Maritime Geothermal Ltd.

NORDIC® models TF-45-55-65

Installation Manual

Revision 1.0 7-Feb-00

"Triple Function" Geothermal Heat Pumps

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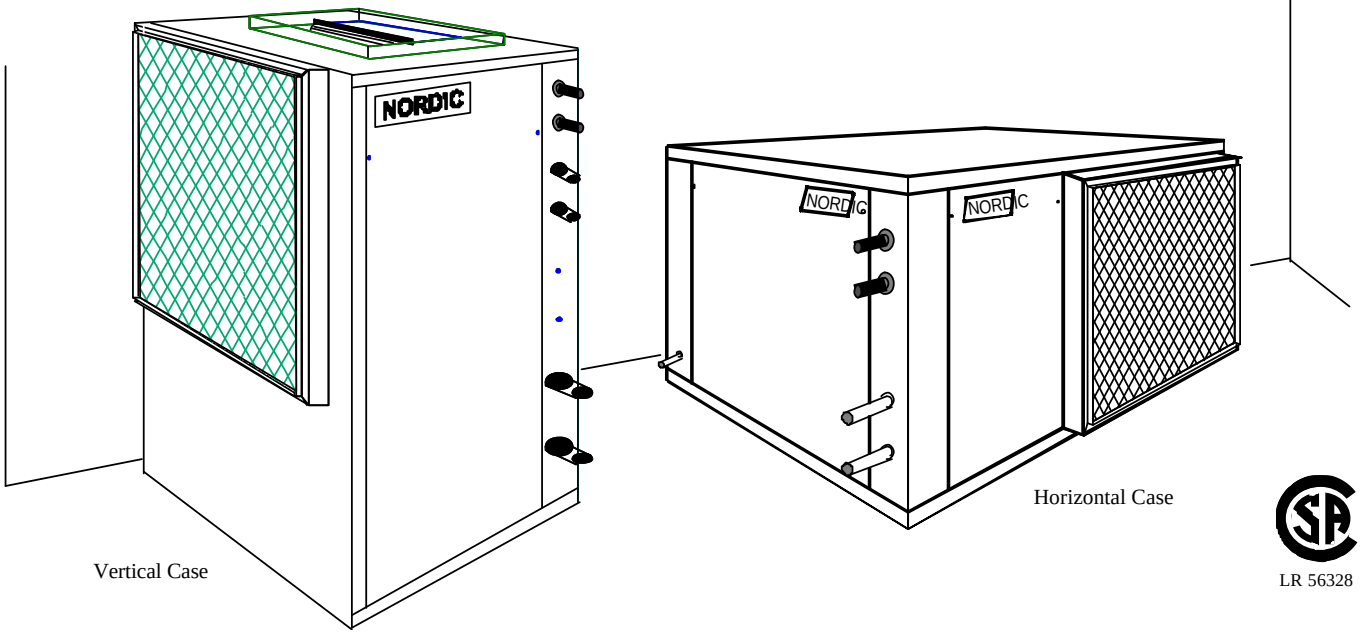

Vertical Case

Horizontal Case

LR 56328

Hot WATER- Active AIR Cooling / Heating

Maritime Geothermal Ltd.
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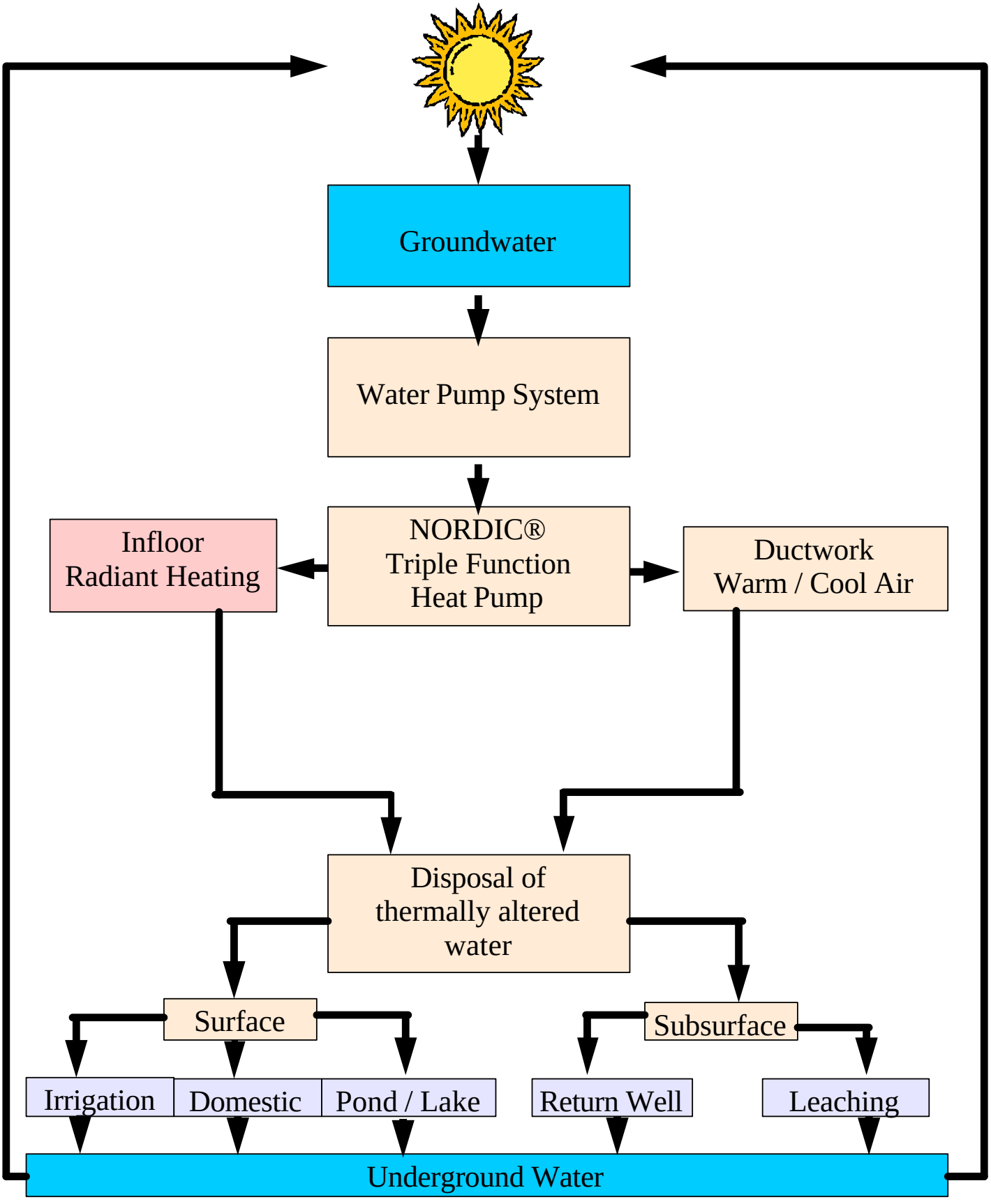
A NORDIC® Triple Function Open Loop System



NORDIC® "TF" Heat Pump Prerequisites

There are five specific parts or sub-systems to a groundwater heat pump installation:

1. The source of energy (groundwater) ..... Water Well
2. The method of supplying energy to the heat pump ..... Water Pump System
3. Converting the energy to a useable form ..... Heat Pump
4. Distributing the heat ..... Ductwork
5. Returning the exhaust water to the earth for reheating ..... Water disposal

Water Well Requirements

1. A ***DRILLED*** well of 5" diameter or larger.
2. Well casing properly sealed or grouted into rock.
3. Water flow preferably entering well at a depth of 75 ft. or more.
4. Temperature of well at least 40° F. (Normally 45+ °F.)
5. Well must be able to supply requirements of ***BOTH*** heat pump and residence usage at the same time with maximum drawdown from static level of 30 ft.

Water Pump System

1. A submersible pump is generally required.
2. Must be able to pump the required water flow listed at a minimum of 30 psig. at the dynamic pumping depth of

Model	Heat Pump	Home	Total
Nordic TF-45	8 Igpm	3	11
Nordic TF-55	10 Igpm	3	13
Nordic TF-65	12 Igpm	3	15

your well.

3. Make sure you select the pump using the pump manufacturers pump chart.
4. Use a minimum of 30 gal. equivalent air bladder tank.

Duct Systems

A duct system capable of supplying the required air flow is of utmost importance.

