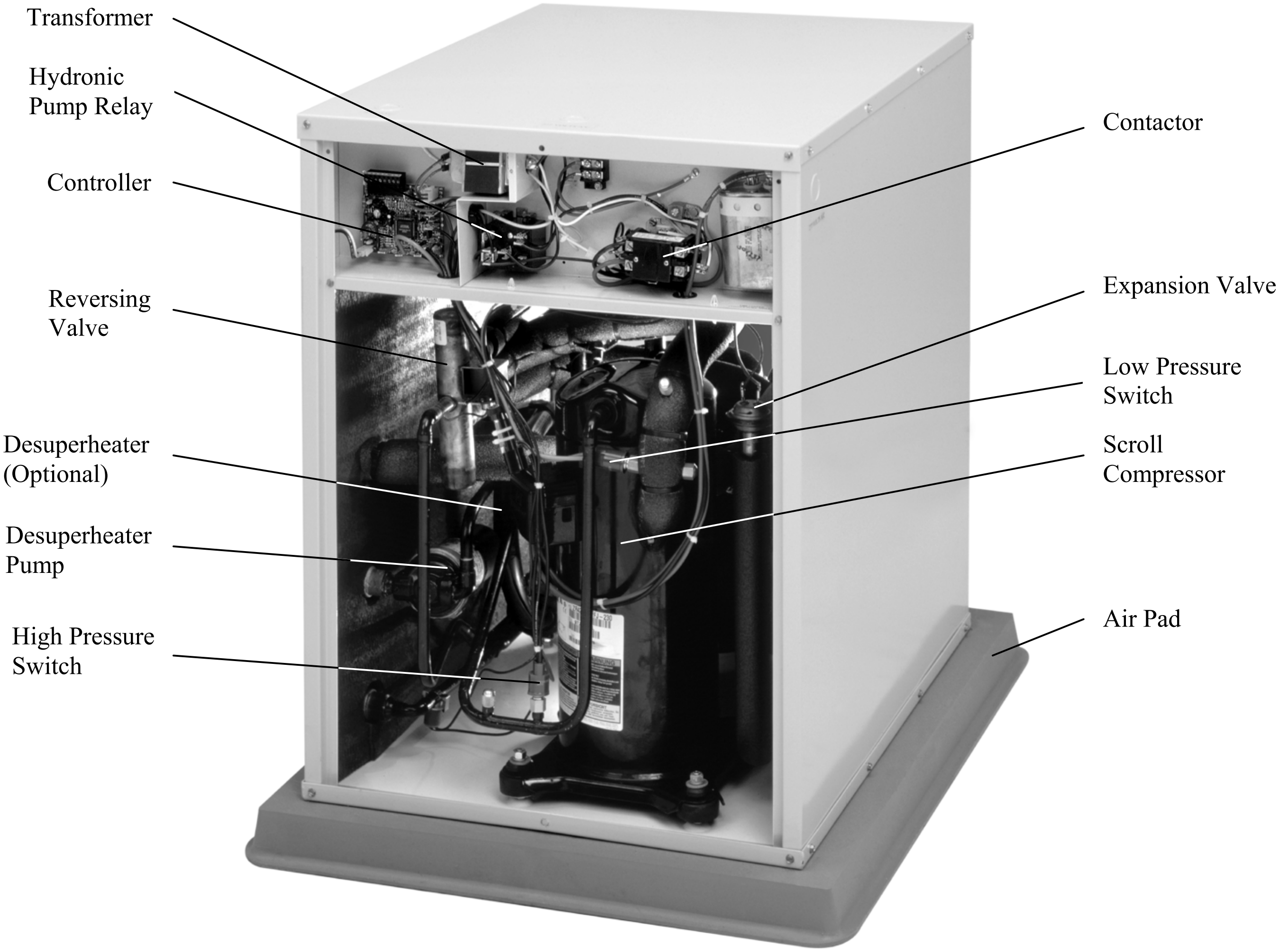
Installation
and
Operating Instructions

ECONAR®

Hydronic
GW 29 Thru 380 Series

GeoSource 2000™

GeoSource 2000 Hydronic Unit



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I. INTRODUCTION TO ECONAR HEAT PUMPS

ECONAR Energy Systems, Corp. has been producing geothermal heat pumps in Minnesota for over fifteen years. The cold winter climate has driven the design of ECONAR Energy System's heating and cooling equipment to what is known as a "Cold Climate" geothermal heat pump. This cold climate technology focuses on maximizing the energy savings available in heating dominated regions without sacrificing comfort. Extremely efficient cooling, dehumidification and optional domestic hot water heating are also provided in one neatly packaged system.

Geothermal heat pumps get their name from the transfer of heat to and from the earth. The earth coupled heat exchanger (geothermal loop) supplies the source energy for heating and absorbs the discharged energy from cooling. The system uses a compression cycle, much like your refrigerator, to collect the earth's energy supplied by the sun and uses it to heat your home. Since the process only moves heat and does not create it, the efficiencies are three to four times higher than the most efficient fossil fuel systems.

ECONAR produces three types of **GeoSource 2000** heat pumps: hydronic heat pumps, which transfer heat from water to water; forced air heat pumps, which transfer heat from water to air; and combination heat pumps, which incorporate the hydronic heating of a water to water unit into a forced air unit. This guide discusses the hydronic units.

ECONAR's hydronic heat pump transfers energy from the earth-coupled heat exchanger to hydronic heating and cooling equipment. Water-to-water heat pumps have the ability to supply heated or chilled water for use in a wide range of heating and cooling applications.

Safety and comfort are both inherent to, and designed into ECONAR Energy System's geothermal heat pumps. Since the system runs completely on electrical energy, your entire home can have the safety of being gas free. The best engineering and quality control is built into every ECONAR heat pump built. Proper application and correct installation will assure excellent performance and customer satisfaction.

ECONAR's commitment to quality is written on the side of every heat pump we build. Throughout the building process the technicians that build each unit sign their names to the quality assurance label after completing their inspections. As a final quality test, every unit goes through a full run test where the **performance and operation** is verified in both the heating and cooling modes. No other manufacturer goes as far as to run a full performance check to assure system quality.

**** IMPORTANT****

Service of refrigerant based equipment can be hazardous due to system pressure and 230 volt electrical energy. Only trained or qualified service personnel can install, repair or service refrigerant equipment.

☠ **Warning -** Turn off the main switches before performing service or maintenance to this unit. Electrical shock can cause personal injury. The installer is responsible to see that all local electrical, plumbing, heating and air conditioning codes are followed.

II. UNIT LOCATION/ MOUNTING

Locate the unit in an indoor area where the ambient temperature will remain above 45°F. Servicing of the heat pump is done primarily from the front. Rear access is desirable and should be provided when possible. A field installed drain pan is required under the entire unit where accidental water discharge could damage surrounding floors, walls or ceilings.

Units must be mounted on a vibration-absorbing pad slightly larger than the base to provide isolation between the unit and the floor. Water supply pumps should not be hard plumbed directly to the unit with copper pipe; this could transfer vibration from the water pump to the refrigeration circuit, causing a resonating sound. Hard plumbing could also transfer vibration noise from the unit through the piping to the living space.

✋**CAUTION** - Before driving screws into the cabinet, check on the inside of the unit to be sure the screw will not hit electrical or refrigeration lines.

III. EARTH LOOP WATER PIPING

Since water is the source of energy in the wintertime and the energy sink in the summertime, good water supply is possibly the most important requirement of a geothermal heat pump system installation. There are two common types of water supplies, closed loop systems and open loop systems.

A. Closed Loop Applications

A closed loop system recirculates the same water/ antifreeze solution through a closed system of underground high-density polyethylene pipe. As the solution passes through the pipe, it collects heat (in the heating mode) that is being transferred from the relatively warm surrounding soil through the pipe and into the relatively cold solution. The solution is circulated to the heat pump, which pulls heat out of the solution, and then back through the ground to extract more heat from the earth.

The **GeoSource 2000** is designed to operate on either vertical or horizontal closed loop applications. Vertical loops are typically installed with a well drilling rig up to 200 feet deep or more. Horizontal systems are typically installed with excavating or trenching equipment approximately six to eight feet deep, depending on geographic location and length of pipe used. Earth loops must be sized properly for each particular geographic area, soil type, and individual capacity requirements. Contact your local installer or ECONAR's Customer Support for loop sizing requirements in your area.

Since normal wintertime operating entering water temperatures (EWT) to the heat pump are from 25°F to 32°F, the solution in the earth loop must include antifreeze. GTF and propylene glycol are common antifreeze solutions. GTF is methanol-based antifreeze, which should be mixed 50% with water to achieve freeze protection of 10°F. Propylene glycol antifreeze solution should be mixed 25% with water to obtain a 15°F freeze protection. **DO NOT** mix more than 25% propylene glycol with water in an attempt to achieve a lower than 15°F freeze protection, since more concentrated mixtures of propylene glycol become too viscous at low temperatures and cannot be pumped through the earth loop. Insufficient amounts of antifreeze may result in a freeze rupture of the unit, and can cause unit shutdown problems during cold weather operation (when the heat pump experiences the longest run time) due to loop temperatures falling below the freeze protection of the loop solution.

Flow rate requirements for closed loops are higher than open loop systems because water temperatures supplied to the heat pump are generally lower (see Table 1). Between 2.5 to 3.0 gallons per minute (GPM) per ton are required for proper operation of the heat pump and the earth coupled heat exchanger.

Pressure/Temperature (P/T) ports should be installed in the entering and leaving water line of the heat pump on a closed loop system (see Figure 1). A thermometer can be inserted into the P/T ports to check entering and leaving water temperatures. A pressure gauge can also be inserted into these P/T ports to determine the pressure differential between the entering and leaving water. This pressure differential can then be compared to the specification data on each particular heat pump to determine the flow rate of the system.

A PumpPAK™ that is individually sized for each application can supply pumping requirements for the earth loop fluid. The PumpPAK™ can also be used to purge the loop system. The PumpPAK™ is wired directly to the contactor and operates whenever the compressor runs (see Electrical Diagram – Figure 7). If a PumpPAK™ is not used, a separate pump can be used which is energized with a pump relay (note: electrical code will require a fused disconnect for pumps other than PumpPAKs™).

Filling and purging a closed loop system are very important steps to assure proper heat pump operation. Each loop must be purged with enough water flow to assure a two feet per second flow rate in each circuit in the loop. This normally requires a 1½ to 3 HP high head pump to circulate fluid through the loop to remove all the air out of the loop and into a purging tank. Allow the pump to run 10 to 15 minutes after the last air bubbles have been removed. Enough antifreeze must be added to give a 10°F to 15°F freeze protection to the earth loop system. This amount should be calculated and added to the loop after purging is complete. After antifreeze has been installed it should be measured with a hydrometer, refractometer or any other device to determine the actual freezing point of the solution. Remember that a low antifreeze level will lock the heat pump out on low pressure during wintertime operation.

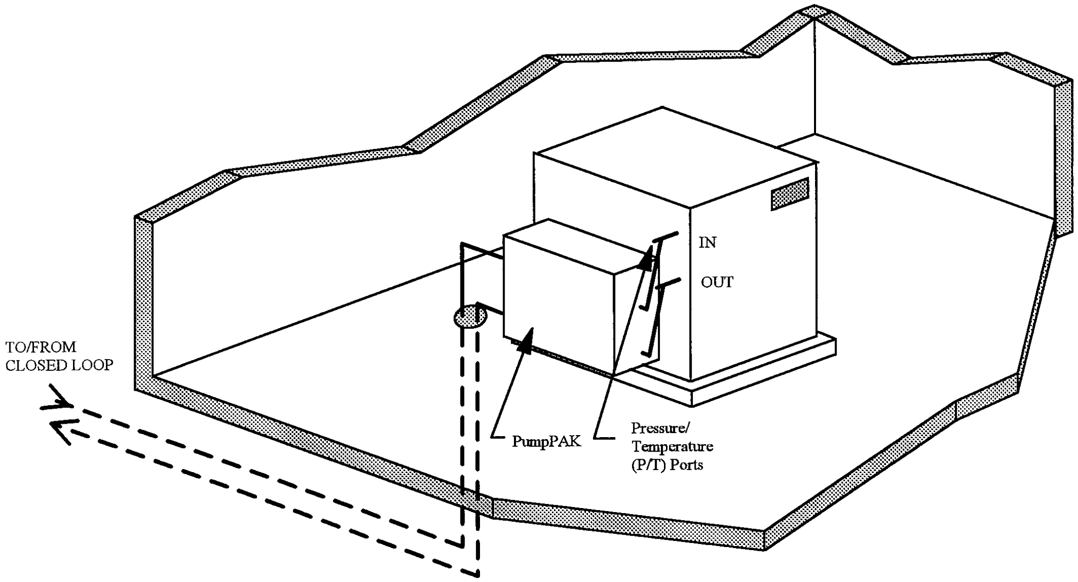


Figure 1 – Closed Loop Water Plumbing

The purge pump can be used to pressurize the system to an initial static pressure of 30 to 40 psi. Make sure the system is at this pressure after the loop pipe has had enough time to stretch. In order to achieve the 30 to 40 psi initial pressure, the loop may need to be pressurized to 60 to 65 psi. This static pressure will fluctuate from heating to cooling season, but the pressure should always remain above zero so circulation pumps do not cavitate and air cannot be pulled into the system. ☎For information regarding earth loop installations contact your local installer, distributor or factory representative.

Table 1 – Loop Side Flow Rates

Model	**Closed Loop**		**Open Loop**	
	Flow (gpm)	**dP (psi)**	**Flow (gpm)**	**dP (psi)**
GW29	7	4.0	4	1.5
GW36	8	5.5	4	1.5
GW42	10	7.8	5	1.7
GW52	11	5.2	6	1.6
GW59	13	17.0	8	5.6
GW67	14	7.0	10	3.8
GW98	22	3.8	14	2.7
GW120	26	4.5	16	3.0
GW380	78	8.3	N/A	

B. Open Loop Applications

An open system gets its name from the open discharge of water after it has been used by the heat pump. A well must be available that can supply all of the water requirements (see Table 1) of the heat pump along with any other water requirements drawing off that same well. The well must be capable of supplying the heat pump's required flow rate for up to 24 hours per day on the coldest winter day.

