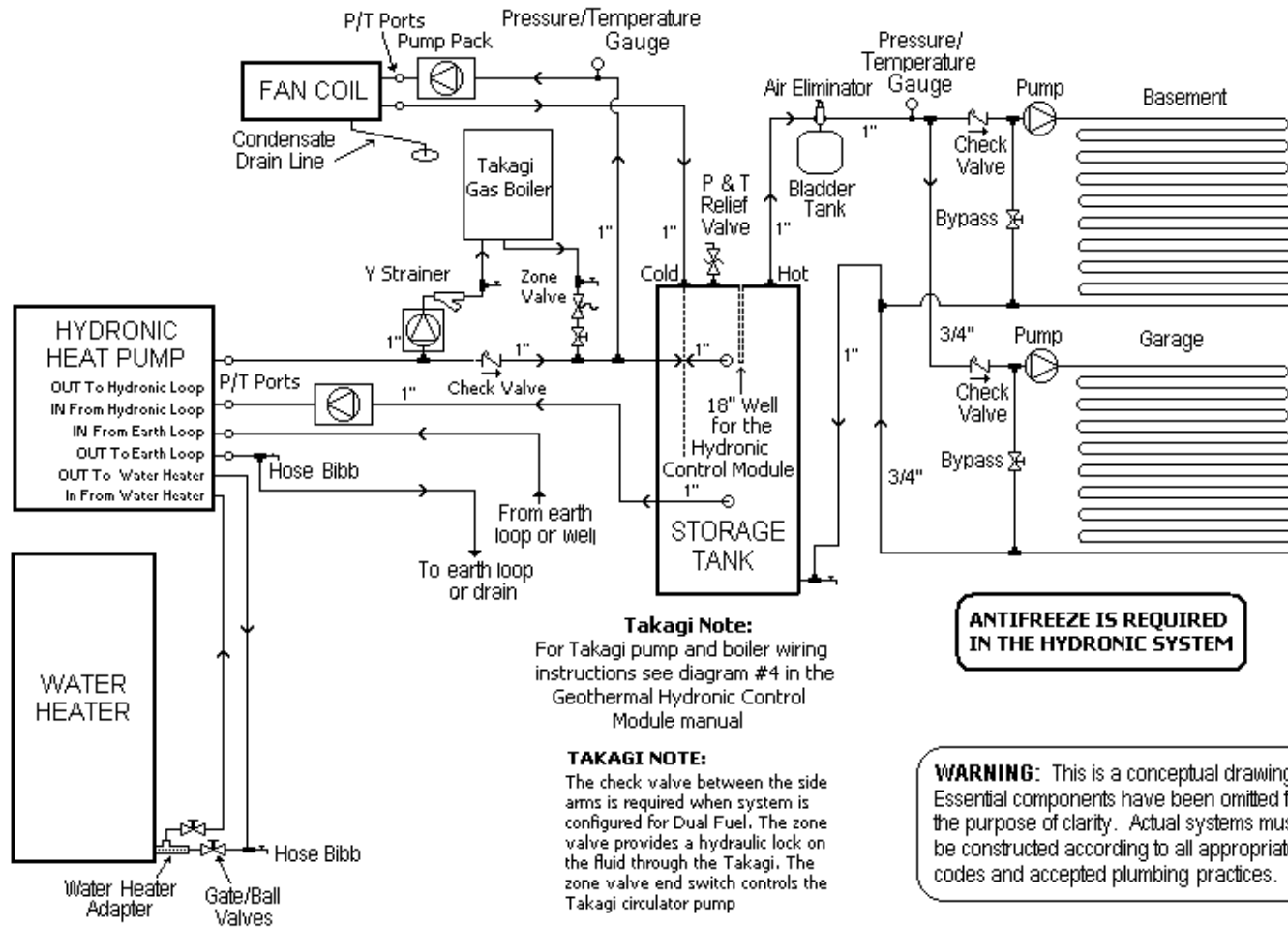


WARNING: This is a conceptual drawing. Essential components have been omitted for the purpose of clarity. Actual systems must be constructed according to all appropriate codes and accepted plumbing practices.

POOL HEATING
152 Tekmar with 2 sensors, #1 sensor is a high limit and #2 sensor is for maintaining pool temperature.

CONCEPTUAL PLUMBING DIAGRAM

GeoSource 2000 Hydronic Heat Pump with Desuperheater
Fan Coil Heating and Air Conditioning and Hydronic Radiant Floor Heating
With Takagi Gas Boiler Backup



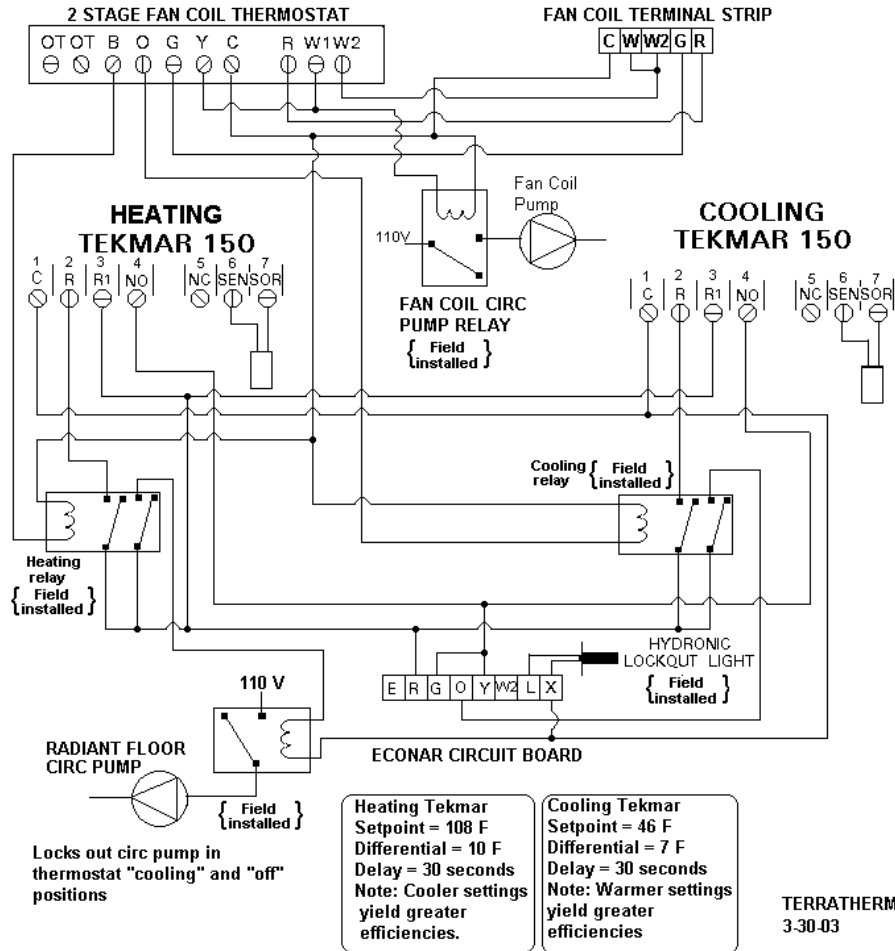
Common\Drawings\Heat Pump Systems with Boilers\1HP, 1FC, 3Z RFH Takagi

TERRA-THERM, INC.
3/22/10



HYDRONIC CONTROLS

FAN COIL HEATING & COOLING WITH TEKMAR CONTROLS THERMOSTAT SWITCHING



TERRA THERM HYDRONIC CONTROL WIRING