Nordic® TF-45 will heat up to 1800 sq.ft.
Nordic® TF-55 will heat up to 2700 sq.ft.
Nordic® TF-65 will heat up to 3500 sq.ft.
Assuming at least R-20 walls and R-40 ceiling

Generally allow 100 cfm for each floor grill.

All leads to the grills should be 6" in diameter (28 sq.in. each). Your main hot air trunks should be at least 75% of the square surface area of leads being fed at any given point.

Return air grills should have the same total square surface area as the total of your supply grills. (minimum)

Air Flow Available from each heat pump	
Nordic® TF-45 models	1600 cfm
Nordic® TF-55 models	1900 cfm
Nordic® TF-65 models	2100 cfm

@ 80°F DB / 67°F WB and static pres of .2" H_20

The square surface area of your return trunks should equal the square surface area of the grills being handled at any given point along the trunk.

Nordic® TF-45 could have up to 16 hot air grills.
Nordic® TF-55 could have up to 19 hot air grills.
Nordic® TF-65 could have up to 21 hot air grills.

It is ***VERY IMPORTANT*** that all turns in both the supply trunks and the return trunks be made with ***TURNING RADII***. Remember that air is a fluid and, just like water, pressure drop is increased when air is forced to change direction rapidly around a sharp or irregular corner.

Discharge Water Methods

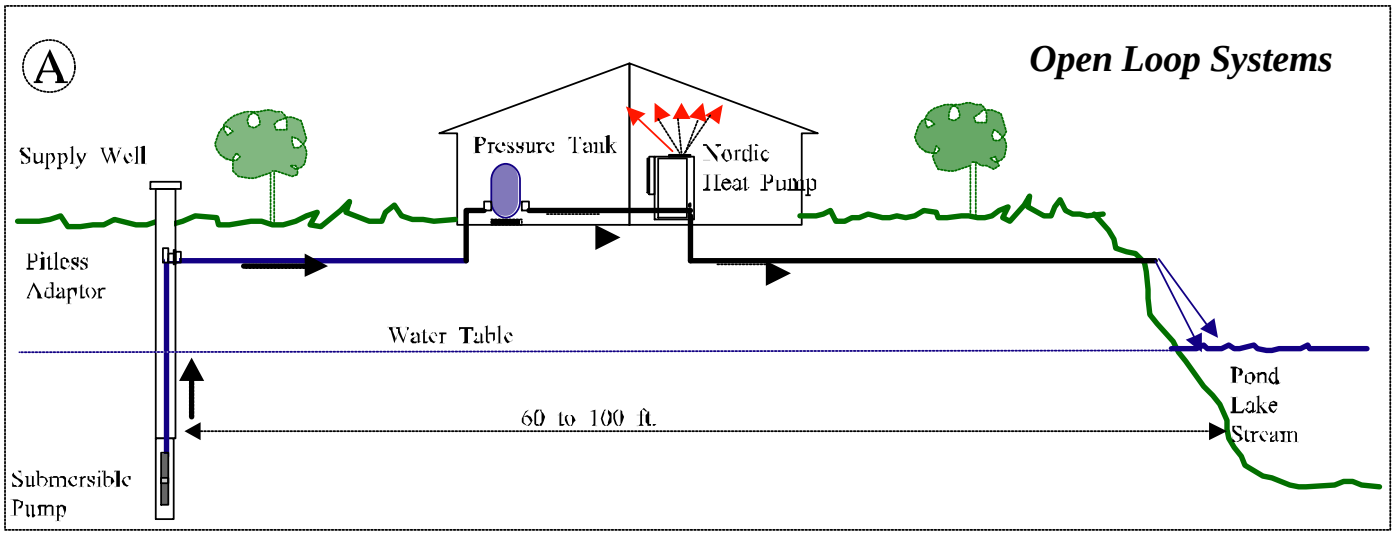
You do NOT necessarily have to have a return well. At least 50% of our customers do one of the following with their return or waste water:

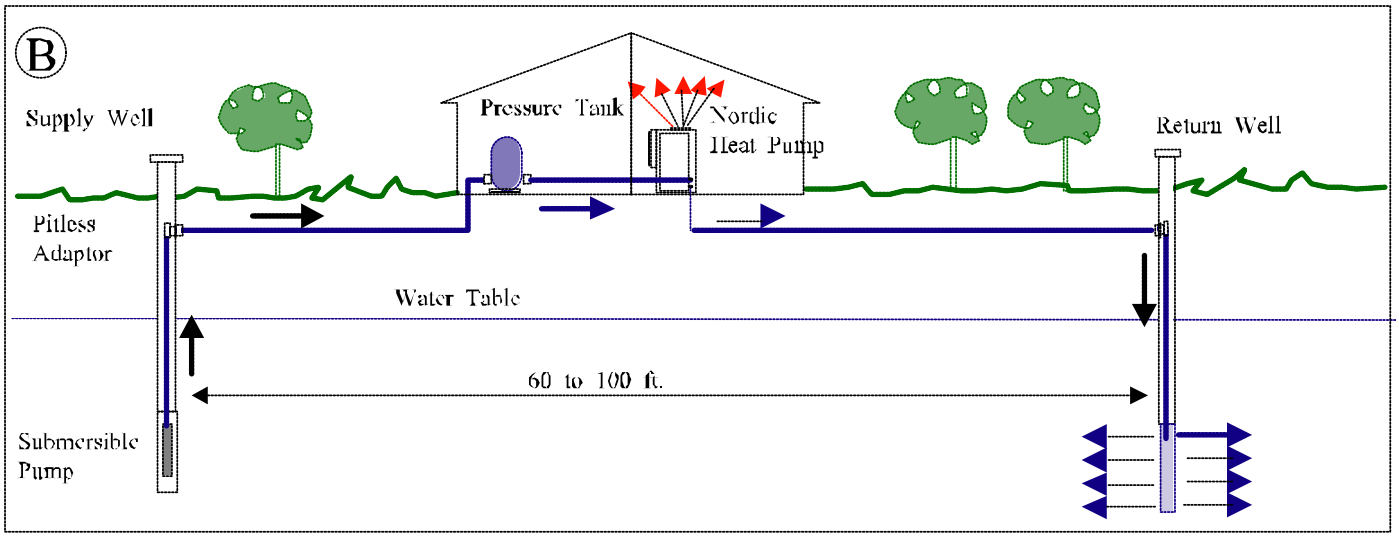
? ? Run it into a drain or ditch.
? ? Pond, river or stream.
? ? Leaching field.

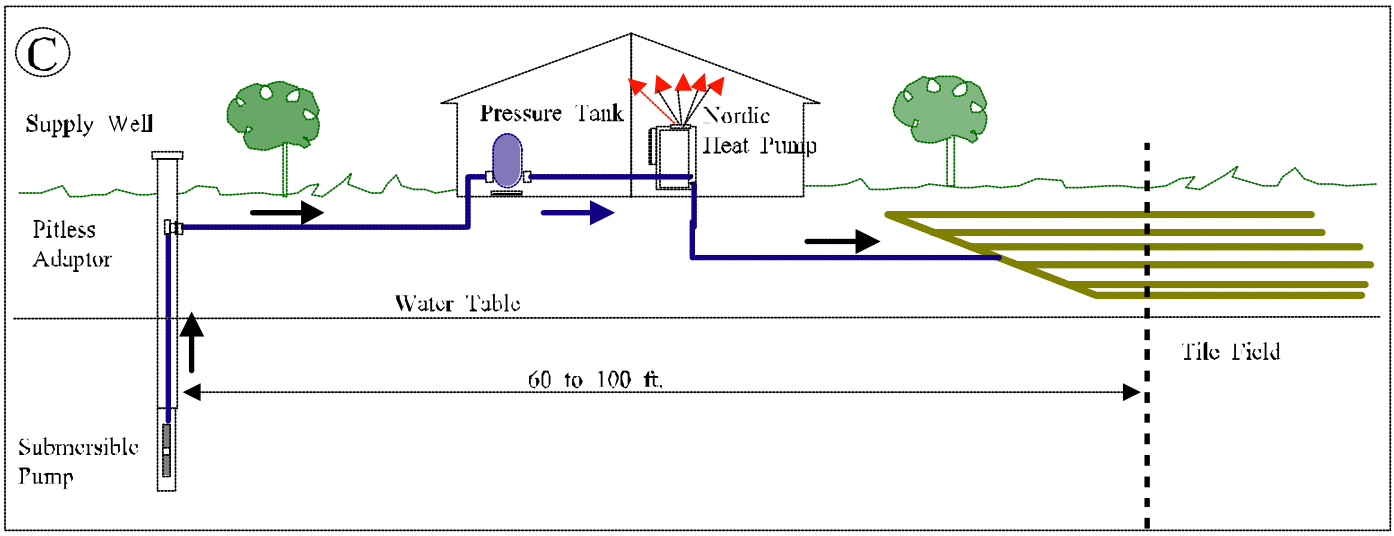
In most instances if you run the water right out on top of the ground it will soak back into the ground in less than 50 ft. of travel. If suitable care is taken to insure that the drain pipe runs downhill and the end of the pipe is protected by a bale of hay or spruce bows etc. the end of the pipe will not freeze. When snow comes it will usually cover the entire process much like a small spring.