Figure 2 shows the necessary components for water piping of an open system. First, a bladder type pressure tank with a "draw down" of at least 1½ times the well pump capacity must be installed on the supply side of the heat pump. Shut off valves and boiler drains on the entering and leaving water lines are necessary for future maintenance issues. A screen strainer is placed on the supply line with a mesh size of 40 or 60 and enough surface area to allow for particle buildup between cleanings.

Pressure/Temperature (P/T) ports are placed in the supply and discharge lines so that thermometers or pressure gauges can be inserted into the water stream.

On the well water discharge side of the heat pump, a flow control valve must be mounted next to the heat pump to regulate the maximum water flow through the unit. A solenoid valve is then installed and wired to the accessory plug on the controller. This valve will open when the unit is running and close when the unit stops. A visual flow meter is then installed to allow visual inspection of the flow requirements. The flow meter is useful in determining when maintenance is required. (If you can't read the flow, cleaning is required. See Water Coil Maintenance for cleaning instructions.)

Schedule 40 PVC piping, copper tubing, polyethylene or rubber hose can be used for supply and discharge water lines. Make sure line sizes are large enough to supply the required flow with a reasonable pressure drop (generally 1" diameter minimum). **NOTE:** Do not use plastic female fittings with metal male fittings, or fractures may result in the female fittings. Always use plastic male <u>into</u> steel female!

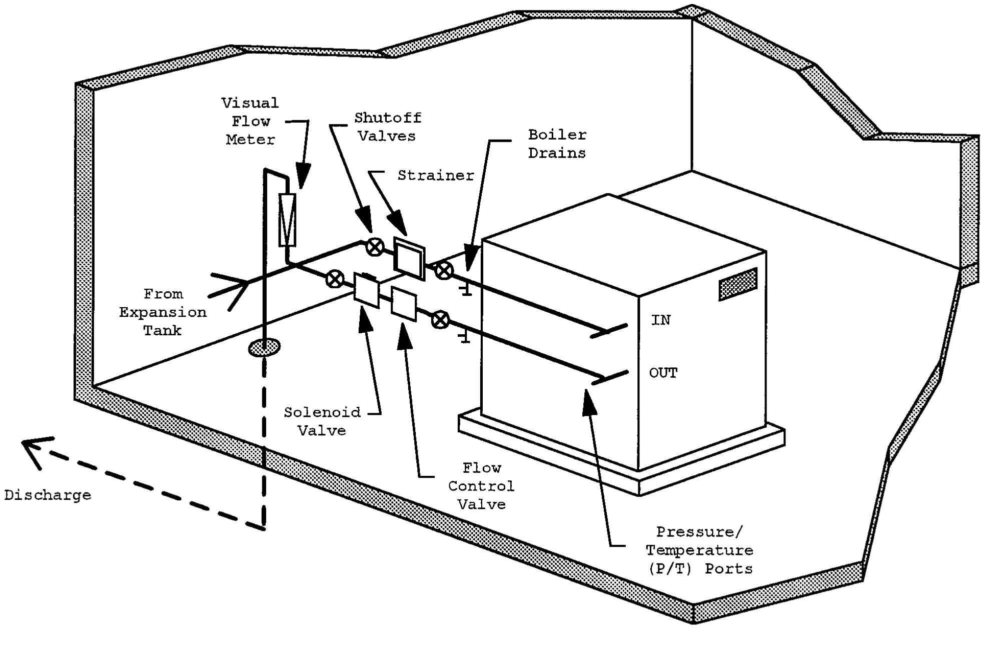


Figure 2 – Open Loop Water Plumbing

Water discharge is generally made to a drain field, stream, pond, surface discharge, tile line, or storm sewer.

✋**CAUTION**: Using a drain field requires soil conditions and adequate sizing to assure rapid percolation, or the required flow rates will not be achieved. Consult local codes and ordinances to assure compliance. **DO NOT** discharge water to a septic system.

The heat pump should never be operated with flow rates less than specified. Low flow rates or no flow may result in freezing water in the water to refrigerant heat exchanger. This will cause the unit to shut down on low-pressure lockout. If the unit locks out, verify that the unit has the required flow and reset the unit by shutting off power to the unit for one minute. ✋**DO NOT** continually reset the unit, if the unit locks out more than once call your service professional. ☎Continued reset of the unit can freeze water inside the water coil to the point of rupturing the water coil.

1. Open Loop Freeze Protection Switch

Heat pump installations on open loop systems, using a non-antifreeze protected water source during the heating mode, require the use of a freeze protection switch. If the water supply to the heat pump is interrupted for any reason, continued operation of the compressor would cause the water remaining in the water-to-refrigerant heat exchanger to freeze and rupture the copper inner tube. The freeze protection switch (ECONAR Part # 75-1028) will shut the unit down before freezing can occur and protect the heat pump in case of loss of flow. A freeze protection switch must be field installed on open loop **GeoSource 2000** heat pumps before the warranty can be registered on the heat pump. The switch mounts on the compressor's suction line and is wired to terminals on the controller (from X to FP). After the freeze protection switch is installed, the J4 jumper must be removed from the controller to activate the switch. The low pressure switch now locks the unit off at 35 psi pressure in the heating mode.

2. Water Coil Maintenance

Water quality is a major concern for open systems. Problems can occur from scaling, particle buildup, suspended solids, corrosion, pH levels outside the 7-9 range, or biological growth. If poor water quality is known to exist in your area, a cupro-nickel water coil may be required when ordering the system, or installing a closed loop system may be the best alternative. Water coil cleaning on open loop systems may be necessary on a regular basis. Depending on the specific water quality issue, the water coil can be cleaned by the following methods:

a. Freeze Cleaning (Scale deposits, particle buildup)

I. Before using the freeze cleaning procedure, verify that it needs to be done. Answer the following questions to determine if servicing is required.

1. Determine and verify that the required water flow rate in GPM is both present and correct.
2. Determine the temperature differential of the water. Under normal conditions, there should be a temperature difference of about 10-15 degrees between the supply side and discharge side. If the temperature difference is 8 degrees or less, consideration should then be given to cleaning the water coil heat exchanger.

II. If cleaning of the water coil is indicated, please carefully follow the steps listed below to utilize the freeze cleaning method.

1. Turn off the heat pump and its water supply.
2. Open a plumbing connection on the water supply side, if possible, to break the system vacuum and allow easier drainage of the system and water coil.
3. Drain the water out of the system and water coil via the boiler drains on the entering and leaving water lines, and the drain on the heat exchanger.

☠**WARNING!!** ☠ FAILURE TO COMPLETELY DRAIN THE WATER COIL HEAT EXCHANGER COULD POSSIBLY RESULT IN A FREEZE RUPTURE!

4. Set the thermostat to "Heat" to start the heat pump in the heating mode and quickly freeze the coil.
5. Allow the heat pump to run until it automatically shuts off on low pressure and then turn the thermostat to the "Off" position.
6. Recap the water coil drain and tighten any plumbing connections that may have been loosened.
7. If so equipped, open the field installed drain cock on the water discharge side of the heat pump, and install a short piece of rubber hose to allow drainage into a drain or bucket. A drain cock on the discharge side allows the water flow to bypass the solenoid valve, flow valve, flow meter, or any other item that may be clogged by mineral debris. Drainage to a bucket helps prevent the clogging of drains and allows you to visually determine the effectiveness of the procedure.
8. Turn on the water supply to the heat pump in order to start the process of flushing any mineral debris from the unit.
9. Set the thermostat to "Cool" and start the heat pump in the cooling mode to quickly thaw out the water coil.
10. Run the heat pump until the water coil is completely thawed out and any loosened scale, mineral deposits, or other debris buildup is flushed completely from the water coil. Allow at least 5 minutes of operation to ensure that the water coil is thoroughly thawed out.

11. If the water still contains mineral debris, and if the flow through the unit did not improve along with an increase in the temperature difference between the water supply and discharge, repeat the entire procedure listed above.
12. Reset the heat pump for normal operation.

b. Chlorine Cleaning (Bacterial Growth)

1. Turn the thermostat to the "Off" position.
2. Connect a submersible circulating pump to the hose bibs on the entering and leaving water sides of the heat exchanger.
3. Submerse the pump in a five-gallon pail of water and chlorine bleach mixture. The chlorine should be strong enough to kill the bacteria. Suggested initial mixture is 1 part chlorine bleach to 4 parts water.
4. Close the shut off valves upstream and downstream of the heat exchanger.
5. Open the hose bibs to allow circulation of the bleach solution.
6. Start the pump and circulate the solution through the heat exchanger for 15 minutes to one hour. The solution should change color to indicate the chlorine is killing the bacteria and removing it from the heat exchanger.
7. Flush the used solution down a drain by adding a fresh water supply to pail. Flush until the leaving water is clear.
8. Repeat this procedure until the solution runs clear through the chlorine circulation process.
9. Flush the entire heat pump system with water.

This procedure can be repeated annually, semiannually, or as often as it takes to keep bacteria out of the heat exchanger, or when bacteria appears in a visual flowmeter to the point the flow cannot be read.

Another alternative to bacteria problems is to shock your entire well. Shocking your well may give longer term relief from bacteria problems than cleaning your heat exchanger, but will probably need to be repeated, possibly every three to five years. ☎Contact a well driller in your area for more information.

c. Miratic Acid Cleaning (Difficult Scaling and Particle Buildup Problems)

1. Consult installer due to dangerous nature of acids.
2. Iron out solutions and de-scaling products are also useful.

IV. HYDRONIC HEAT EXCHANGERS

A. Radiant Floor Heating

Hydronic side heat exchangers can be a variety of different types. Probably the most popular form of hydronic heat exchangers is radiant floor heat tubing.

Radiant floor heating gives excellent comfort and very high efficiencies by supplying low temperature water to the floor slab, and keeping the heat concentrated evenly near the floor. Radiant floor systems heat the occupants and surfaces directly with radiant energy. Forced air heating moves heated air around the building, which transfers the heat to the occupants. Air movement can create drafts, temperature stratification, and air rising to the ceiling, which must be considered when designing heating systems. Always remember that hot air rises, heat does not.

Radiant floor heating usually consists of 1/2 inch plastic tubing, approximately one linear foot of pipe per square foot of floor space. This value is doubled for one pass along the outside walls to concentrate more heat in this area. The tubing is generally laid into the concrete slab floor of the building. New construction techniques have also made installation into wood floors and suspended floors possible. The amount and spacing of the tubing is sized to meet the capacity of the space at a certain fluid temperature inside the tubing. To optimize efficiency and capacity, the fluid temperature inside the tubing should be maintained as low as comfortably possible.

The type of floor covering and the spacing of the pipe in the floor have the greatest effect on operating fluid temperature. Table 2 gives a rough estimate of expected operating temperatures for specific floor coverings:

Table 2 – Expected Operating Floor Temps

Floor Covering	Temp (^{o}F)
Carpeting	115
Tile/Linoleum/Hard Wood	100
Concrete/Quarry Tile - Residential	85
Concrete/Quarry Tile - Commercial	70

ECONAR designs its hydronic heat pump line using a 115^{o}F leaving water temperature design point. This leaving water temperature is the ideal maximum fluid temperature for radiant floor systems. Operating temperatures higher than this would result in an uncomfortable hot feeling in the conditioned space. In fact, boilers connected to radiant floor heating systems must be restricted to a 115^{o}F maximum operating temperature by mixing valves or other control devices.

Distributors of radiant floor heat exchanger tubing can help size the length of pipe and fluid temperature required for your specific radiant floor heat exchanger applications. Be sure to include insulation under the slab and around the perimeter. Two inches of polystyrene under the slab and two to four inches on the perimeter down to a four-foot depth are required. This insulation reduces the heat loss to the ground and decreases the response time of the heating system. Building insulation is important in radiant floor heating, as in other methods of heating. Poorly insulated buildings can result in higher floor temperatures needed to heat the building, which could exceed the level of human comfort.

Night setback thermostats are not recommended on radiant floor systems due to the response time of the slab.

Radiant floor systems are not usually recommended for cooling, since cold, clammy floors and poor dehumidification may result. To provide cooling to a radiant floor heating installation, the installation of a fan coil unit is recommended. Another alternative is a **GeoSource 2000** combination heat pump.

B. Fan Coils

Fan coils can be used with ECONAR's hydronic heat pumps in the heating and cooling mode. In many cases, radiant floor heating and fan coil cooling are used together. Fan coils also provide dehumidification in the cooling mode. The rate of dehumidification can be adjusted by varying the fan coil operating temperature.

Fan coils are available in many different sizes and configurations, making them very flexible to your particular application. Valence heating and cooling systems, which use natural convection to move air, can also be very versatile.

☞**Note:** When selecting fan coil units for cooling use, make sure they include condensate pans.

Fan coils are sized for capacity at specific water temperature and flow rate combinations. Their sizing is also based on air temperatures, air flow rates (which remain constant based on fan speed selection and static pressure differential), and humidity conditions. The fan coils are then matched to the heat pump at a common system flow rate and operating temperature to provide the overall system capacity to a space load.

High static pressure fan coils have recently come onto the market, which work well with ECONAR's hydronic heat pumps. These systems provide heating and cooling for houses without ductwork. They use a high static pressure blower to supply air through small tubes, which run through chaseways to the living space. The blower passes air though a water-to-air coil that is coupled to a hydronic heat pump to provide heating and cooling. These systems work nicely on retrofit applications where ductwork isn't available or wanted. Fan coil data is available in Table 5.