The above information is intended to give the prospective purchaser some insight as to the general requirements for a successful applcation of the NORDIC® heat pump.

NORDIC® "TF" Series - Water Disposal Methods







Unpacking

When the heat pump reaches it's destination it should be unpacked to determine if any damage has occurred during shipment. Any visible damage should be noted on the carrier's freight bill and a suitable claim filed at once.

The heat pump is well constructed and every effort has been made to insure that it will arrive intact, however it is in the customer's best interest to examine the unit thoroughly when it arrives.

Optimum Placement

The ***NORDIC®*** heat pump has an air-filter rack which can be removed for easy entry through a doorway or to facilitate moving the unit with a furniture cart. Simply remove the two screws which hold the end cap in place, slide the cap off and push the rack back off it's rails. When the heat pump is in place the filter rack can be reinstalled with the removable end (where the filter is changed) facing the direction that allows easiest access for changing the filter.

To achieve the greatest efficiency, the heat pump should be centrally located in the home with respect to the conditioned space. This design provides the utmost in economy and comfort and usually can be accomplished in harmony with the design of the home. A heating system cannot be expected to produce an even warmth throughout the household when it is located at one end of the structure and the warm air is transmitted with uninsulated metal ductwork.

If possible the three main service doors should remain clear of obstruction for a distance of (2) two ft. so that servicing and general maintenance can be carried out with a minimum of difficulty. Raising the heat pump off the floor a few inches by mounting it on a base is generally a good practice since this will prevent unnecessary rusting of the bottom panel of the unit. We recommend that the heat pump be placed on a piece of 2" styrofoam covered with 1/4" plywood. The styrofoam will smooth out any irregularities in the cement floor while the plywood will distribute the weight of the NORDIC® unit evenly over the styrofoam. This process will also deaden the compressor noise emitted from the bottom of the cabinet.

As an alternative, several pieces of 2”x 4” lumber can be placed under the unit running from the electrical connection side to the filter rack side of the heat pump. Laying the 2" x 4" 's in this manner will give the best support since they will be at right angles with the internal steel compressor and heat exchanger supports.

Triple Function System Operation

Triple Function heat pumps are essentially an "R" and a "W" series combination heat pump. The addition of a second, full condensing capability, refrigerant-to-water heat exchanger allows the TF unit to function as a **liquid-to-water heat pump** whenever the unit is not calling for **HEATING** or **COOLING** via the duct system. These units are ideally suited to a home or business which will be heated with infloor heating and cooled via a conventional central duct system. Switching of modes is done electronically via the room thermostat.

Units are available from 3 HP to 5.75 HP with either type 316 stainless steel exchangers or cupro-nickel coaxial coils.

Duct design for a Triple Function unit is exactly the same as a regular "R" unit and hot water side plumbing is done in a similar fashion to a "W" series heat pump.

Plumbing the Supply Water Side of the Heat Pump

The NORDIC® heat pump must be supplied with an adequate water supply, since in essence, water is the fuel for the unit. It is imperative that the flow requirements listed in the engineering section be closely adhered to.

Maritime Geothermal Ltd. recommends the installation of a **water flow meter** on the discharge line so that the exact amount of water flowing can be determined at a glance.

Plumbing lines, both supply and discharge, must be of adequate size to handle the water flow necessary for the heat pump. For distances less than 40 ft. from the pressure tank, 3/4” copper or plastic lines should be run while for longer distances we recommend that 1” should be run to the heat exchanger. Similarly, a 3/4” to 1" line should be run from the discharge pipe to the method if disposal.

Ideally there will be water flow available in excess of the requirement of the heat pump. In such a situation the proper pump can be selected to maintain a pressure of 30 to 40 Psig. on the lines when the heat pump is operating. However in some cases a well can supply a heat pump only if the minimum requirement for water is used.

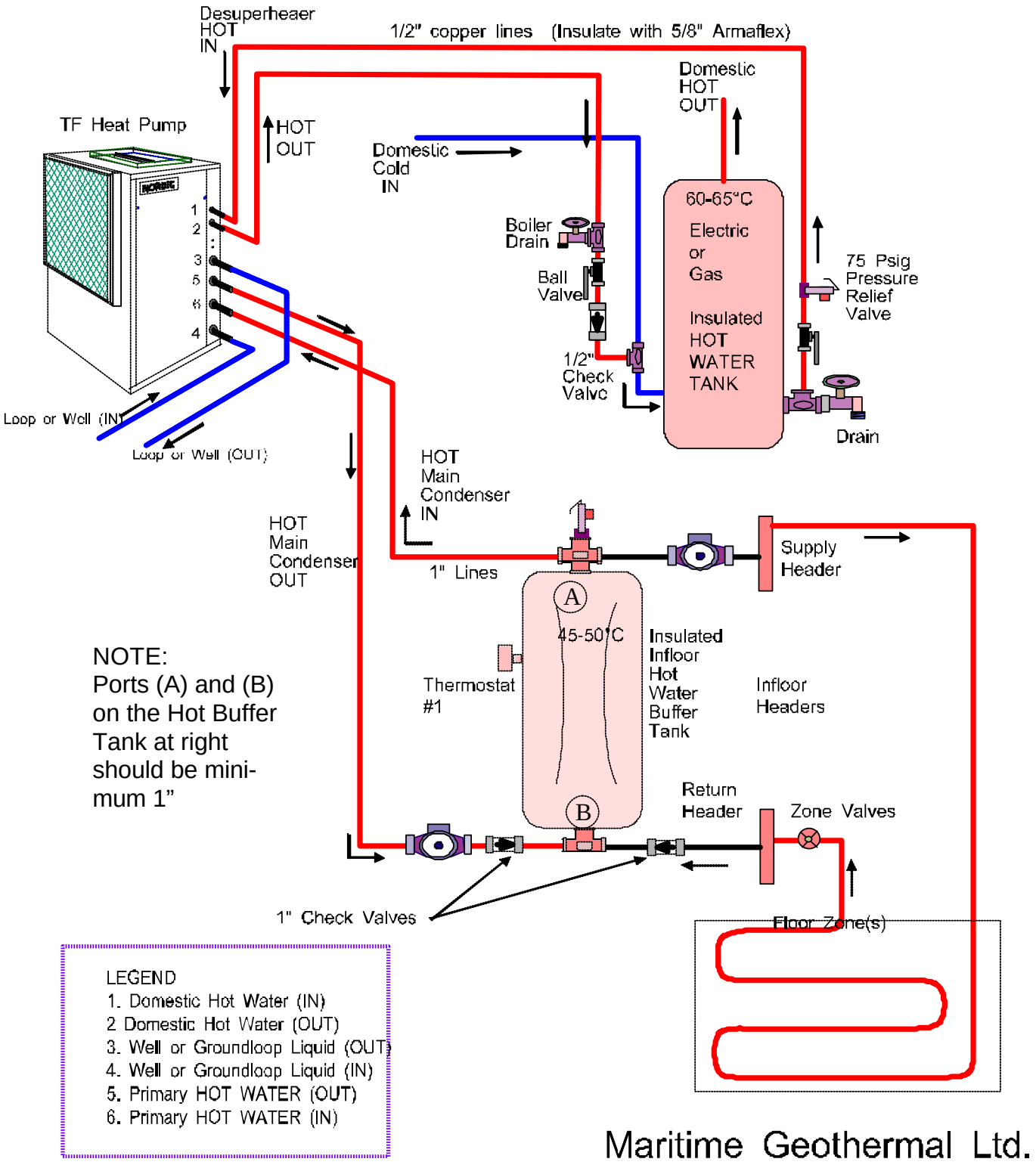
Water flow to the heat pump can be controlled very accurately by the installation of a **REVERSE ACTION PRESSURE VALVE** in the discharge line of the unit. Another method of regulating the flow is by the use of a **“DOLE”** valve. This valve will automatically control the amount of water flowing through it by varying the diameter of a flexible rubber orifice through which the water passes. If either of such valves is needed they can be supplied and installed by your dealer.

All water line valves on both the supply and discharge lines should be either **BALL** or **GATE** valves since a **GLOBE** valve will create too much restriction across the line possibly causing the heat pump to trip out on it's low pressure safety cutout control as a result of insufficient water flow.

Exposed water lines will have a tendency to sweat or loose heat when the heat pump is in operation, therefore it is recommended that all loop or well water, desuperheater and condenser lines be insulated with suitable insulation.

NORDIC® "TF" Series Typical Plumbing

2 Port hot buffer tank



Hot Water Connections

Connection to the hot water generator feature of the heat pump is accomplished by teeing into an electric or oil fired hot water tank with a capacity of 40 gal. minimum. A typical piping diagram is shown elsewhere in this manual. ***Be sure to note the position of the check valve and the direction of water flow.*** One should be sure the tank is filled with water and is under pressure before activating the heat pump.

Slightly loosen the copper union on the hot water discharge pipe to allow air to escape from the system before the unit is started. Repeat this procedure until all air is purged from the system. This step will make certain that the water circulator is flooded with water when it is started. Since the pump is water lubricated, damage will occur to the pump if it is run dry for even a short period. The union on the discharge water line may have to be purged of air several times before good circulation is obtained. A hand placed several feet down the line will sense when the water is flowing. The thermostats on the hot water tank should be set to 120°F. since the heat pump has an internal thermostat set at a low of 130 deg.F. By setting the tank thermostats as described, the heat pump will try to keep the tank above the cut-in point of the electric element settings thus generating hot water from the heat pump only. During summer, or periods of high demand, the electric elements will energize to help make hot water.

NOTE: If (2) shut-off valves are located on the hot water lines as shown in the diagram, be sure that the valves are open when the heat pump is operating. If both valves are closed when the heat pump is operating, water will expand in the hot water heat exchanger and could cause damage to the hot water circulator pump.

Condensate Drain

You will notice in the piping diagram that there is a small drain pipe to the left of the front door. This drain allows the condensed water vapor which forms during the air-conditioning cycle to escape to a suitable area of your selection. On a very humid day there could be as much as 25 gallons of water formed. Care should be taken in the spring to insure that this pipe is not plugged with dust that has collected during the winter since the water formed will overflow into the bottom of the heat pump.

Water Disposal Methods

Water disposal methods vary from area to area however some consideration should be made to prevent the cooled discharge water from immediately coming in contact with the supply source. Generally speaking, returning water to a second well, pond lake or stream is acceptable while returning water to the same well will usually cool the water so much that the heat pump will shut off on it's low pressure / temperature safety control.

A return well should be a minimum of 80 ft. from the supply well for residential applications. The water returned to the well will not be necessarily be pumped into the same aquifer, depending on underground conditions, but the return well does have to be able to supply the same quantity of water as the amount you wish to recharge into it. If the static level (level when not being pumped) of a well is high (10 to 20 ft. from the surface) it may be necessary to place a well cap on the well to keep the return water from flowing out the top of the well. This cap is commonly required since a certain amount of pressure is needed to force the return water back down the well if the static level is high.

Return wells are not always the answer and to some it may be more satisfactory to pump the water to a pond or away into the woods.

Water recharged naturally through percolation into the soil is an alternative to a recharge well. The water discharged will generally soak into the ground within a distance of 50 to 100 ft. If care is taken to make sure the end of the pipe does not freeze then this method of disposal works well.

Safety Controls

The NORDIC® heat pump has two built in safety controls which are designed to protect the unit from situations which could damage it.

1. LOW PRES. / TEMPERATURE CONTROL

The low refrigerant pressure / temperature control is designed to shut the unit down if the refrigerant evaporating pressure becomes too low thus risking the danger of freezing conditions in the evaporator.

There are only (4) reasons why this control would activate and they are:

? ? Low water flow. (See requirements for each mode
? ? Low water temperature. (Below 40 deg.F.)
? ? Dirty or fouled heat exchanger.
? ? Low refrigerant charge.

2. HIGH PRESSURE CONTROL

The second safety control is a high pressure safety limit which monitors compressor discharge pressure. This device will not normally trip unless there is an interruption in air flow. Such a situation could occur if the blower motor or fan belt failed or if the heat pump had an extremely dirty air filter.

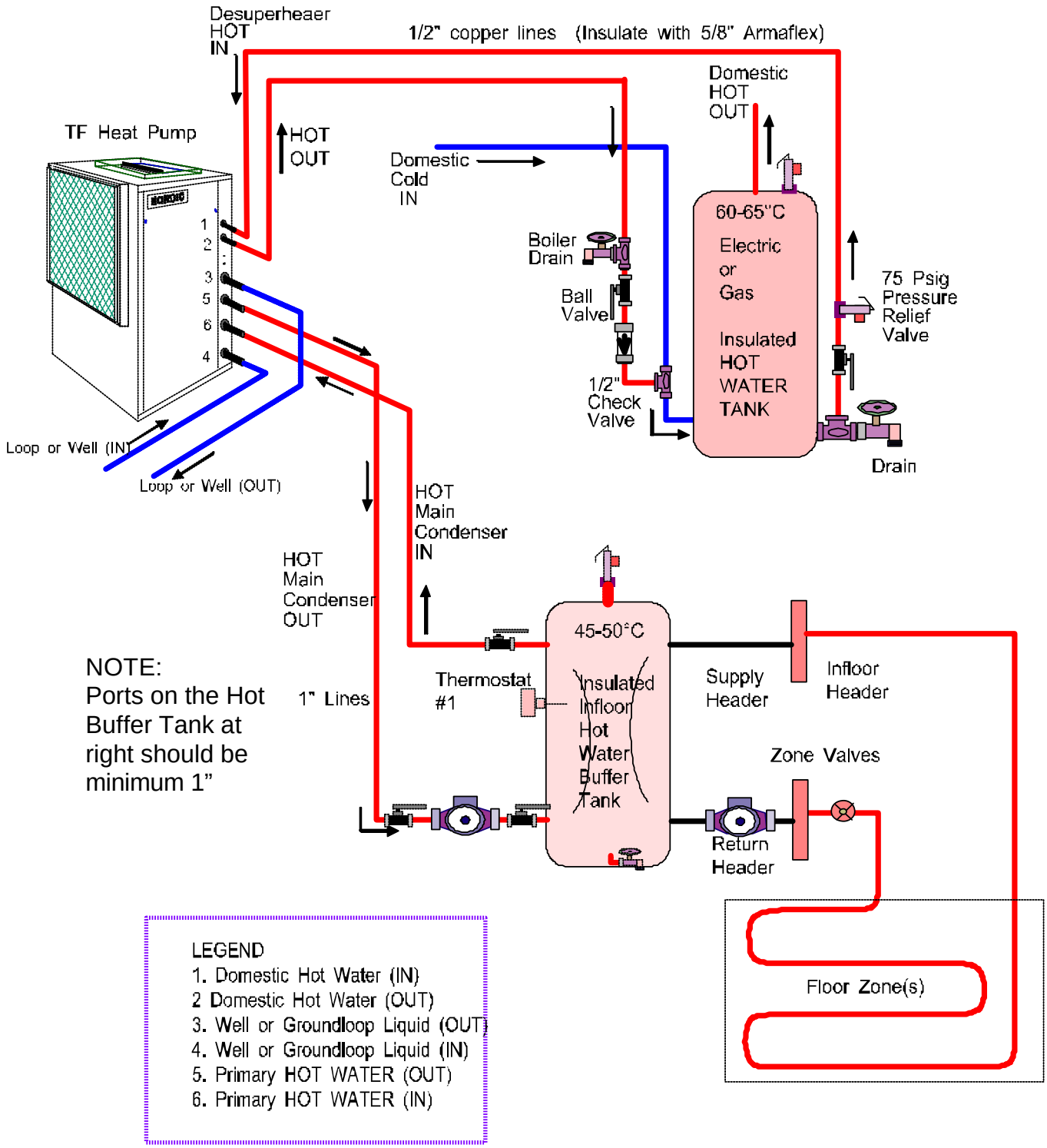
If either of these controls trips it will activate a **LOCK-OUT RELAY** which prevents the unit from restarting until power to the control circuit is broken (by turning the thermostat to the **OFF** position and then back on again) or the electrical supply to the unit is broken by opening the heat pump breaker and then closing it again.