C. Baseboard Heating

Another application of hydronic heating is finned tube baseboard heating. This is the same tubing used with boilers with one major difference. The discharge temperature of a boiler is much higher than geothermal heat pumps. The heat pump system should be sized at 115°F hydronic leaving water temperature to maintain efficiency. At a 125°F hydronic leaving water temperature, the heat pump is at a maximum operating temperature and may start to trip off on high head pressures. Standard 3/4" finned tube baseboard conductors have an average output of 230 Btuh/ft at 120°F hydronic leaving water temperature. In most cases there is not enough perimeter area in the conditioned space to allow for the required length of tubing to handle the entire heating load. There have been successful installations using baseboard as supplemental heating but many factors must be considered.

Cast iron radiators have been used successfully. If these radiators are rated for an output of 70 Btuh/square inch at a 130°F hydronic leaving water temperature, they work well with geothermal systems. Although the radiator may be rated at 130°F, the system should still operate at the standard 115°F leaving water temperature of the water-to-water heat pump.

D. Other Applications

Additional open loop hydronic applications such as outdoor swimming pools, hot tubs, whirlpools, tank heating, etc. are easily sized based on heat exchanger operating temperature and flow. The worksheet in Appendix 1 was taken from the ASHRAE 95 Applications Manual and can be used for outdoor swimming pool sizing. In many instances, sizing a heat pump to these applications comes down to recovery time. The larger the heat pump (within reason to avoid short cycling) the faster the system recovery time will be.

☞**Note:** Installing a plate heat exchanger (see Figure 6 for an example) between the heat pump and an open system is required when corrosive fluid is used in the open loop, especially on swimming pools where pH imbalance can damage the heat pump. ☞**Note:** Expect the maximum operating temperature of an indirect coupled application to be 10°F below the maximum operating temperature of the heat pump.

Other forms of closed loop systems such as indoor swimming pools, pretreated fresh air systems, snow melt systems, and valance heating/cooling systems are also very common with hydronic heat pumps. The sizing of the heat pump to these systems is more precise and information from the system manufacturer is required.

V. APPLICATIONS OF HYDRONIC HEAT EXCHANGERS

This section deals with some common practices used when coupling the ECONAR **GeoSource 2000** hydronic heat pumps to the space conditioning heat exchanger. There are so many possible applications for hydronic systems that they cannot all be covered in this text. Hopefully these ideas can help in many of your system designs.

☞**Note:** Actual systems must be constructed to all appropriate codes and according to accepted plumbing practices.

A. Storage Tanks

Coupling the heat pump to the space conditioning heat exchanger through a water storage tank is very common. In fact, the only instance where these storage tanks are not recommended is when the heat pump is coupled to a large heat exchanger capable of absorbing the entire heating or cooling capacity of the heat pump (see Figure 5). In applications that use multiple smaller zones, storage tanks absorb the relatively large amount of energy supplied by the heat pump, in order to provide longer run times and less compressor cycling for the heat pump. Storage tanks also serve to dispense energy in small amounts so that the conditioned zones have time to absorb heat without requiring high discharge water temperatures. Insulated hot water heaters are commonly used for storage tanks.

☞**Note:** While all hot water tanks are insulated on the top and sides, many do not have insulation on the bottom. An insulated pad beneath uninsulated tanks will reduce energy loss to the floor.

When properly sized, a storage tank eliminates many problems with multiple zone hydronic systems. These problems include excessive leaving water temperature if a single zone cannot dissipate heat quickly enough, and hydronic flow reduction through the heat pump when only one zone is calling. This may occur because the hydronic circulating pump is normally sized to provide the heat pump's required flow with all zones calling. When sizing storage tanks to the heat pump, a good rule of thumb is ten gallons of storage tank per ton of hydronic capacity.

The tank temperature can be controlled with a simple aquastat or a setpoint controller. The setpoint controller senses tank water temperature and outside air temperature to increase the tank temperature as the outside air temperature goes down. This control scheme provides the highest heating efficiencies by requiring the lowest possible water temperature to heat the space. Setting the optimal design temperatures in the controller is difficult, and the simple aquastat does have its advantages. To help in setpoint control, the following equation can be used.

$$\text{Reset Ratio} = \frac{\text{Design Water Temp – Indoor Design Temp}}{\text{Indoor Design Temp – Outdoor Design Temp}}$$

Always check local codes to be sure hot water heaters can be used as storage tanks. Using the electric elements in the tank as a secondary heat source to the heat pump is appealing in some applications, but special UL listing is required by many local codes. Specially listed hot water heaters are available.

B. Hydronic Side Circulators

Hydronic circulator pumps transfer the energy supplied by ECONAR's hydronic heat pumps to the space conditioning heat exchanger. When selecting a circulator, be sure to select a quiet operating pump with the ability to supply the required flow rate at the system pressure drop. The circulator supplying the heat pump should be placed in the water supply line into the unit to provide the best pump performance. Individual zone circulators should also be placed in the supply lines of the heat exchangers they serve. These pumps are often used as the on/off control mechanism for the zone they supply as shown in Figure 4. Zone valves are also commonly used for this purpose using a common pump (shown in Figures 3 and 6).

☞**Note:** Select a common pump at the total flow of all the zones and the highest pressure drop of any one parallel zone.

Small Grundfos pumps (230 VAC) can be used as circulator pumps. These pumps are impedance protected and do not require additional fusing if powered directly from the heat pump, since the heat pump is rated to accept up to a 1/3 horsepower circulator. If impedance protected pumps are not used, inline fuses should be supplied according to code.

Pumps must be sized to provide the required flow to a heat exchanger at its corresponding pressure drop. This pressure drop can be calculated from the total pressure drop through the piping, added to the pressure drop of the space conditioning heat exchanger. The hydronic side pressure drop through each particular heat pump is listed in Table 3. This table can be used for sizing the circulating pump between the hydronic side of the heat pump and a storage tank.

Table 3 – Storage Tank Circulators

	Hyd. Loop		**Grundfos**
Series	**Flow (gpm)**	**dP (psi)**	**Circulator**
29	4	1.5	15-42F (Brute)
36	5	1.7	15-42F (Brute)
42	6	2.8	15-42F (Brute)
52	7	4.8	26-116
59	9	7.0	26-116
67	11	11.7	26-116 x Two
98	15	4.0	26-116
120	18	4.5	26-116
380	54	4.0	N/A*

This table represents the minimum pump sizing required to supply the heat pump's required hydronic side flow rate at the pressure drop of the heat pump and 30 feet of 3/4" type K copper tubing or combination of elbows and pipe (1-1/4" pipe on 98, 120 series and 2" pipe on 380 series). *Hydronic side circulators for GW3800's should be sized for each specific installation.

A common problem with circulator pumps is trapped air in the system. This air accumulates in the suction port of the circulator causing cavitation in the pump, which leads to premature pump failure and noisy operation. The air can be eliminated by completely purging the system or by placing an air separator in the plumbing lines.

The entire system must be purged of air during initial installation and pressurized to a 10-25 psi static pressure to avoid air entering the system. This initial static pressure may fluctuate when going from the heating to cooling modes but should always remain above zero. If a leak in the system allows the static pressure to drop, the leak must be repaired to assure proper system operation. Air continually entering the loop can cause corrosion, bacteria, or pump cavitation.

The hydronic side circulator supplying the heat pump should be controlled to run only when the compressor is also running. If the pump is allowed to circulate cold water through the system during off cycles, the refrigerant in the heat pump will migrate to the hydronic side heat exchanger. This can cause heat pump starting problems (especially when this refrigerant migrates into the condenser).

C. Circulation Fluid

The fluid circulating through the hydronic side of the geothermal heat pump system is the transfer medium for the heating and cooling being supplied to the conditioned space. Selection of this fluid is very important. Water is the most readily available fluid but has the drawback of expansion during freezing which can damage the system. System operation in the cooling mode, extended power interruption to a structure, or disabling of an outside zone (such as a garage floor) provides the opportunity for freezing the circulating fluid.

Antifreeze must be used whenever the possibility of freezing exists from the environment or from use of the unit in the cooling mode. A propylene glycol based antifreeze (readily available through HVAC wholesalers) and water solution is recommended. Methanol based antifreeze is not recommended for use on any hydronic system where heat is being added to the system for structural heating purposes. Freeze protection for the hydronic side fluid down to 20°F (20% propylene glycol by volume in water) is recommended for most indoor applications (see Chart 1). Forty percent propylene glycol in water (-5°F freeze protection) is recommended by radiant tubing manufactures for snow melt applications, in order to protect the tubing from expansion in outdoor applications. Using over 40% in hydronic side applications can cause pumping problems due to high viscosity.

The water being added to the system should have 100-PPM grain hardness or less. If poor water conditions exist on the site, softened water is recommended, or acceptable water should be brought in. Bacteria or algae growth in the water is a possibility, especially bacteria or algae that thrive at the particular temperatures produced in the heating system. This growth can cause buildup on hydronic side heat exchanger surfaces, reducing the efficiency of the system or causing the heat pump to run at higher head pressures and possibly lock out. Adding a gallon of bleach or boiler system conditioner can reduce the possibility of growth and clean up visual flow meters and other components in the system.

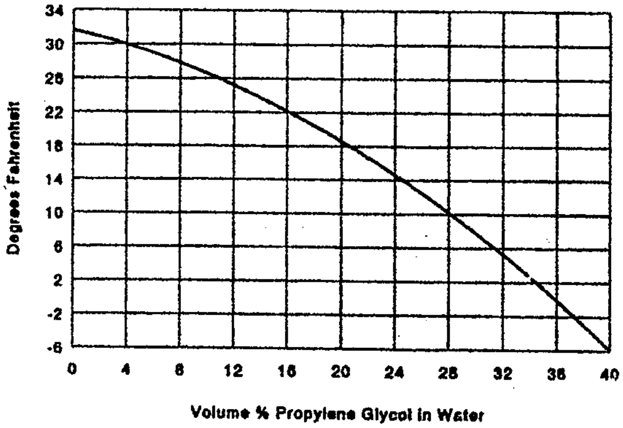


Chart 1 -Propylene Glycol/Water Solution Freeze Point

D. Expansion Tanks

Expansion tanks must be used in the hydronic side of the water-to-water system to absorb the change in pressure of the closed system due to the change in temperature when heat is supplied to the system. Diaphragm-type expansion tanks should be used. The diaphragm in these tanks is filled with pressurized air which expands or contracts to maintain a constant overall system pressure as the fluid in the system expands with increasing temperature. Use EPDM diaphragm tanks because they are compatible with glycol-based antifreeze fluids (butyl rubber diaphragms will slowly dissolve with glycol-based antifreezes).

Tanks from 1 to 10 gallons are generally used with heat pump systems in residential and light commercial applications. Expansion tanks should be installed in the system near the suction of the circulator pump whenever possible. This maintains positive pressure at the circulator pump and reduces the highest working pressure of the system. A pressure gauge near the inlet of the expansion tank gives a good indication of how the system is operating.

Pressure relief valves are required on all hydronic applications. A 30 psi relief is adequate if the system is operated at 12 to 15 psi pressure. If a hot water heater is used for a storage tank, the 150 psi pressure relief may be acceptable (check local codes).

E. Application Diagrams

Figures 3 through 6 show the components of a hydronic heat pump system discussed above used in some common applications. These figures by no means represent all the possible hydronic heat pump applications, but they do show some important principals that can be applied to any system.