If one of these controls trips there is a serious problem with the system and it must be rectified if the unit is to maintain good service.

NOTE: Under no circumstances should the heat pump lock-out relay be reset more than twice in an hour. If the heat pump is shutting off because of LOW or NO water flow then repeated resetting of the unit could cause the heat exchanger to freeze and rupture destroying the heat pump.

NORDIC® "TF" Series Alternate Plumbing

4 Port hot buffer tank



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Electrical NORDIC® (TF) models

The NORDIC® unit is supplied with an opening for 3/4" conduit nipple on the right blank side of the unit. An additional knockout (1/2") is provided to facilitate connection of a plenum heater blower control wire if required. Above this is another 3/8" hole for the thermostat wire. A wiring diagram is located inside the electrical box cover for quick reference and although the connections to be made are quite simple, Maritime Geothermal Ltd. recommends that a properly qualified electrician be retained to make the connections and wire the thermostat.

The NORDIC® unit comes supplied with a thermostat and connections are clearly marked on the control box. Using a 8-conductor (18 gauge) wire suitable for the job, connect the terminals in the heat pump electrical box to the corresponding terminals on the thermostat.

An additional 4-conductor wire will be required for low voltage control of a NORDIC® plenum heater if required.

Ductwork

Ductwork layout for a NORDIC® heat pump will differ from normal design in the number of leads and size of main trunks required. Air temperature leaving the heat pump is normally 95º to 105º F., much cooler than that of a conventional warm air furnace. To compensate for this, larger volumes of lower temperature air must be moved and consequently duct sizing must be able to accommodate the greater air flow without creating a higher static pressure or high velocity at the floor diffusers. Maritime Geothermal Ltd. recommends that the static pressure be kept below .2 inches of water total. Return ducts should ideally be placed in every room and be sized 50% larger than corresponding supplies. In some instances the number of floor diffusers will actually double when compared to the number that would normally be used for a warm air oil-fired furnace.

NOTE: See the duct sizing chart in the engineering section of this manual.

Starting the Heat Pump

BEFORE starting the heat pump the following areas should be rechecked to assure proper operation.

Check all high voltage field wiring and electrical connections inside the control box for good connection.

Check all low voltage thermostat to make sure they are connected properly. Place thermostat **HEAT-OFF-COOL** switch in the **OFF** position.

Turn on the main power switch. Allow the power to remain **ON** without starting the unit for a period of 4 hours. Refrigerant migrates to the compressor oil when the compressor is unheated. A crankcase heater is standard equipment on your heat pump and it will warm the compressor, dispelling the liquid refrigerant. Compressor damage can occur if the heat pump has been brought in from a cold location and immediately started up.

Turn on the water supply and check all plumbing for leaks.

Check the hot water tank to be sure it is filled with water before energizing the circuit.

NOTE: In a low ambient air start-up the hot water tank should be energized for at least 4 hours before the heat pump is started. A combination of low air temperature and 45º F. water in the hot water tank can sometimes cause the unit to shut down on it's low pressure control. If this happens close ONE valve in the hot water circuit to temporarily shut off the flow to the hot water generator. Do not shut off both valves since water expanding in the hot water generator loop may cause damage to the circulator pump housing. When the home has come up to temperature open the valve for normal hot water operation. Slightly open the union on the hot water discharge pipe to make sure that all air is out of the system and the circulator pump is flooded with water.

Make sure the air filter is clean and in place.

Vacuum out any dust and debris that may have collected in the unit during installation.

Check the condensate drain to be sure that it is free of obstruction.

Make sure the unit is sitting level so that condensate water will not overflow the catch pan.

Make sure the proper time-delay fuse has been installed in the fuse box.

Have the following tools on hand and know how to use them.

A. A refrigeration gauge set.
B. An electronic or other accurate thermomete
C. An amprobe.
D. A water flow meter.

TF Thermostat Function

The room thermostat on a TF unit decides whether the home is in HEATING or COOLING mode. The mode selection switch can be set for (HEAT) (COOL) (OFF) or (AUTO) by the homeowner.

(OFF) - All systems OFF.

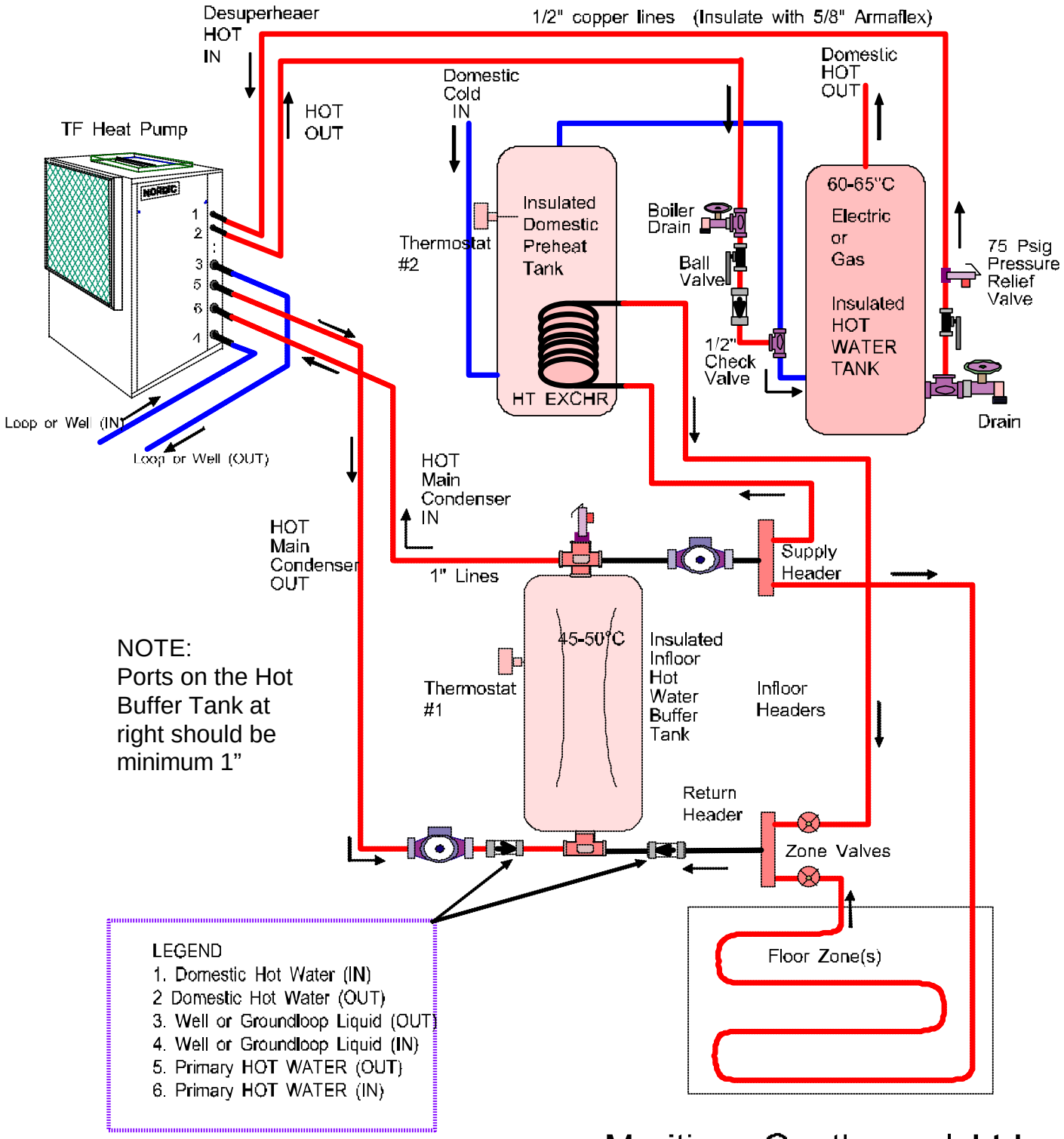
(HEAT) - This position allows the hot buffer tank aquastat to operate the heat pump compressor and associated circulator pump. The blower will not operate in this mode. **Individual thermostats in each zone or room of the building control the flow of hot water from the buffer tank to the floor.** Setting the main room thermostat temperature up or down will have no effect on the operation of the compressor or the temperature in the home. The thermostat will NOT automatically go into COOLING mode when set on HEAT. The domestic hot water desuperheater functions in this mode.