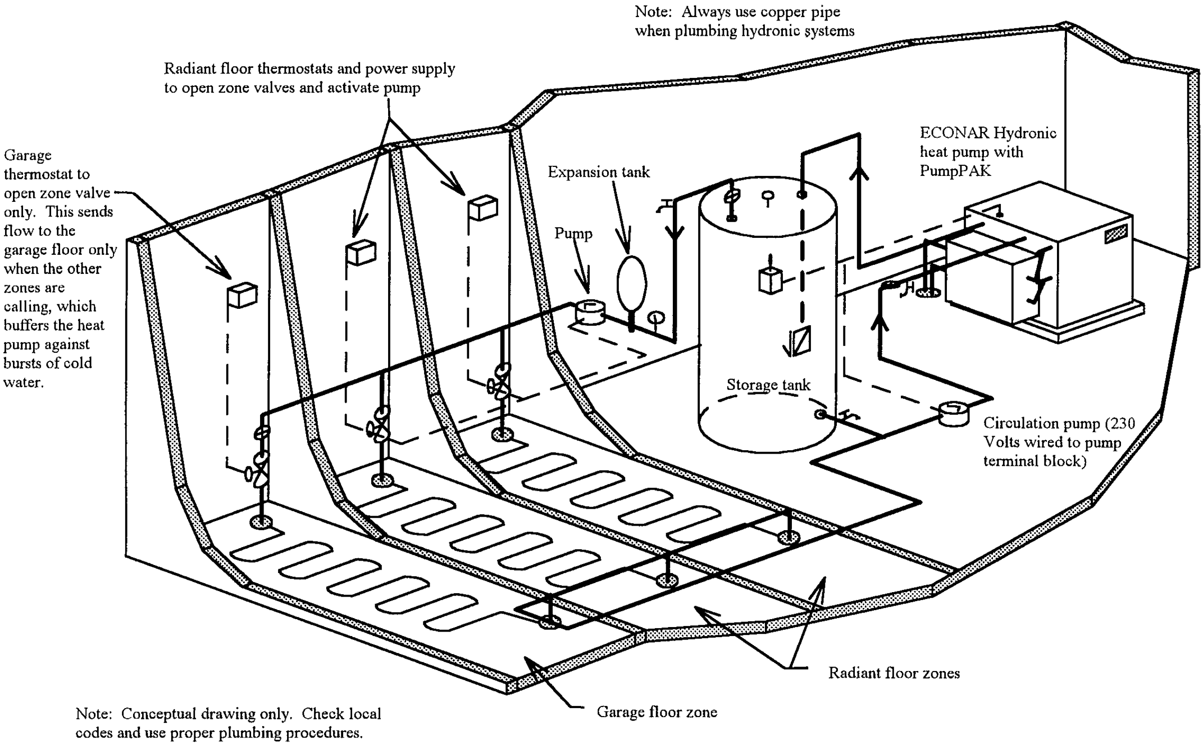


Figure 3 – ECONAR Hydronic Heat Pump – Multizone System

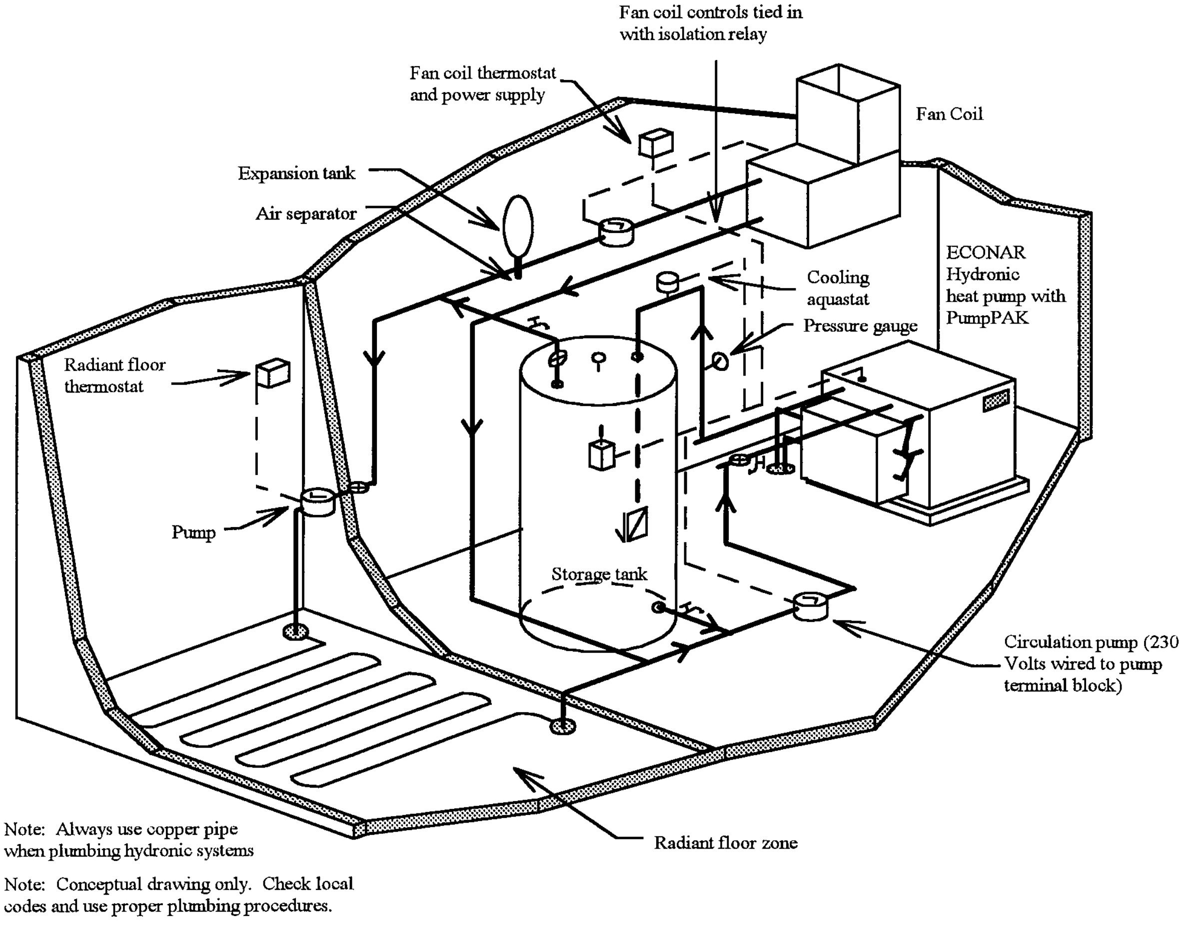
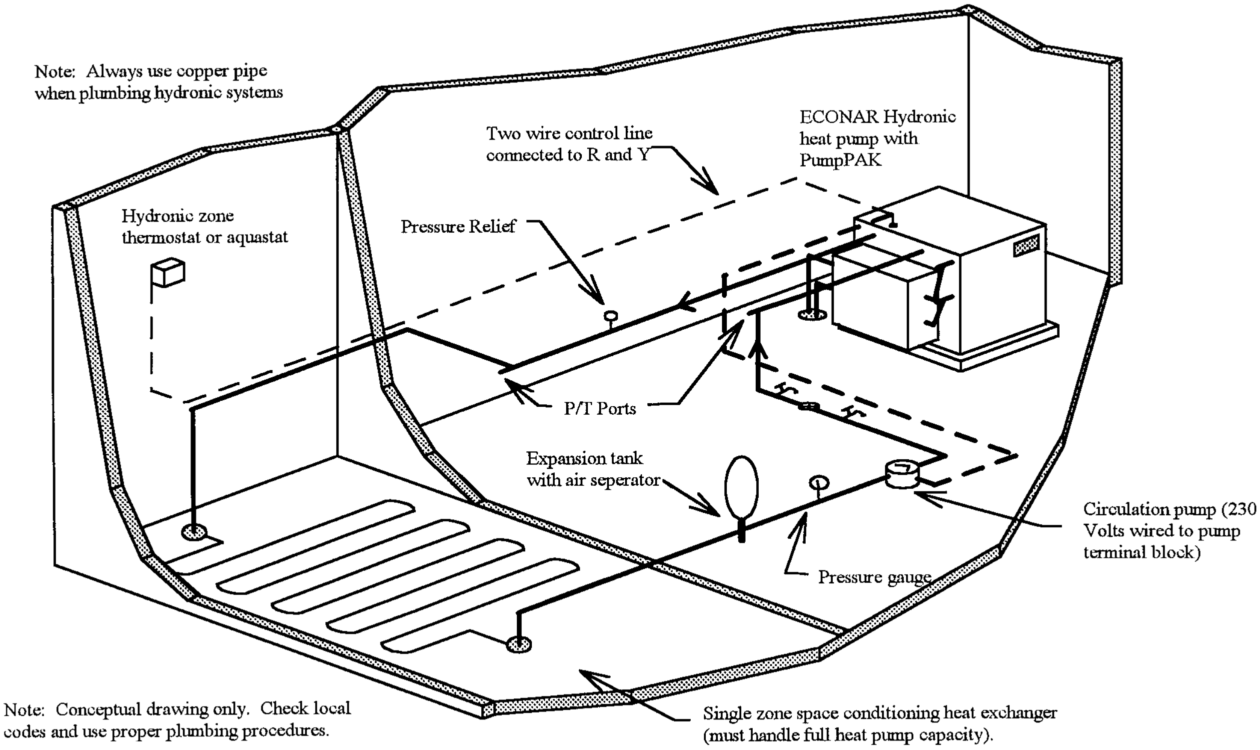
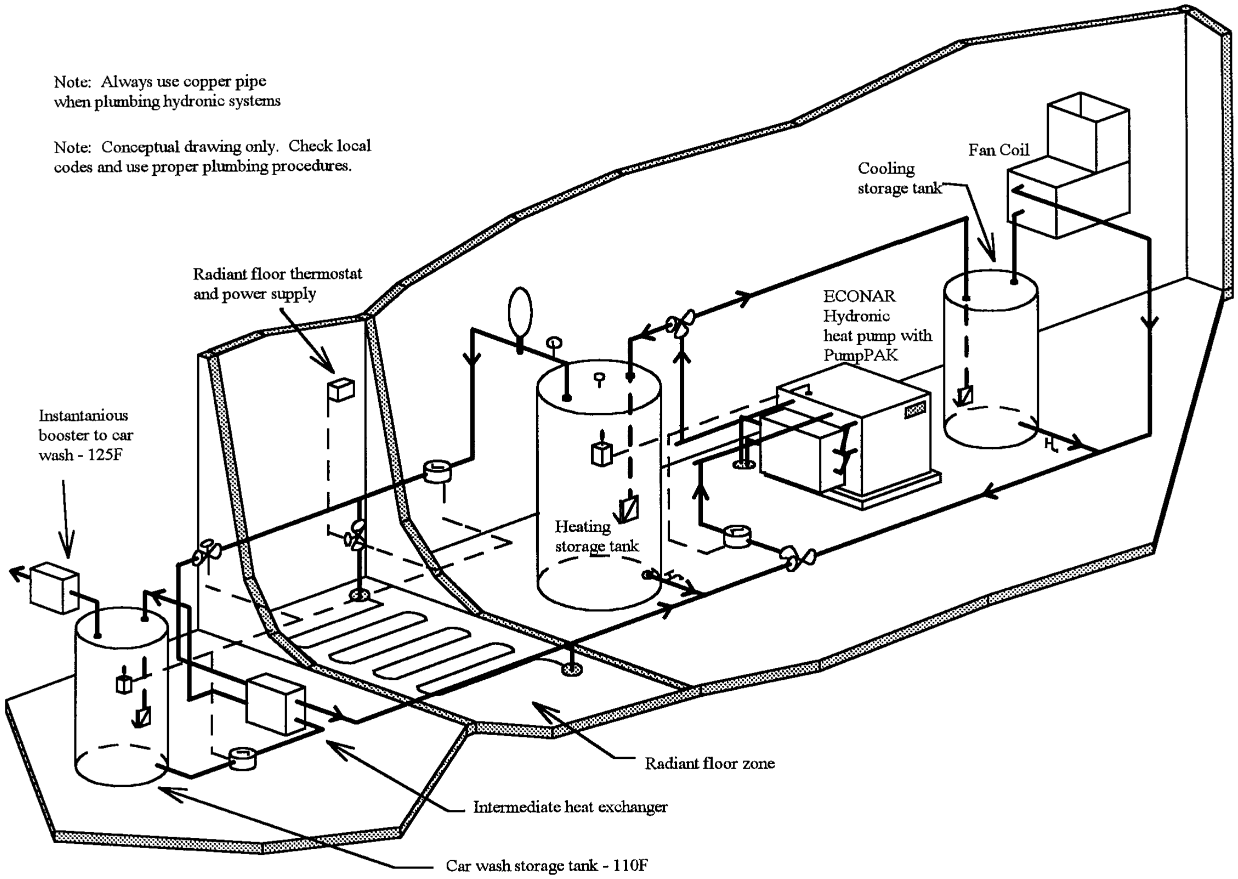


Figure 4 – ECONAR Hydronic Heat Pump – Radiant Floor Heating and Fan Coil Cooling


Note: Always use copper pipe when plumbing hydronic systems

Note: Conceptual drawing only. Check local codes and use proper plumbing procedures.

Figure 5 – ECONAR Hydronic Heat Pump – Single Zone Hydronic Heating Heat Exchanger


Note: Always use copper pipe when plumbing hydronic systems

Note: Conceptual drawing only. Check local codes and use proper plumbing procedures.

☞**Note:** Expect a 10°F temperature differential between supply tank and receiving tank when transferring heat with intermediate heat exchanger.

Figure 6 – ECONAR Hydronic Heat Pump – Supplying Radiant Floor Heating, Fan Coil Cooling, and Car Wash Water Heating for a Service Station

VI. UNIT SIZING

Selecting the unit capacity of a hydronic geothermal heat pump requires four things:

A) Earth Loop Configuration and Design Water Temperatures.
B) Hydronic Side Heat Exchanger Operating Temperatures.
C) Building Heat Loss/Heat Gain.
D) Temperature Limitations

A. Earth Loop Configuration and Design Water Temperatures

Loop configurations include the open and closed loop varieties. Heat pump flow rate requirements vary depending on loop configuration (see Table 1). Consult ECONAR's Engineering Specifications Manual for capacities at different loop entering water temperatures and hydronic leaving water temperatures.

1. Closed Loop Systems

Closed loop systems use a heat exchanger of high density polyethylene pipe buried underground to supply a tempered water solution back to the heat pump. Closed loops operate at higher flow rates than open loops since the entering water temperature (EWT) is lower. The loop EWT supplied to the heat pump has a great effect on the capacity of the unit in the heating mode. Earth loops in cold climates are normally sized to supply a wintertime EWT to the heat pump from 32°F down to 25°F, which minimizes the installation cost of the earth loop and still maintains proper system operation. The GPM requirements and pressure drops for loop pump sizing are shown in Table 1.

2. Open Loop Systems

On an open loop system the design water temperature will be the well water temperature in your geographic region. Many cold climates are in the 50°F range for well water temperature. If your well water temperatures are lower than 50°F, for instance Canadian well water can be as low as 43°F, the flow rate must be increased to avoid leaving water temperatures below the freezing point. If well water temperatures are above 50°F, as in some southern states where well water temperatures are above 70°F, the flow rates may need to be increased to dump heat more efficiently in the cooling mode.

Varying well water temperatures will have little effect on unit capacity in the cooling mode (since the well is connected to the heat pump condenser), but can have large effects on the capacity in the heating mode (since the well is connected to the evaporator). If well water temperatures are to exceed 70°F, special considerations, such as closed loop systems, should be addressed.

B. Hydronic Side Heat Exchanger Operating Temperatures

The hydronic side heat exchangers discussed in section IV are designed to operate at a specific fluid supply temperature. This operating temperature will have to be supplied to the selected space conditioning heat exchanger by the hydronic heat pump. The manufacturers or distributors of the hydronic side heat exchangers publish the capacity of their equipment at different operating temperatures and fluid flow rates. These capacities and operating temperatures are required to select the heat pump to be used in the system.

When selecting the heat pump, choose a unit that will supply the necessary heating or cooling capacity at the minimum and maximum hydronic loop temperature conditions respectively. Example; if a fan coil system requires 35000 Btu/hr to cool a space with 45°F water temperature entering the water-to-air fan coil, a GW42x **GeoSource 2000** heat pump is required to handle the cooling load.

If an intermediate heat exchanger is used between the storage tanks as pictured in Figure 6, expect a 10°F operating temperature difference between the two tanks. For example, if the direct coupled storage tank is at 120°F, expect the maximum operating temperature of the tank connected through an intermediate heat exchanger to be 110°F. This occurs when connecting open loop applications to the closed loop systems with plate heat exchangers or with indirect water heaters.

C. Building Heat Loss/Heat Gain

The space load must be estimated accurately for any successful HVAC installation. There are many guides or computer programs available for load estimation including the ECONAR GeoSource Heat Pump Handbook, Manual J, and others. After the heat loss/heat gain is completed, loop EWT's are established, and hydronic side heat exchanger conditions are determined, the heat pump can now be selected using the hydronic heat pump data found in the Engineering Specifications. Choose the capacity of the heat pump based on both heating and cooling load.

D. Temperature Limitations

Be aware of the operating range of the geothermal system when sizing the particular heat pump. An operating range of 15°F (minimum for heating) to 110°F (maximum for cooling) is required for the earth loop side. These limits have been established based on efficiency limitations and safety pressure switch limits (25-psi low-pressure cutout and 400-psi high-pressure cutout). Hydronic side limitations in heating have a minimum of 50°F HYD entering water temperature and a maximum of 130°F HYD leaving water temperature range (entering water to the hydronic side below 50°F gives low head pressures that drives the suction pressure below cutout conditions). Hydronic side limits in cooling fall into the 25°F entering water temperature range.

VII. ELECTRICAL SERVICE

The main electrical service must be protected by a fuse or circuit breaker, and be capable of providing the amperes required by the unit at nameplate voltage. All wiring shall comply with the national electrical code and/or any local codes that may apply. Access to the line voltage contactor is gained through the knockouts provided on either side of the heat pump next to the front corner. Route EMT or flexible conduit with appropriate 3-conductor wire to the contactor.

☠**WARNING - The unit must be properly grounded!**☠

✋**CAUTION:** Three-phase units **MUST** be wired properly to insure proper compressor rotation. Improper phasing may result in compressor damage. An electronic phase sequence indicator must be used to check supply-wiring phase. Also, the "Wild" leg of the three-phase power must be connected to the middle leg on the contactor.

When supplying power to external water pumps with the heat pump's power supply, use only impedance protected motors. An ECONAR PumpPAK™ can be wired directly to the contactor and grounded in the grounding lug. A pump relay and a terminal block (BP) are supplied in the electrical box for the hydronic side pump (not available on GW380's). The relay will start the pump with a call from the aquastat or thermostat. The pump relay is activated by power to Y on the terminal strip of hydronic units (wire Y to X). The use of impedance protected pumps eliminates the need for additional fusing. Do not connect more than a 1/3 horsepower pump to the internal pump relay.

If larger pumps are required, a separate power supply is required to supply the pump. To start this pump use a 24-volt relay pulled in from the Y and X terminals.

VIII. 24 VOLT CONTROL CIRCUIT

The wiring diagrams in Figures 7 and 8 show the low voltage controls of the heat pump and some generic external control schemes. This section will break down the three basic components of the low voltage circuit; transformer, thermostat/aquastat, and controller.

A. Transformer

Electrical diagrams are provided in Figures 7 and 8, and also on the electrical box cover panel of the heat pump. An internal 24-volt, 55 VA transformer (100 VA on GW380's) is provided to operate all control features of the heat pump. Even though the 55 VA transformer is larger than the industry standard 40 VA transformer, it can still be overloaded quickly when using it for control equipment like zone valves or fan coil relays. Table 4 shows the transformer usage for the hydronic heat pumps.

Table 4 – Transformer Usage (VA)

Component	29-67	98, 120	380
Contactor	7	7 x 2	14 x 2
Pump Relay	3	3	N/A
Reversing Valve	4	4	9
Controller	1	1	1
Thermostat	1	1	1
Total	16 VA	23 VA	39 VA
Available	39 VA	32 VA	61 VA

If the system's external controls require more than the VA available for external use from the transformer, an external transformer must be used. You can see that in Figure 5, the heat pump's internal transformer can easily power the external 24-Volt system. In contrast, Figure 4 shows a fan coil system with its own power supply, which must be coupled to the heat pump to put the heat pump into the cooling mode. This can be accomplished using an isolation relay which isolates the fan coil power supply from the heat pump's transformer (e.g. use the fan coils independent power supply to energize the coil of a relay, passing a signal across the N.O. contacts from the heat pump's transformer).

The heat pump's transformer can generally power simpler control systems consisting of a few relays or zone valves (depending, of course, on the VA draw of the components). On more complicated control systems the transformers capacity is used up very quickly.

☞**Note:** For units operating on 208V electrical service, the transformer must be switched to the correct lead (see electrical diagram – Figures 7 and 8). Units are factory shipped with the transformer set for 240V service. Operating a unit on 208V with the transformer set to 240V will cause the unit to operate with lower than normal control voltage.

B. Thermostat/Aquastat

Consult the instructions in the thermostat box for proper mounting and thermostat operation.

✋ **CAUTION**- miswiring of control voltage on system controls can result in transformer burnout.

☞**Note:** If a single thermostat controls multiple heat pumps, the control wiring of the heat pumps must be isolated from each other. This will prevent the heat pumps from receiving high voltage through the common wiring if it is turned off at the circuit breaker for service.

Power is supplied to the thermostat by connecting the R and X terminals to the heat pump terminal strip. The Y terminal energizes the compressor. The unit is put into the cooling mode when the thermostat energizes the O terminal, which operates the 4-way reversing valve. The L terminal is used to power the lockout LED on a thermostat, which indicates a compressor lockout. The pump relay is connected to the circulation pump's 3 pole, high voltage terminal block (BP). The hydronic side circulation pump receives power from BP, which is energized by the pump relay.

A simple, single stage heating aquastat on a storage tank or wall mounted thermostat may be all that is required for simple heat only systems. This aquastat closes and passes power to the Y terminal, energizing the compressor and circulation pumps in the heating mode. When mounting an aquastat inside a storage tank, always use a submersible type aquastat. The aquastat should be installed approximately 1/3 of the way down into the tank. Set the aquastat differential to 15°F to avoid short cycling

A cooling aquastat can be mounted on the water supply line, as shown in Figure 4. This aquastat acts as a low limit, which shuts the heat pump down when the cooling water reaches a minimum (e.g. 35°F).

Changeover from heating to cooling can be achieved in two ways:

1) A manual toggle switch to select the control aquastat (heating or cooling)
2) A cooling thermostat which powers the coil of a single pole/double throw relay which selects the heating aquastat (normally closed contact) or cooling aquastat (normally open contact) shown in Figure 4.

☞**Note:** Always wire the system to shut down (Anti-short-cycle) between a heating and cooling mode changeover. Nuisance trip-outs could occur from changing modes “on the fly”.

Any number or types of thermostats, aquastats, or switches can be used with an independent power supply (typically a 24-volt transformer) to activate specific zone controls. These zone controls are normally either a zone pump (Figure 4) or zone valves (Figures 3 and 6). End switches on the zone valves can be used to pass a signal to a pump relay when the zone valve is open. The pump relay then activates a common pump, which supplies any number of zones. Example: the fan coil in Figure 4 could be supplied by the same pump as the radiant floor system if zone valves were used instead of two pumps.

☞**Note:** A common maximum aquastat setpoint is 115°F (with a 15°F differential). The tank will then shut down when it reaches 115°F, however, the leaving water temperature from the heat pump is actually 130°F (the maximum operating temperature). The aquastat maximum setpoint should limit the head pressure of the heat pump to 325 psi.

If a thermostat is equipped with an anticipator it should be set to its maximum setting to avoid interfering with heat pump operation. The anticipator is a resistor in the thermostat that heats up as current is drawn through and satisfies the thermostat prematurely. This reduces system capacity by restricting run time.

C. Controller

The controller receives a signal from the thermostat and initiates the correct sequence of operations for the heat pump. The controller performs the following functions:

1) Earth Loop Pump Initiation
2) Compressor Operation
3) 4-Way Valve Control
4) Compressor Lockouts
5) Compressor Anti-Short-Cycle
6) System Diagnostics

1. Earth Loop Pump Initiation

If a PumpPAK™ is used, it should be wired directly to the contactor of the compressor. If a PumpPAK™ is not used, a separate pump can be used which is energized with a pump relay (Note: electrical code will require a fused disconnect for pumps other than PumpPAKs™). When there is a call for an M1 output from the controller, the contactor will energize, starting the compressor and earth loop pump.

2. Compressor Operation

A Y1 signal from the thermostat will ask the controller to initiate heating or cooling. The controller then decides, based on lockout and anti-short-cycle periods, when to bring the compressor on. The M1 output of the controller energizes the compressor. This compressor stays on until on the thermostat is satisfied.

3. 4-Way Valve Control

The controller energizes the 4-way reversing valve to direct the flow of refrigerant. When the thermostat calls for cooling on the O terminal, the controller energizes its O output to send control power to the reversing valve (VR), to switch the refrigerant circuit to the cooling mode.

4. Compressor Lockouts

A compressor lockout occurs if the high-pressure, low pressure, or freeze protection pressure switches open. The controller blocks the signal from the thermostat to the contactor that normally would energize the compressor. In the event of a compressor lockout the controller will send a signal from L on the terminal strip to an LED on the thermostat to indicate a lockout condition. This lockout condition means that the unit has shut itself down to protect itself, and will not come back on until power has been disconnected (via the circuit breaker) to the heat pump for one minute. Problems that could cause a lockout situation include:

1. Water flow or temperature problems
2. Internal heat pump operation problems
3. Cold ambient air temperature conditions

☎If a lockout condition exists, the heat pump should not be reset more than once; a service technician should be called immediately.

✋The cause of the lockout must be determined. Repeated reset may cause damage to the system.

5. Compressor Anti-Short-Cycle

An anti-short-cycle is a delay period between the time a compressor shuts down and when it is allowed to come on again. This protects the compressor and avoids nuisance lockout conditions. Anti-short-cycles occur after these two conditions;

1. A 30 second to one minute time-out period occurs on the compressor before it will start after its last shutdown.
2. A 4 minute 35 second delay is incorporated into the timing function immediately after power is applied to the heat pump. This occurs only after reapplying power to the unit. To avoid this timeout while servicing the unit, apply power, disconnect and reapply power very quickly. This can sometimes eliminate the waiting period.

6. System Diagnostics

The controller is equipped with diagnostic LED lights which indicate the system status at any particular time. The lights indicate the following conditions:

1. 24 Volt system power	GREEN
2. Fault or Lockout	YELLOW
3. Anti-short-cycle mode	RED

IX. STARTUP

Before applying power to the heat pump, check the following items:

- Water supply plumbing to the heat pump is completed and operating. Manually open the water valve on well systems to check flow. Make sure all valves are open and air has been purged from a loop system. Never operate the system without correct water supply.
- Low voltage wiring of the thermostat and any additional control wiring is complete. Set thermostat to the "OFF" position.
- All high voltage wiring is correct including fuses, breakers, and wire sizes.
- The heat pump is located in a warm area (above 45°F). Starting the system with low ambient temperature conditions is more difficult; do not leave the area until the space is brought up to operating temperatures.
- Hydronic side water temperatures are warm enough (50°F or above) to start in the heating mode.
- The hydronic side water flow rate is correct (shown in Table 1). Low water temperature starting may require flow reduction until the system is up to operating temperature.

You may now apply power to the unit. A 4 minute 35 second delay on power up is programmed into the heat pump before the compressor will operate. During this time the pump relay will energize the hydronic side-circulating pump. Verify that the flow rate and temperature of the hydronic side flow are at the recommended levels.

The following steps will assure that your system is heating and cooling properly. After the initial time-out period is completed, the red indicator light on the controller will shut off. The heat pump is now ready for operation.

- Turn the thermostat up to its highest temperature setting. Place the thermostat to the "HEAT" position. The compressor should start 1 to 2 seconds later. If an electronic thermostat is used it may cause its own compressor delay at this time, but the compressor will come on after the time-out period.
- After the unit has run for 5 minutes, check the hydronic side return and supply water temperatures. A water temperature rise of 10°F to 15°F is normal in the heating mode, but variations in water temperature and water flow rate can cause variations outside the normal range.
- Turn the thermostat to the "OFF" position. The compressor will shut down in 1 to 2 seconds.
- Next, turn the thermostat down to its lowest setting. Place the thermostat in the "COOL" position. The compressor will start after an anti-short-cycle period of 2 to 3 minutes from its last shutdown. The anti-short-cycle period is indicated by the red light on the controller.
- After the unit has run for 5 minutes, check the hydronic side return and supply water temperatures. A water temperature drop of 10°F to 15°F is normal in the cooling mode but factors mentioned in the heating section can also effect temperature drop.
- Set the thermostat for normal operation.
- Instruct the owner on correct operation of the thermostat and heat pump system. The unit is now operational.

The heat pump is equipped with both high and low pressure switches that shut the unit off if the refrigerant pressure exceeds 400 psi or goes below 25 psi. If the system exceeds 400 psi, the high-pressure switch will trip and lock the unit off until power has been disconnected at the circuit breaker for approximately one minute. System pressures below 25 psi in the heating mode will trip the low pressure switch and lock the unit out until the power supply has been de-energized for one minute. On a well water system, the freeze protection switch (field installed part number 75-1028) will activate the lockout at 35 psi in the heating mode to protect the water coil against freeze rupture. After resetting a lockout (by disconnecting power to the unit) verify that water flow is at the recommended levels before energizing the compressor. **DO NOT** reset a well water system without verifying water flow. **DO NOT** reset the system more than once.

✋Repeated resetting of the lockout can cause serious damage if the reason for lockout is not corrected.

☠ - **If lockout occurs more than once contact your ECONAR dealer immediately.** ☎

X. SERVICE

Regular service to a **GeoSource 2000** hydronic heat pump is very limited. Setting up regular service checkups with your ECONAR dealer could be considered. Any major problems with the heat pump system operation will be indicated on the thermostat lockout light.