(COOL) - This position allows the room thermostat to operate the compressor and blower in the cooling mode. Hot water making capability is disabled while in COOL mode. The main room thermostat has full control of the heat pump therefore setting the temperature up or down will affect the temperature in the entire home. The desuperheater functions during this mode.

(AUTO) - In this position the thermostat automatically

NORDIC® "TF" Series Preheat & Final DHW Tanks

NORDIC® TF series Preheat Tank & HOT Water Tank Connections



selects the MODE (ie. HEAT or COOL) based on the setpoints entered into the thermostat. The stat will change back and forth from HEAT mode to COOL mode as required by changes in temperature in the home.

Heating Mode Check-Out

Connect the refrigerant gauge set to the high and low ports provided on the front of the machine.

NOTE: Some machines have refrigerant gauges built into the unit. If your heat pump is so equipped, you will not need to attach a serviceman's gauge set but simply observe the readings on the built-in gauges.

After the 4 hour warm-up period place the thermostat function switch in the **HEAT** position.

On TF unit the central room thermostat set to the HEAT mode enables the **AQUASTAT** in the buffer tank to cycle the heat pump **ON** if it is calling for heat.

NOTE: If the unit is equipped with an electric TACO® water valve it will take 30 to 60 seconds before you hear the compressor start. Inside the Taco® valve an internal heater expands a push-rod which opens the valve. When the TACO water valve is fully open, an internal switch activates the compressor circuit.

Observe the readings on the high and low pressure gauge set. The suction pressure (blue gauge) should be approximately 50 to 60 psig. while the head or discharge pressure (red gauge) should be in the area of 200 to 300 psig.

NOTE: The suction pressure (LOW gauge) will be affected by the volume and temperature of water flowing from the well or groundloop through the machine. Larger flow and higher temperature will both increase the suction pressure which in turn increases the COP or efficiency of the unit.

The discharge pressure (HIGH gauge) will be affected by the temperature and flow of water from the hot buffer tank. Cooler water will lower the discharge pressure while lower water flow will tend to raise the discharge pressure. Normal operating range for a buffer tank cycling between 110°F. and 120°F will be about 260 Psig. to 300 Psig.

Record this information on the warranty test card.

Using an electronic thermometer or other accurate thermometer, record the supply water temperature from your well or groundloop "IN" and the water temperature "OUT". The outlet water temperature should be from 4 to 7 degrees cooler than the inlet water temperature.

Record the supply water flow in gpm.

At the electrical disconnect switch place the amprobe jaws around the supply wires and record the current in each.

Cooling Check-Out

Place the thermostat function selector in the **COOL** position and turn down the stat to a temperature that will cause the air-conditioning to begin. When the thermostat selector switch is set in the COOL mode the reversing valve will be energized. The blower should start followed by the compressor. The outlet temperature will be approx. 15 to 20 deg.F. cooler than the return air temp.

General Maintenance

As with any piece of equipment there will eventually be some maintenance to be done on the heat pump. Several areas will need attention and they are as follows:

? ? Change the air filter when required.

? ? *Clean the groundwater heat exchanger.

*Well water applications only.

? ? Inspect the blower belt for cracks & wear.

? ? Insure the condensate drain is clean.

Triple Function NORDIC® heat pumps are equipped with coaxial type heat exchangers. These heat exchangers are not manually cleanable however they can be cleaned with a sulfamic acid solution commonly marketed under the trade name ***"Iron-Out".*** If you are operating the unit from a water well or other open source of water and suspect that the water being pumped through the unit is of a poor quality or you notice a decrease in performance after several years of use it may be necessary to have the liquid heat exchanger cleaned.

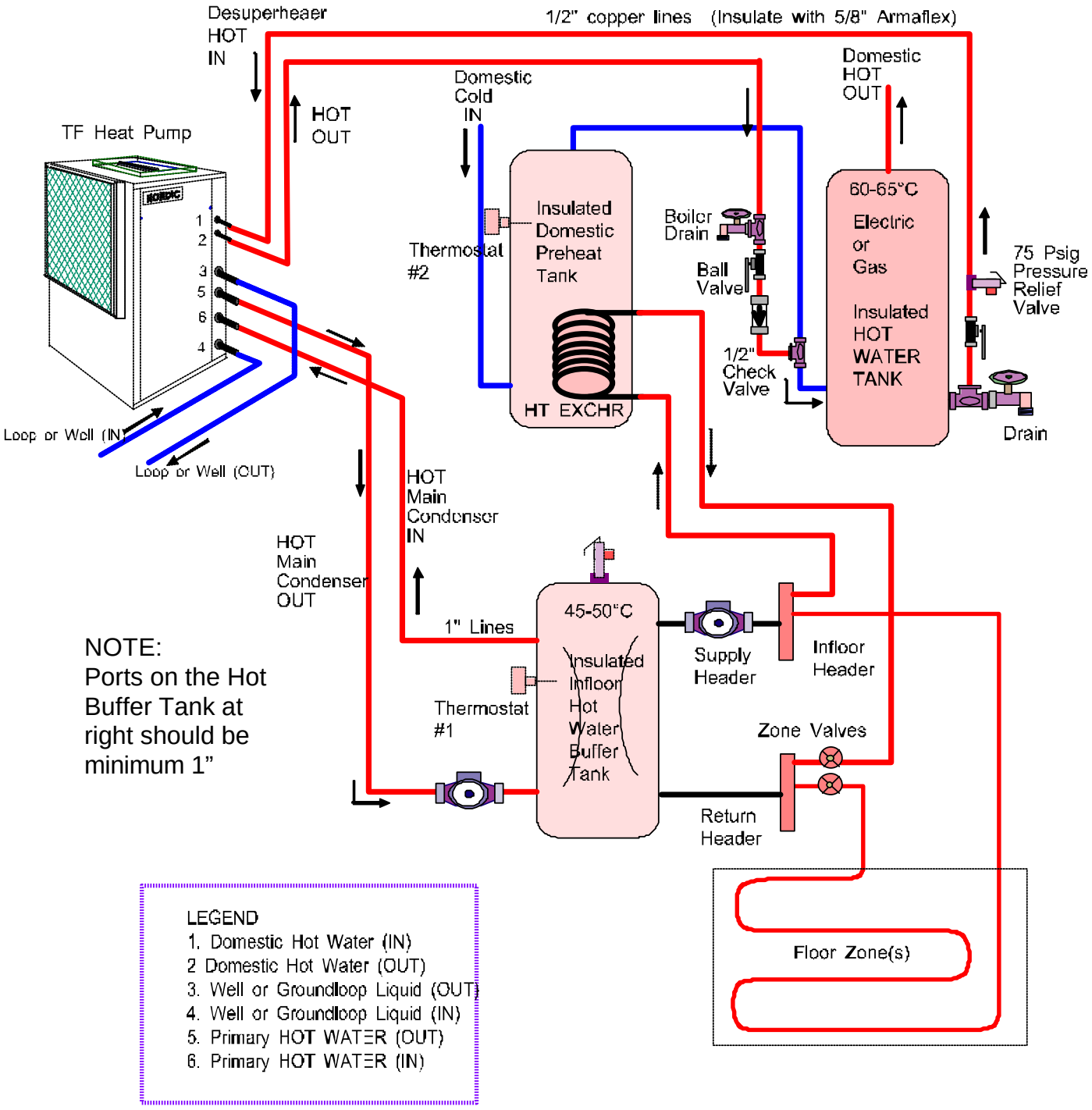
Maritime Geothermal recommends that a qualified serviceman be retained to carry out this procedure since the solution involved is highly corrosive.