A. Lockout Lights

A lockout light on the thermostat will light to indicate major system problems. If lockout occurs, follow the procedure below:

1) Check for correct water supply from the earth loop or well water system.
2) Reset the system by disconnecting power at the circuit breaker for one minute and then reapplying power.
3) If shutdown reoccurs, check the indicator lights on the controller in the unit and review the lockout troubleshooting guide in section XI of this manual.
4) ☎If lockouts persist, call your ECONAR dealer. Do not continuously reset the lockout condition or damage may occur.

XI. THERMOSTAT OPERATION

This section covers basic operation of the standard 2-heat 1-cool thermostat that ECONAR carries. This thermostat is ECONAR part number 70-2002, Honeywell part number T8511G. If your thermostat is a different style, please refer to the instructions supplied with that thermostat.

The settings of the thermostat are controlled with the “System”, “Fan”, “i”, up key, and down key buttons. The System and Fan buttons are located behind the flip-down panel.

By pressing the “System” button, you can control the mode that the thermostat operates in. The five system settings are:

1. Em. Heat – Controls backup heating. In this mode, the heat pump’s compressor is locked out, and only the backup heating elements (if installed) operate.
2. Heat – Controls normal heating operation.
3. Off – Both heating and cooling are off.
4. Cool – Controls normal cooling operation.
5. Auto – The thermostat automatically changes between heating and cooling operation, depending on the indoor temperature.

Note: When the thermostat is set to Auto, there must be at least a 2^{o}F difference between the Heating setpoint temperature and the Cooling setpoint temperature.

The “Fan” button controls the operation of the heat pump’s blower. The Fan button has two settings:

1. On – The blower operates continuously.
2. Auto – The blower operates with either a heating or cooling call.

By pressing the “i”, or information, key, you can cycle through your temperature setpoints. If you wish to change a temperature setting, press either the up key or down key when the appropriate mode is displayed. For example, you wish to change the heating setpoint from 68^{o}F to 70^{o}F. Push the “i” key until the heating setpoint appears on the LCD display. Then, press the up key until the desired setpoint is reached. The thermostat will automatically switch back to the room temperature display after a few seconds.

If the LED on the bottom of the thermostat is lit, your heat pump has locked itself out to protect itself. If this occurs, please see the Compressor Lockout section of this manual.

If you have additional questions about your thermostat, please see the installation manual that was sent with the thermostat.

XII. TROUBLESHOOTING GUIDE FOR LOCKOUT CONDITIONS

If the heat pump goes into lockout on a high or low pressure switch, the cause of the lockout can be narrowed down by knowing the operating mode and which pressure switch the unit locked out on. The following table will help track down the problem once this information is known. Note: A lockout condition is a result of the heat pump shutting itself off to protect itself, never bypass the lockout circuit. Serious damage can be caused by the system operating without lockout protection.

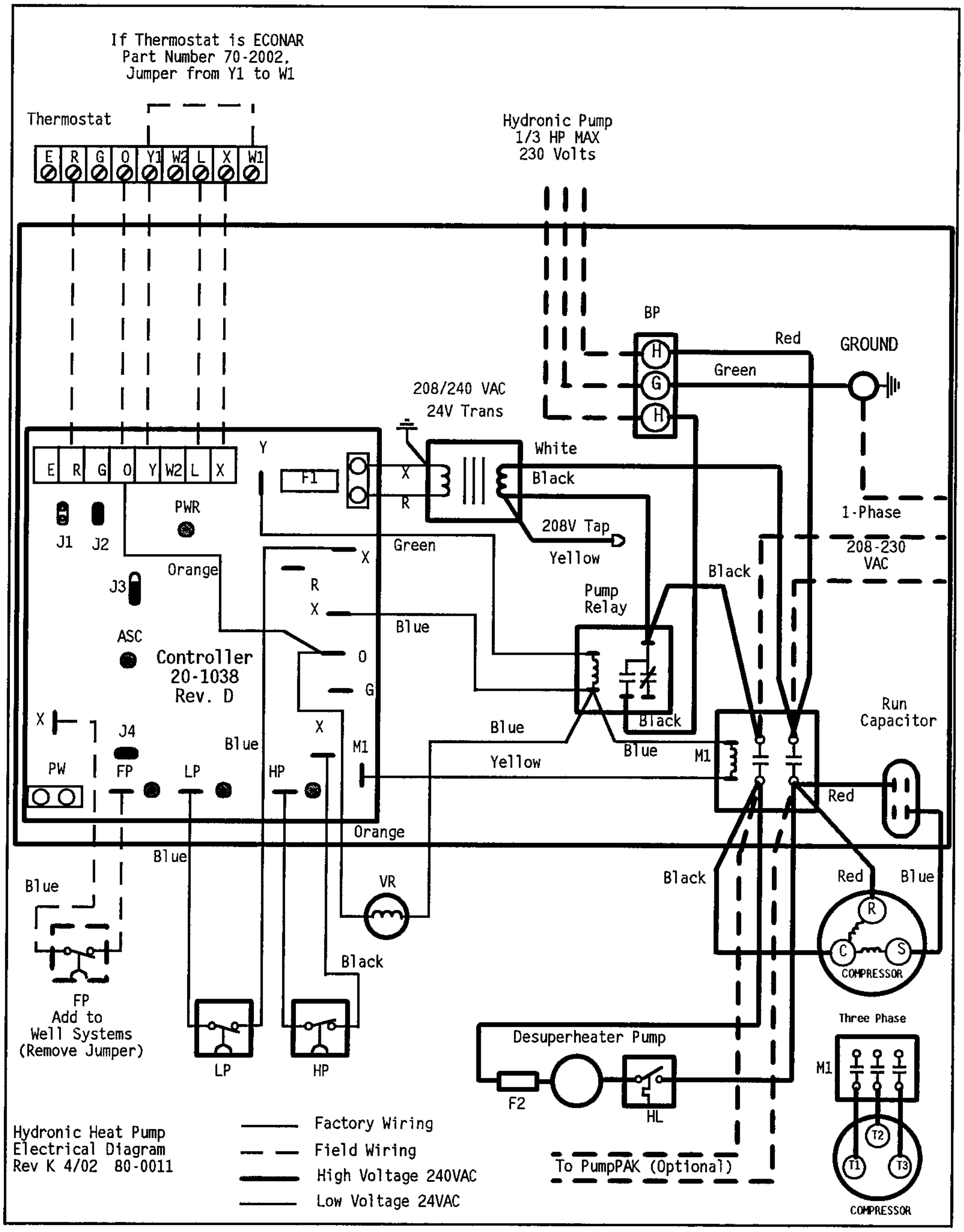
MODE	LOCKOUT CONDITION	POSSIBLE CAUSE
Heating	High Pressure (Condenser/Hydronic Side)	-Loss/lack of flow through hydronic heat exchanger -High fluid temperature operation in the hydronic loop -Overcharged refrigerant circuit
	Low Pressure (Evaporator/Earth Coupled Side)	-Loss/lack of flow through earth coupled coil -Low fluid temperature operation in the earth loop -Freezing fluid in heat exchanger (lack of antifreeze) -Undercharged/overcharged refrigerant circuit -Expansion valve/sensing bulb malfunction
Cooling	High Pressure (Condenser/Earth Coupled Side)	-Loss/lack of flow in earth loop -High fluid temperature operation in the earth loop -Dirty (fouled) condenser coil -Overcharged refrigerant circuit
	Low Pressure (Anti-Short Cycle) (Evaporator/Hydronic Side)	-Loss/lack of flow through hydronic heat exchanger -Low fluid temperature operation in the hydronic loop -Freezing fluid in hydronic heat exchanger (lack of antifreeze) -Undercharged/overcharged refrigerant circuit -Expansion valve/sensing bulb malfunction

XIII. TROUBLESHOOTING GUIDE FOR UNIT OPERATION

PROBLEM	POSSIBLE CAUSE	CHECKS AND CORRECTIONS
Entire unit does not run.	Blown Fuse/Tripped Circuit Breaker	Replace fuse or reset circuit breaker. (Check for correct size fuse or circuit breaker.)
	Blown Fuse on Controller	Replace fuse on controller. (Check for correct size fuse.)
	Broken or Loose Wires	Replace or tighten the wires.
	Voltage Supply Low	If voltage is below minimum voltage on data plate, contact local power company.
	Low Voltage Circuit	Check 24-volt transformer for burnout or voltage less than 18 volts.
	Thermostat	Set thermostat on "Cool" and lowest temperature setting, unit should run. Set thermostat on "Heat" and highest temperature setting, unit should run. If unit does not run in both cases, the thermostat could be wired incorrectly or be faulty. To prove faulty or miswired thermostat, disconnect thermostat wires at the unit and jumper between "R", "Y" and "G" terminals and unit should run. Replace thermostat with correct thermostat only. A substitute may not work properly.
	Interruptible Power	Check incoming supply voltage.
Insufficient cooling or heating	Water	Lack of sufficient pressure, temperature and/or quantity of water.
	Unit Undersized	Recalculate heat gains or losses for space to be conditioned. If excessive, rectify by adding insulation, shading, etc.
	Loss of Conditioned Air by Leaks	Check for leaks in ductwork or introduction of ambient air through doors and windows.
	Thermostat	Improperly located thermostat (e.g. near kitchen sensing inaccurately the comfort level in living areas). Check anticipator setting (Should be 1.0 or 1.2).
	Airflow (Across fan coil)	Lack of adequate airflow or improper distribution of air. Check the motor speed and duct sizing. Check the filter, it should be inspected every month and changed if dirty. Remove or add resistance accordingly.
	Refrigerant Charge	Low on refrigerant charge causing inefficient operation. Adjust only after checking CFM and GPM.
	Compressor	Check for defective compressor. If discharge pressure is too low and suction pressure too high, compressor is not pumping properly. Replace compressor.
	Reversing Valve	Defective reversing valve creating bypass of refrigerant from discharge to suction side of compressor. When it is necessary to replace the reversing valve, wrap it with a wet cloth and direct the heat away. Excessive heat can damage the valve.
	Desuperheater	The desuperheater circuit (in-line fuse) should be disconnected during cold weather to allow full heating load to house.

PROBLEMS	POSSIBLE CAUSE	CHECKS AND CORRECTIONS
Hydronic pump runs but compressor does not, or compressor short cycles.	Thermostat	Check setting, calibration, and wiring, if thermostat has an anticipator, set it at 1.0 or 1.2.
	Wiring	Check for loose or broken wires at compressor, capacitor, or contactor.
	Blown Fuse	Replace fuse or reset circuit breaker. (Check for correct size fuse or circuit breaker.)
	High or Low Pressure Controls	The unit could be off on the high or low-pressure cutout control. Check water GPM, ambient temperature and loss of refrigerant. If the unit still fails to run, check for faulty pressure controls individually. Replace if defective.
	Defective Capacitor	Check capacitor, if defective remove, replace, and rewire correctly.
	Voltage Supply Low	If voltage is below minimum voltage specified on the data plate, contact local power company. Check voltage at compressor for possible open terminal.
	Low Voltage Circuit	Check 24-volt transformer for burn out or voltage less that 18 volts. With a voltmeter, check signal from thermostat at Y to X, M1 on controller to X, capacitor voltage drop. Replace component that does not energize.
	Compressor Overload Open	In all cases an "internal" compressor overload is used. If the compressor motor is too hot, the overload will not reset until the compressor cools down. If the compressor is cool and the overload does not reset, there may be a defective or open overload. Replace the compressor.
	Compressor Motor Grounded	Internal winding grounded to the compressor shell. Replace the compressor. If compressor burnout replace the liquid line filter/drier.
	Compressor Windings Open	Check continuity of the compressor windings with an ohmmeter. If the windings are open, replace the compressor.
	Seized Compressor	Try an auxiliary capacitor in parallel with the run capacitor momentarily. If the compressor still does not start, replace it.
Unit short cycles	Thermostat	Improperly located thermostat (e.g. near kitchen, sensing inaccurately the comfort level in living areas). Check anticipator setting. Should be 1.0 or 1.2.
	Compressor Overload	Defective compressor overload, check and replace if necessary. If the compressor runs too hot, it may be due to a insufficient refrigerant charge.
	Aquastat	The differential is set to close on aquastat. Increase differential setting to 15°F.
	Wiring and Controls	Loose wiring connections, or control contactor defective.
Unit will not operate in "heating"	Thermostat Improperly Set	Is it below room temperature? Check the thermostat setting.
	Defective Thermostat	Check thermostat operation. Replace if found defective.
	Incorrect Wiring	Check for broken, loose, or incorrect wires.
	Aquastat set Too High	Heat pump is trying to heat hot water to too hot of a temperature (over 120°F). Reduce aquastat setpoint.
Unit does not cool (Heats Only)	Reversing Valve does not Shift	Defective solenoid valve will not energize. Replace solenoid coil.
	Reversing Valve does not Shift, the Valve is Stuck	The solenoid valve is de-energized due to miswiring at the unit or thermostat-correct wiring. Replace if valve is tight or frozen and will not move. Switch from heating to cooling a few times to loosen valve.
	Aquastat set Too Low	Heat pump is trying to cool water too low. Increase aquastat setpoint.
	Insufficient Antifreeze	Water is freezing in hydronic coil. Check antifreeze level and add antifreeze to obtain correct freeze protection.
Noisy Operation	Compressor	Make sure the compressor is not in direct contact with the base or sides of the cabinet. Cold surroundings can cause liquid slugging, increase ambient temperature.
	Contactor	A "clattering" or "humming" noise in the contactor could be due to control voltage less than 18 volts. Check for low supply voltage, low transformer output or extra long runs of thermostat wires. If the contactor contacts are pitted or corroded or coil is defective, repair or replace.
	Rattles and Vibrations	Check for loose screws, panels, or internal components. Tighten and secure. Copper piping could be hitting the metal surfaces. Carefully readjust by bending slightly.
	Water and Airborne Noises	Undersized ductwork will cause high airflow velocities and noisy operation. Excessive water through the water-cooled heat exchanger will cause a squealing sound. Check the water flow ensuring adequate flow for good operation but eliminating the noise.
	Cavitating Pumps	Purge air from closed loop system.

XIV. ADDITIONAL FIGURES, TABLES, AND APPENDICES



Legend

BP Block, Pump
F1 Fuse, Transformer
F2 Fuse, Desuperheater
HL High-Temp Limit

HP High Press Switch
LP Low Press Switch
M1 Contactor
PW Plug, Water Valve

VR Valve, Reversing
J1 Remove for Hydronic
J2 Ties W2 to E
J3 Overflow Protection
J4 Remove for Freeze Protection

Figure 7 - Electrical Diagram for GeoSource 2000 Hydronic Series Heat Pump (GWxxx-x-TxOx)

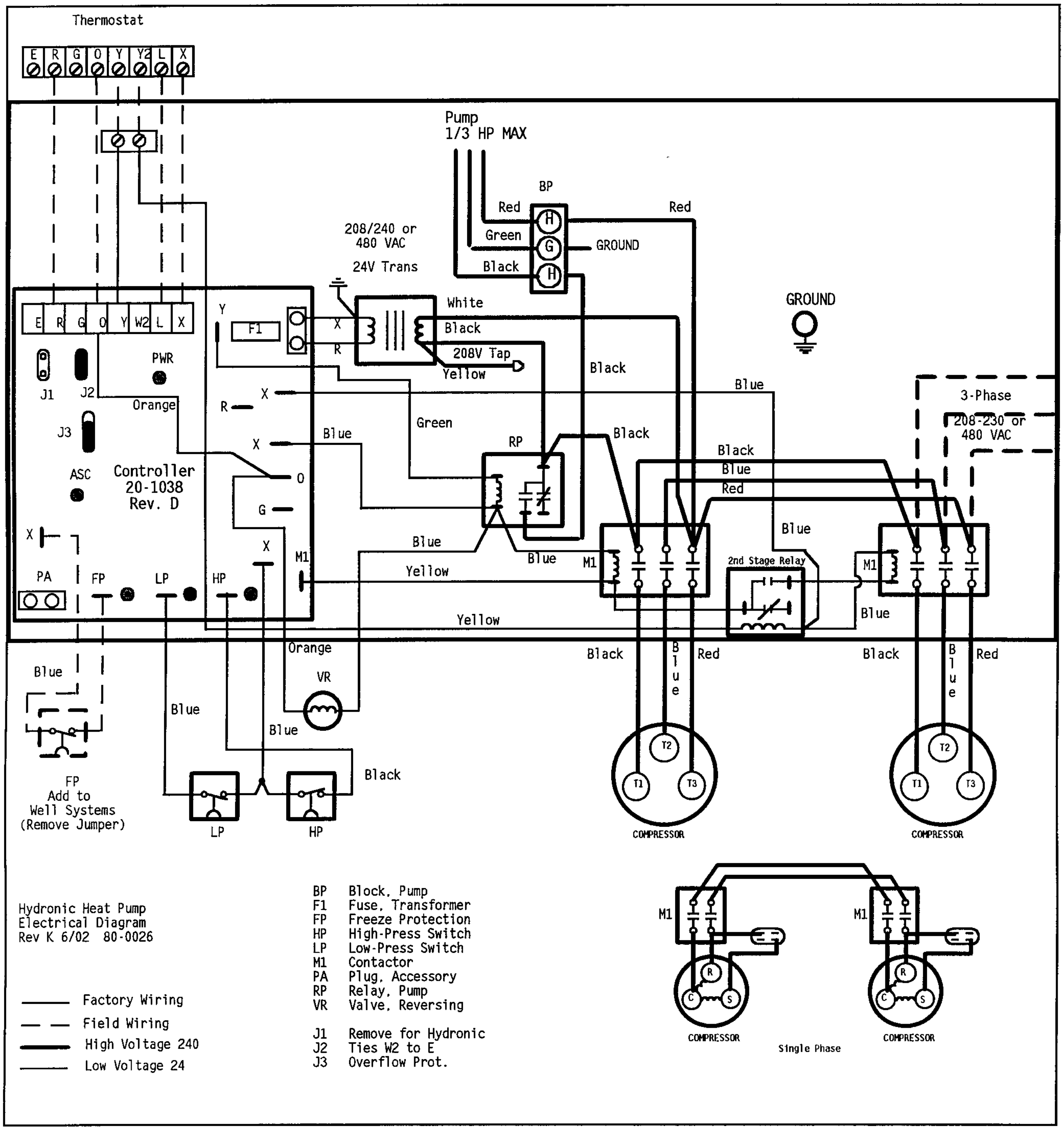


Figure 8 – Electrical Diagram for GeoSource 2000 Hydronic Series Heat Pump [GW(98,120)0-x-TxTx]

Heating					
Model	CFM	GPM	dP	Capacity (1000 BTU/hr)	
			(Ft. of Head)	120°F EWT	140°F EWT
3 HBC-3	310	3.0	12.0	12.2	17.4
		2.0	6.0	11.7	16.7
		1.0	1.9	10.5	14.9
4 HBC-3	510	3.5	18.0	16.1	22.9
		2.5	10.0	15.7	22.3
		1.5	4.5	14.5	20.6
5 HBC-3	600	4.0	10.0	19.7	28.0
		3.0	5.9	19.1	27.1
		2.0	2.9	17.9	25.4
6 HBC-3	730	5.5	17.0	24.1	34.3
		4.0	10.0	23.4	33.3
		2.5	4.2	21.9	31.2
8 HBC-3	870	6.0	11.0	29.2	41.5
		4.5	6.5	28.3	40.2
		3.0	3.0	26.3	37.4
10 HBC-3	1070	8.0	14.0	34.9	49.7
		6.0	8.1	34.2	48.6
		4.0	3.9	32.0	45.6
13 HBC-3	1400	10.0	22.0	45.9	65.3
		7.5	13.0	44.8	63.7
		5.0	6.2	41.9	59.5

Ratings at 70°F entering air temperature

Cooling									
				Capacity (1000 BTU/hr) at 45°F EWT					
Model	CFM	GPM	dP	80°F DB/67°F WB			75°F DB/63°F WB		
			(Ft. of Head)	TH	SH	TR	TH	SH	TR
3 HBC-3	310	2.8	10.3	10.8	6.9	8.0	8.6	6.3	6.4
		2.1	8.0	10.1	6.7	10.0	8.1	6.1	8.0
		1.6	4.2	9.2	6.4	12.0	7.5	6.0	10.0
4 HBC-3	510	3.6	19.0	14.2	9.3	8.0	11.6	8.4	6.7
		2.8	12.5	13.4	9.0	10.0	11.0	8.1	8.1
		2.1	7.6	12.3	8.4	12.0	10.0	7.6	10.0
5 HBC-3	600	4.5	12.0	17.4	11.5	8.0	14.0	10.2	6.4
		3.3	8.0	16.3	11.0	10.0	12.9	9.7	8.0
		2.6	4.5	15.1	10.5	12.0	12.0	9.2	9.5
6 HBC-3	730	5.7	18.0	22.2	15.5	8.0	17.8	14.1	6.5
		4.3	10.5	20.7	14.4	10.0	16.7	13.6	8.0
		3.3	6.9	19.4	14.4	12.0	15.6	13.1	9.8
8 HBC-3	870	6.4	12.1	25.2	18.3	8.0	20.6	16.5	6.6
		4.7	8.0	23.2	17.4	10.0	19.0	15.9	8.3
		3.7	4.5	21.4	16.6	12.0	17.9	15.5	10.0
10 HBC-3	1070	8.4	15.0	32.2	22.3	8.0	25.8	19.7	6.5
		6.0	8.0	28.0	21.0	10.0	23.4	18.6	8.3
		4.6	5.0	26.4	20.2	12.0	21.6	17.8	10.0
13 HBC-3	1400	10.8	25.0	42.0	29.6	8.0	34.6	27.2	6.7
		7.8	14.0	37.0	28.0	10.0	30.8	25.8	8.0
		6.0	8.7	34.5	27.2	12.0	28.2	24.8	10.0

TH = Total Heating Capacity SH = Sensible Heating Capacity TR = Water Temperature Rise

Table 5 – Fan Coil Data

	INDICATOR LIGHTS					
CONDITION	PWR	ASC	LP	HP	FP	COMMENTS
AC power applied						Blown fuse or power removed.
"	X	X				ASC indicator on for 4' 35" on power initialization.
"	X					Power applied - unit running or waiting for a call to run.
Run cycle complete	X	X				ASC indicator ON for 30 to 60 seconds after compressor shutdown.
LP (HYD heating - before call)	X		X			Indicates LP switch position (ON = open).
LP (HYD heating - after call)	X	X	X			Lockout, indicators latched and resettable by removing power.
LP (HYD cooling - before call)	X		X			Indicates LP switch position (ON = open).
LP (HYD cooling - after call)	X	X	X			Lockout, indicators latched and resettable by removing power.
HP (HYD heating - before call)	X			X		Indicates HP switch position (ON = open).
HP (HYD heating - after call)	X	X		X		Lockout, indicators latched and resettable by removing power.
HP (HYD cooling - before call)	X			X		Indicates HP switch position (ON = open).
HP (HYD cooling - after call)	X	X		X		Lockout, indicators latched and resettable by removing power.
FP (F/A heating - before call)	X				X	Indicates FP switch position (ON = open).
FP (F/A heating - after call)	X	X			X	Lockout, indicators latched and resettable by removing power.
FP (F/A cooling)	X					FP switch disabled in cooling mode.

Table 6 – Controller #20-1038 LED Indicator Chart

Outdoor Swimming Pool Heat Pump Sizing Worksheet

For In-ground Pool Applications

Project Name:
Date:

1) Pool Length in Ft. ☐
2) Pool Width in Ft. ☐ ======> 4) Pool Surface Area in Sq. Ft. ☐
3) Average Pool Depth in Ft. ☐ ======> 5) Pool Volume in Cu. Ft. ☐
6) Pool Volume in U.S. Gallons ☐

7) Calculated Pounds of Water to be Heated. ☐

	Initial	Maintain
8) Desired Pool Water Temperature in °F	80	80
9) Starting Pool Water Temperature in °F		
10) Average Ambient Air Temperature in °F		
11) Calculated Water Temperature Difference in °F		
12) Calculated Air Temperature Difference in °F		
13) Initial BTU's to Heat the Pool Water with no Surface Heat Loss		
14) Hours Allowed to Heat the Pool Water to Desired Temperature	120	
15) Initial BTU/hr Needed to Heat Pool Water in Time Allowed		
16) Average Wind Speed Factor (see below)		
17) Heat Loss from Pool Surface in BTU/hr		
18) Total BTU/hr Required to Heat & Maintain Pool Water Temperature		

Instructions, Assumptions, and Additional Notes

A) Enter the appropriate pool dimensions where requested on lined 1, 2, and 3. If the pool depth is not constant, please enter the overall average depth. If the pool is not rectangular in shape, please move on to the next step.

B) Calculate lines 4, 5, and 6 after lines 1-3 are filled in. There are 7.48 Gal Water per Cu. Ft. If the pool is not rectangular in shape, such as elliptical, oval, & kidney shapes, manually calculate the information needed for lines 4 and 5 and enter the results in the appropriate boxes where requested on these lines.

C) Line 7: There are 62.42 Lb. Water per Cu. Ft., and 8.34 Lb. Water per U.S. Gallon.

D) Enter the desired pool temperature in both boxes on line 8. If this temperature is not known, 80°F is a good default to use.

E) Enter the initial pool water temperature in the box on line 9. Generally, this will not be any colder than average well water temperature (approximately 50°F.)

F) Enter the average ambient outdoor air temperature for the coldest month that the swimming pool will be in use in the box on line 10.

G) Line 13: Use the following equation to calculate the initial BTU's required to heat the pool without any consideration to time or to surface heat loss via convection.

Initial BTU's = 1.0 [BTU/LB*°F] x Line 7 x Line 11

H) Line 14: Enter the amount of time in hours that will be allowed to initially heat the pool. (4 to 5 days [120 hours] is normally acceptable and economical for private pools.)

I) Line 15: Calculates the heating capacity (BTU/hr) required to initially heat the pool.

Heating Capacity [BTU/hr] = Line 13 / Line 14

J) Line 16: Enter the average wind speed correction factor as listed below. (typically 3-5 MPH)

(<3 MPH = .75, 3 to 5 MPH = 1.0, 5 to 10 MPH = 1.25, >10 MPH = 2)

K) Line 17: Calculate the BTU/hr heat loss from the surface of the pool due to convection.

Convection Losses [BTU/hr] = 10.5 [BTU/hr*Sq Ft*°F] x Line 4 x Line 12 x Line 16

The greatest heat loss (typically 50-60%) in a swimming pool is through evaporation. Radiation and evaporative losses can be reduced 50% through the use of a pool cover. Solar gains in unshaded pools can add up to 100,000 BTU/hr which offsets some convective loss. Because of these solar gains and economic reasons, total heating capacity for only one half of the convective losses are required when sizing. Heat loss by conduction through pool is minimal in an in-ground pool. Conduction losses for above ground pools can be compensated for by the average wind speed correction factor.

L) Line 18: Total BTU/hr = Lines 15 + (Line 17 x 1/2)

XV. DESUPERHEATER

(OPTIONAL)

A **GeoSource 2000** unit equipped with a desuperheater can provide supplemental heating of a home's domestic hot water. This is done by stripping heat from the superheated gas leaving the compressor and transferring it to a hot water tank. A desuperheater pump, manufactured into the unit, circulates water from the domestic hot water tank, heats it using a double walled water-to-refrigerant heat exchanger, and returns it to the tank. The desuperheater provides supplemental heating because it only heats water when the compressor is already running to heat or cool the conditioned space. Because the desuperheater is stripping some of the energy from the heat pump in order to heat the water, the heat pump's capacity in the winter will be slightly less than a unit without a desuperheater. During extremely cold weather, or if the heat pump cannot keep up with heating the space, the desuperheater fuse may be pulled in order to get more capacity out of the unit.