Hot Water Condenser Maintenance

The hot water condensed side of a TF unit is equipped with a stainless steel brazed plate heat exchanger which is normally connected to an infloor heating system, pool spa or domestic hot water supply. In any open loop application where constant new supplies of water and consequently new sources of minerals etc. are introduced to the heat pump, the condenser heat exchanger should be examined periodically to determine whether it is becoming corroded. An easy method of determining whether the heat exchanger is fouled is to have your serviceman keep a record of the output water temperature and corresponding heat pump discharge pressure at start-up each time he visits the unit over the years. After several seasons of operation, if the pressure becomes higher for a given output temperature then the heat exchanger may require cleaning. Since the brazed plate exchanger is not manually cleanable, then a cleaning solution such as that described for the evaporator coil will be necessary.

Piping Layout for Infloor Heating

NORDIC® TF series Preheat Tank & HOT Water Tank Connections



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Triple Function with Infloor Heating Systems

NORDIC® TF heat pumps have been successfully used as the prime heat source for under floor heating systems in many applications. The following information is intended to enable a dealer to install the hot water side of such a system successfully.

Heat Pump Selection

The heat pump should be selected on the basis of heat loss in the building just as it normally would be done with a typical water-to-air unit. The Triple Function model chosen has to be large enough to cool the section of the structure served by the air side as well as the infloor section served by the water side.

Once the size has been selected then the proper evaporator water flow and correct pump for the system can be determined from the engineering section. The remainder of this information is dedicated to the distribution of heat from the heat pump into the concrete floor.

Floor Preparation

Concrete floor heating systems provide good performance when the following steps are followed:

1. The base for the concrete slab must be prepared with material that pro-motes good drainage such as coarse gravel or crushed rock. Provision must be made for adequate drainage from underneath the gravel base by providing a network of drain tiles or by the natural lay of the land. We recommend that the base be well compacted prior to pouring the concrete slab. Good drainage is necessary since excessive accumulation of water under the slab will promote the loss of heat from the slab to the underlying earth thus reducing the efficiency of the system.

2. Since our effort is to heat the building and not the surrounding grounds, the underside of the concrete must be insulated with styrofoam.

Maritime Geothermal recommends 2'' of the high density blue styrofoam or equivalent. This styrofoam should be placed on top of the gravel base and under the entire surface area of the concrete slab.

3. Plastic infloor heating pipes can next be laid on top of the styrofoam in the manner shown in the accompanying diagram. We have found no disadvantage in the heating ability of the system by placing the piping at the interface of concrete and styrofoam and there is much less chance that it will be punctured when carpenters begin to drive cement nails for interior partitions etc.

Maritime Geothermal Ltd. recommends that you make no splices in the piping under the floor since the most probable place for a leak would be at a splice.

4. Wire mesh reinforcing steel should then be laid over the plastic heating pipes to increase the strength of the concrete floor. The mesh pattern provides a good method of fastening the piping in place by tying the pipes at intervals so that they will not move during the pouring if the concrete slab.

5. Tie the header pipes up in position and plug the ends so that foreign material cannot enter and pour the slab. The thickness of the slab will have some bearing on the heat retention ability of the system with a thicker slab taking longer to heat up initially and of course taking longer to cool down in the case of a power failure.

6. Insulate around the outside perimeter of the concrete slab by gluing or otherwise fastening styrofoam vertically to the outside edge of the concrete slab as shown. (Diagram D)

One of the unique features of the concrete slab is it's inherent ability to provide continuing heat through electrical power failures of several hours duration.

Equipment Description and Use

Components shown in the accompanying diagrams are incorporated into the system in the following manner.

1. **Expansion tank** - provides an area for the liquid in the floor to expand when heated by the heat pump. It should be sized large enough to accommodate the expansion of the working fluid when heated to its hottest state. (Typically 120° F.) A 10 gallon equivalent tank with an air bladder is acceptable in most cases. The internal pressure of the tank can be adjusted to approx. 12-15 psig.

2. Select a circulator pump of suitable capacity to circulate the working fluid fast enough to keep the head pressure of the heat pump in the range of 225 to 290 psig. and produce a temperature drop of 8 to 15 deg.F. across the hot water heat exchanger. The pump selected should be of the smallest type that will provide adequate circulation thus minimizing the power consumption of the entire system. On most applications a typical GrunTFos UP 26-99 or a TACO® Model 0011 circulator will be adequate. The amount of fluid needed to cool the heat pumps condenser is directly proportional to the size of the heat pump and the amount of floor area plumbed to radiate the heat produced.

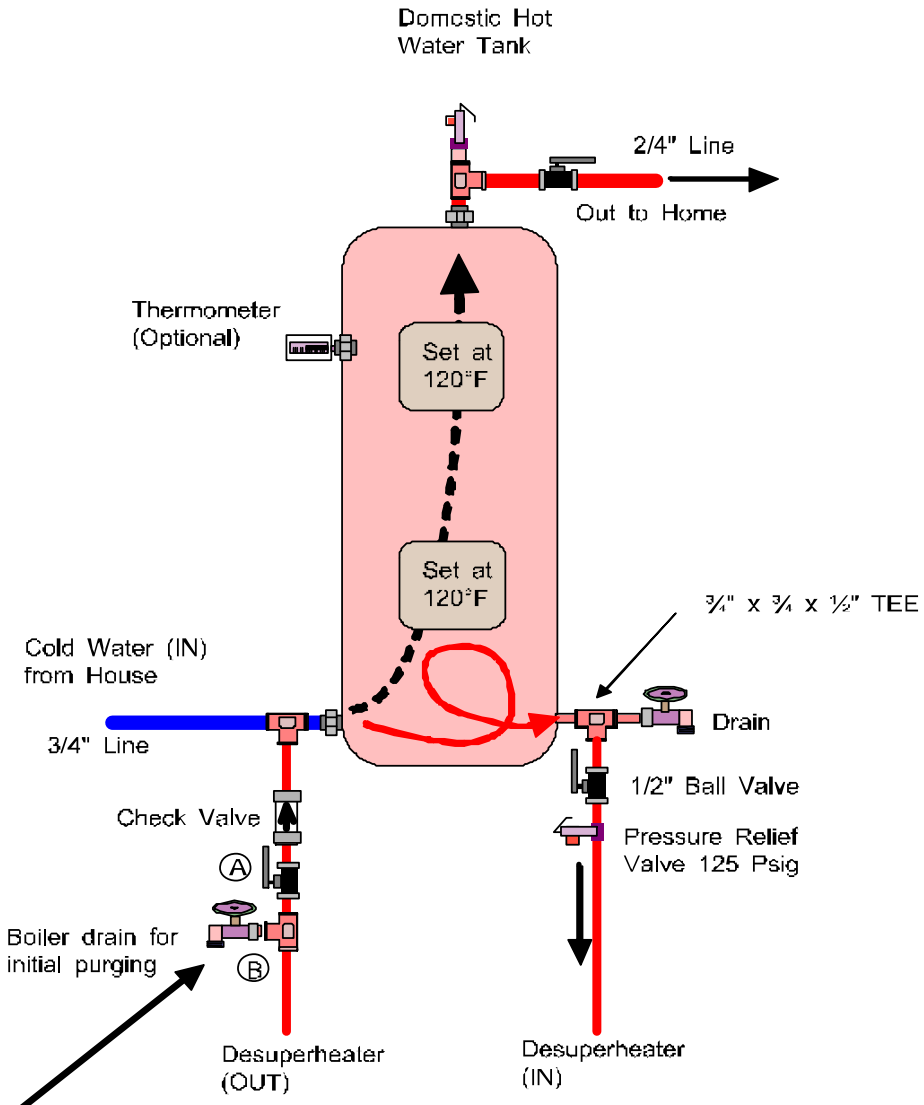
3. Unions or some other type of disconnect should be placed as shown on the diagrams to facilitate the changing or servicing of the circulator pump or heat pump. If shut-off valves are placed as shown, the indiviTriple components can be isolated if required during start-up or for servicing.

4. The **pressure relief valves** are used to prevent the build-up of pressure in the system should the system be started while the condenseris isolated.

5. All valving is done with **full port ball valves** to minimize pressure drop associated with globe valves.

6. The boiler drains shown on the vertical riser pipes are to allow manual removal of air from the system when initially charging the system with water or methanol-water solution. A methanol-water antifreeze solution is used in a floor system whenever the building is heated only intermittently or when there is a possibility that the floor

Maritime Geothermal Ltd.		Revision 1.0	Preliminary
Liquid-to-Air Heat Pumps		Models: TF-45-55-65	Multi Function Models
Date: May 12, 2003	Drawn By: G.Kaye	Title: Desuperheater Connections to HW Tank	



Priming DHW Pump

Close off ball valve A and open boiler drain B to force water at high volume and velocity through the heat pump's domestic hot water exchanger to initially prime the pump and purge air from the system.
When all air has been removed then close A and open B for normal operation.