Insulated copper tubing should be used to run from the hot water tank to the desuperheater connections on the left side of the unit. The built in desuperheater pump can provide the proper flow to the desuperheater if the total equivalent length of straight pipe and connections is kept to a maximum of 90 feet of 1/2-inch type L copper tubing. This tubing can be connected to the hot water tank in two ways:

METHOD 1
Using a desuperheater tee installed in the drain at the bottom of the water heater (See Figure 9). This is the preferred method for ease of installation, comfort and efficiency. The tee eliminates the need to tap into the domestic hot water lines and eliminates household water supply temperature variations that could occur from connecting to the hot water pipes.

METHOD 2
Taking hot water from the bottom drain and returning it to the cold water supply line (See Figure 10). This method maintains the same comfort and efficiency levels but increases installation time and costs. This method requires a check valve in the return line to the cold water supply to prevent water from flowing backwards through the desuperheater when the tank is filling. Water passing through the pump backwards damages the rotor's bearing, which reduces pump life and causes noise problems in the pump. A spring-type check valve with a pressure rating of 1/2 psi or less is recommended.

All air must be purged from the desuperheater plumbing before the pump is engaged. To purge small amounts of air from the lines, loosen the desuperheater pump from its housing by turning the brass collar. Let water drip out of the housing until flow is established, and re-tighten the brass collar. Using 1/2-inch copper tubing from the tank to the desuperheater inlet is recommended to keep water velocities high, avoiding air pockets at the pump inlet. An air vent in the inlet line can also help systems where air is a problem. If one is used (we recommend a Watts Regulator brand FV-4 or Spirovent) mount it near the desuperheater inlet roughly 2-1/2 inches above the horizontal pipe. Shutoff valves allow access to the desuperheater plumbing without draining the hot water tank. Keep valves open when pump is running.
✋**CAUTION**: Running the desuperheater pump without water flow will damage the pump.

Poor water quality may restrict the effectiveness of using the desuperheater tee by plugging the entrance with scale or buildup from the bottom of the tank, restricting water flow. Desuperheater maintenance includes periodically opening the drain on the hot water tank to remove deposits. If hard water, scale, or buildup causes regular problems in hot water tanks in your area, it may result in a loss of desuperheater effectiveness. This may require periodic cleaning with Iron Out or similar products.

The desuperheater's high temperature cutout switch is located on the return line from the water heater. The switch is wired in series with the desuperheater pump to disable the pump from circulating at entering water temperature above 140°F. If the desuperheater causes tank temperatures to become uncomfortably hot, this temperature switch can be moved to the leaving water line which will reduce the tank maximum temperatures 10°F to 15°F. Do not remove the high temperature switch or tank temperatures could become dangerously high.

A fuse is attached to the fuseholder and must be inserted in the fuseholder after the desuperheater is operational. Do not insert fuse until water flow is available or the pump may be damaged. Remove the fuse to disable the pump if the desuperheater isn't in operation.

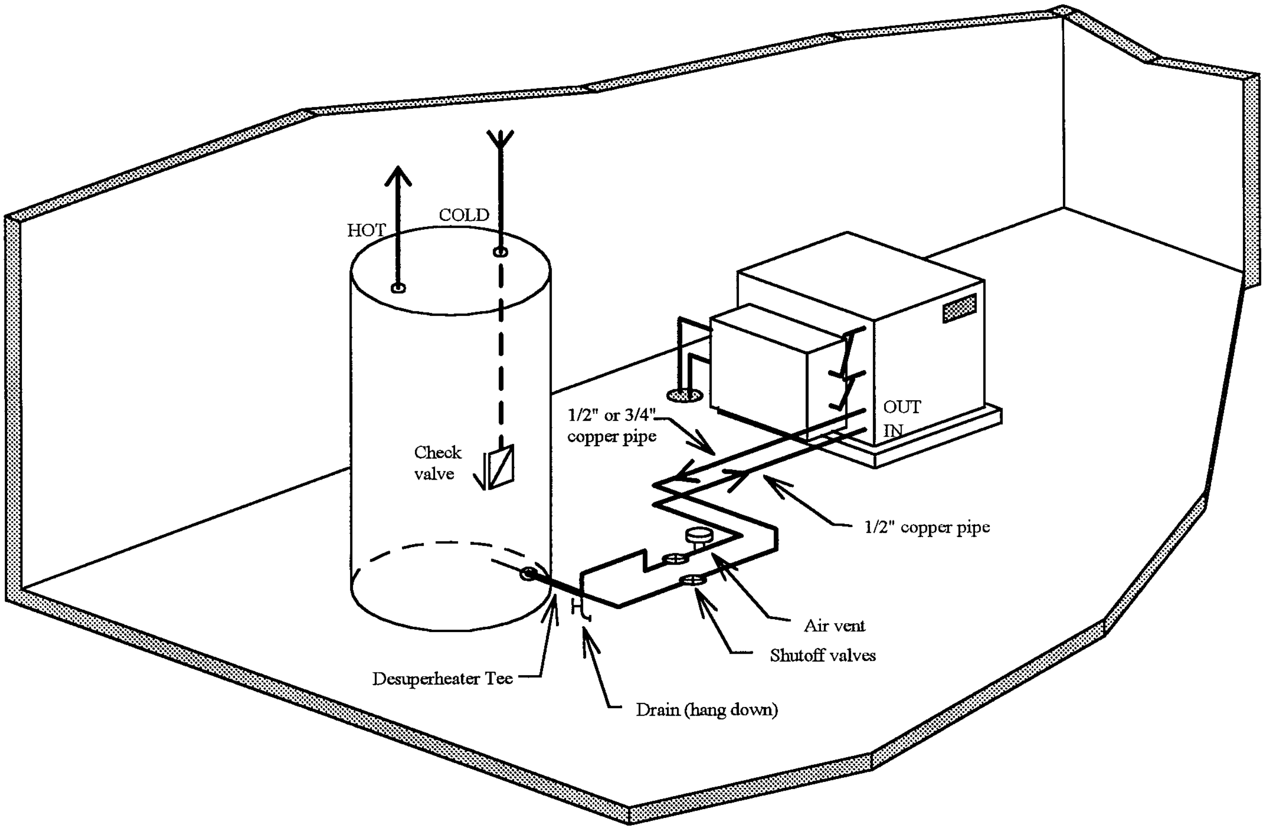


Figure 9 – Preferred Desuperheater Installation

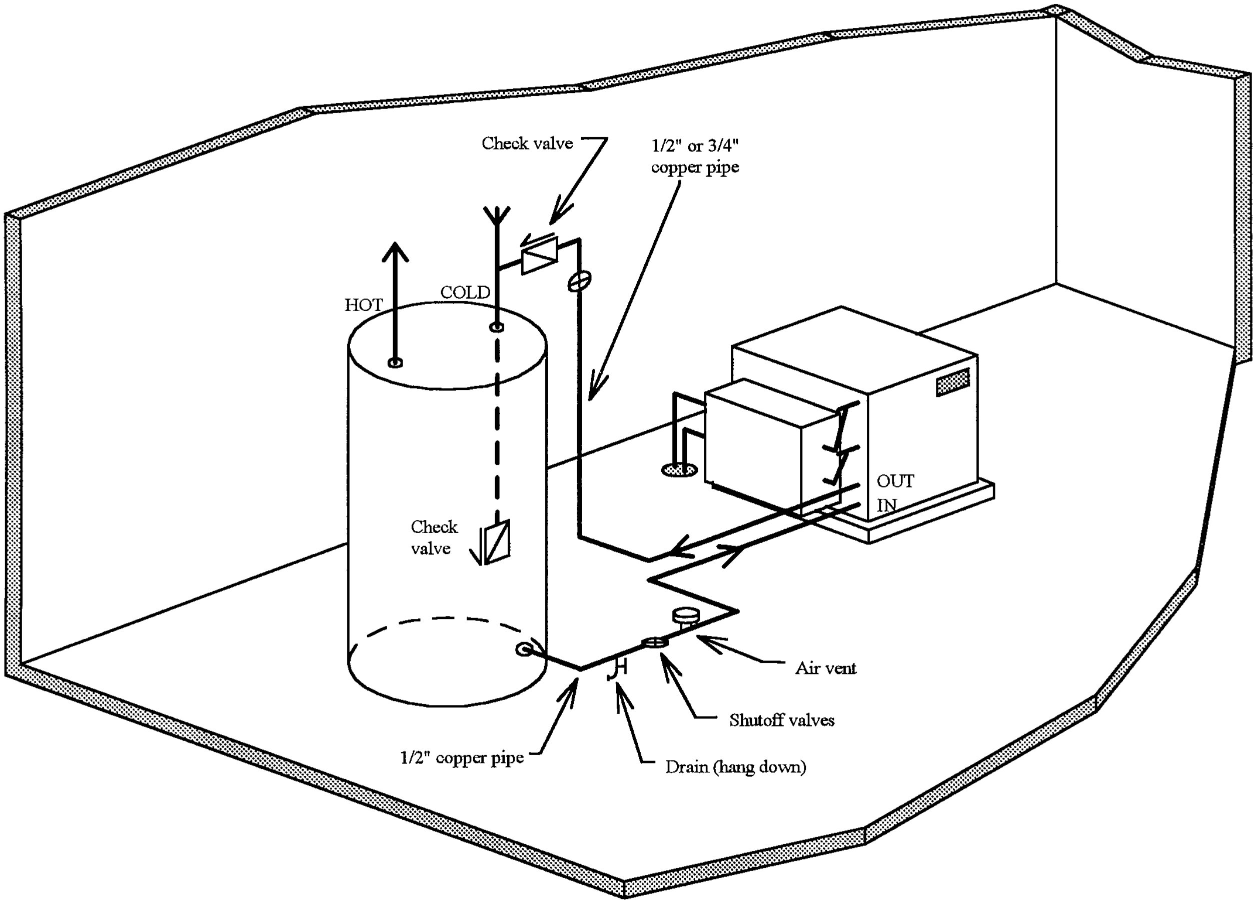


Figure 10 – Alternate Desuperheater Installation

ECONAR®
ENERGY SYSTEMS
CORPORATION

GeoSource® 2000, DualTEK, Vara, Vara 2 Plus™ and Invision^3 Heat Pumps
USA and Caada
*Residential and Limited Commercial Warranty***

Residential Applications Only: All Parts – 2 Years

Years 1 through 2, ECONAR Energy Systems Corp. will provide a free replacement part upon prepaid return of all defective parts, F.O.B. Appleton, MN for any part which fails to function properly due to defective material, or workmanship. * During this period, ECONAR will provide a free relacement part F.O.B. Appleton, MN for any part which fails to function properly due to defective material, or workmanship.

Refrigeration Components – 5 Years

Years 3 through 5, ECONAR will provide a free relacement part upon prepaid return of defective parts, F.O.B. Appleton, MN for any compressor, or refrigeration components (parts only***) which fails to function properly due to defective material or workmanship.

Heat Exchangers – Lifetime

ECONAR will provide a free replacement internal heat exchanger (i.e. water to refrigerant, refrigerant to air) upon prepaid return of defective part F.O.B. Appleton, MN (parts only) for the lifetime of the heat pump.

Commercial Applications Only: All Parts – 1 Year

**First year, ECONAR will provide a free replacement upon prepaid return of all defective parts, F.O.B. Appleton, MN for any part which fails to function properly due to defective material or workmanship. During this period, ECONAR will cover the cost of labor for the replacement of parts found to be defective; not to exceed ECONAR's published Labor Schedule.

Refrigeration Components – 5 Years

Years 2 through 5, ECONAR will provide a free replacement part upon prepaid return F.O.B. Appleton, MN for any compressor, or refrigerant component (parts only) which fails to function properly due to defective material, or workmanship.

All Applications:

Limitations:

- Begins the date of original purchase as recorded by ECONAR with the return of the warranty registration card. (If warranty card is not submitted, warranty begins the date of original manufacture based on serial number).
- Applies to original installation and normal use of the heat pump only and does not include any other component of a system as a whole.
- All ECONAR labeled and manufactured accessories carry a 2 year part warranty for residential duty and 1 year for commerical duty. All other accessories carry the manufacturers warranty only. Labor is excluded on all accessories.
- Service must be performed by an ECONAR authorized service person.
- Replacement parts shall be warranted for 90 days. After the 90 days, the parts will be covered by the remaining warranty of the unit.
- Under no circumstances will ECONAR be liable for incidental, or consequential expenses, losses or damages.

Owners Responsibilites:

- Return warranty card to activate warranty coverage. See form #90-0147
- Provide normal care and Maintenance.
- Make products accessible for service.

Warranty is Void if:

- Data label is defaced, or removed.
- Product has defect, or damage due to product alterations, connection to an improper electric supply, shipping and handling, accident, fire, flood, lightning, act of God, or other conditions beyond the control of ECONAR.
- Products are not installed in accordance with ECONAR instructions and specifications.
- Products which have defects, or insufficient performance as a result of insufficient or incorrect installations, poor water supply, design, or the improper application of products. (This would include a freeze rupture)
- Products are installed, or operate in a corrosive environment causing deterioration of metal parts.

Warranty Performance:

- The installing contractor will provide the warranty service for the owner. If the installing contractor is not available, contact:
  ECONAR Energy Systems, Corp., Customer Support, at 33 West Veum, Appleton, MN 56208 or call toll free 1-800-4-ECONAR.

**Determination of the defect is the sole discretion of ECONAR Energy Systems, Corp.*
***Limited Commercial Warranty covers all non-residential applications.*
****Energy Star rated products include parts and labor.*
This warranty supersedes any and all previously written or implied warranty documentation.

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