Maritime Geothermal Ltd.	
Feb 25, 2002	G. Kaye

might experience freezing conditions at some time.

7. **Thermometers** placed as shown will register the temperature rise across the heat exchanger. From this measurement you can determine whether more flow is required across the heat exchanger, floor temp. etc.

8. Maritime Geothermal Ltd. recommends that you install a **boiler pressure reducing valve** on the suction side of the circulator pump to assist

in the initial loading of the floor working fluid and also to provide positive pressure on the floor system at all times.

Zoning of Floor Systems

There are basically two methods of installing NORDIC water-to-water heat pumps on a concrete floor heating system.

A. The first method requires that the floor be able to reject the entire amount of heat produced by the heat pump at any given time. There is no provision for storing the heat generated and therefore the circulation system and the radiating ability of the slab floor must be able to transfer the heat to the surrounding air as it is being produced. This type of system would normally have only one zone and the heat produced would heat the entire building to an even temperature.

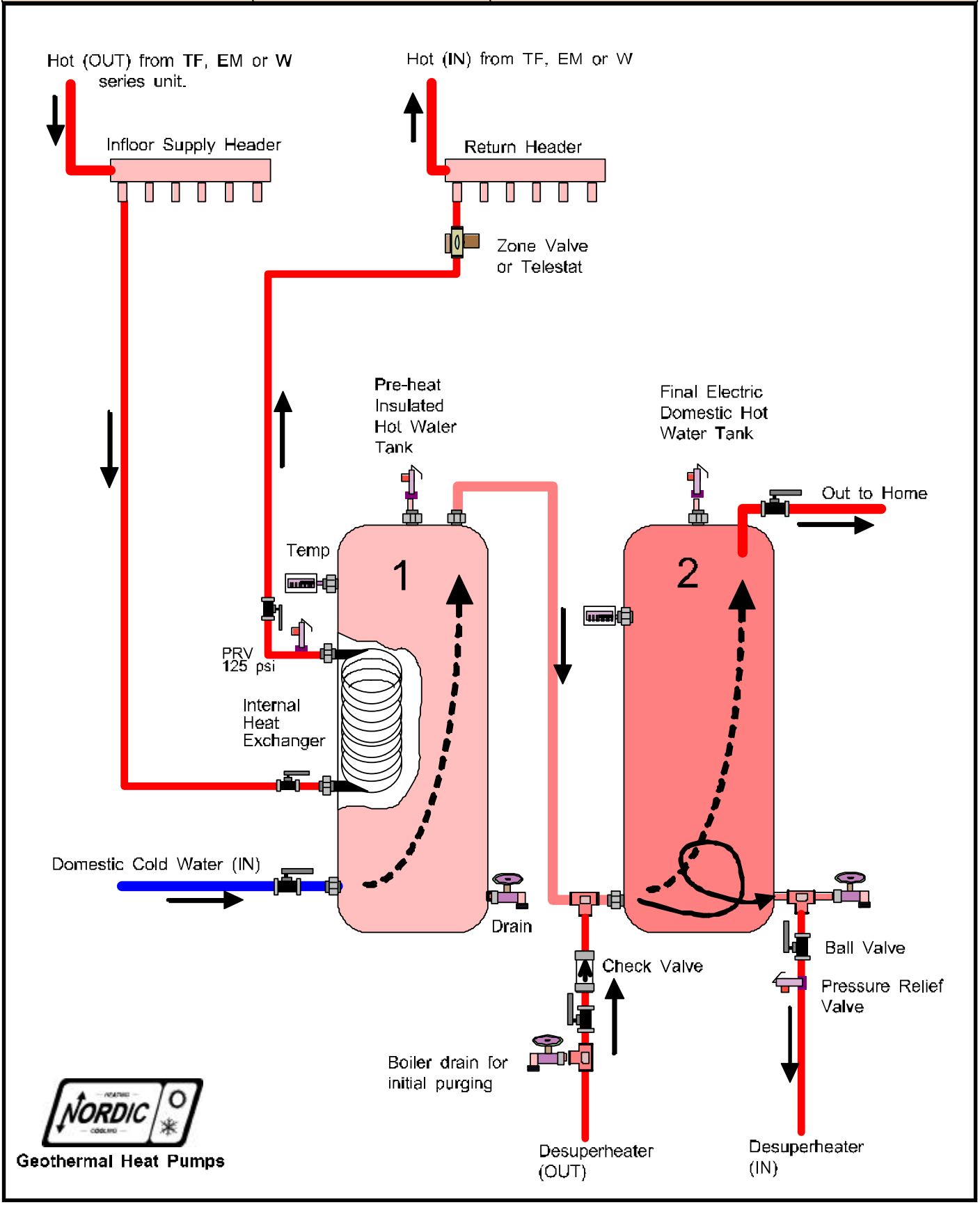
(See diagram A)

Although a holding tank is not required in this application, back-up heat is easily provided by installing an electric hot water tank in the heat pump's hot water discharge line as described below.

B. The second method involves the installation of a suitably sized holding tank from which hot water is distributed to several zones in the building as required. The heat pump is installed so that it heats the water in the tank and shuts off when the tank temperature reaches approximately 120 deg.F. This system requires 2 circulator pumps rather than one and also a zone valve for each area zoned. (See diagram B) One of the advantages of this system is that it is convenient to provide backup heat by simply using an electric hot water tank as the storage tank.

The zone valves used on the system can end switches wired so that the circulator be of whatever variety that you choose with comes on as required.

Maritime Geothermal Ltd.		Revision 1.0	Color: Caissie Grey
Dual Function Heat Pumps		Models: TF-45-55-65	
Date: June 1997	Drawn By: G.Kaye	Title: Preheating Hot Water	

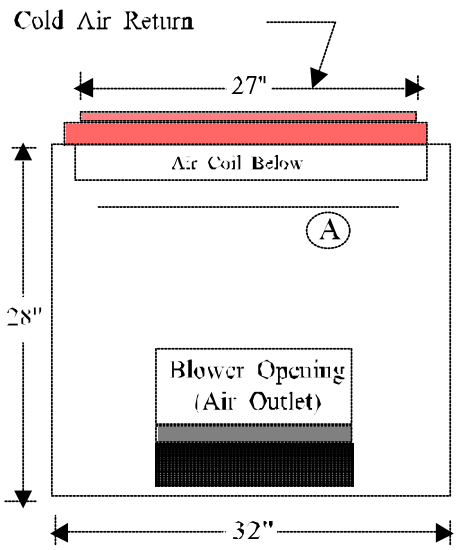


NORDIC® TF-45-55-65 Series

Engineering and Performance Data

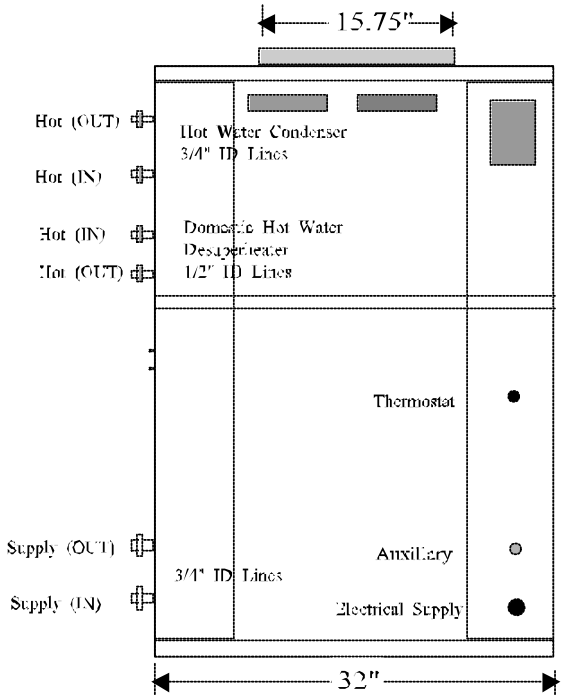
May, 2000

Maritime Geothermal Ltd.		Revision 1.0	Color: Caissie Grey
Liquid -to-Air Heat Pumps		Models: TF-45-55-65	Style: Vertical
Date: June 1999	Drawn By: G.Kaye	Title: Cabinet & Piping Layout	

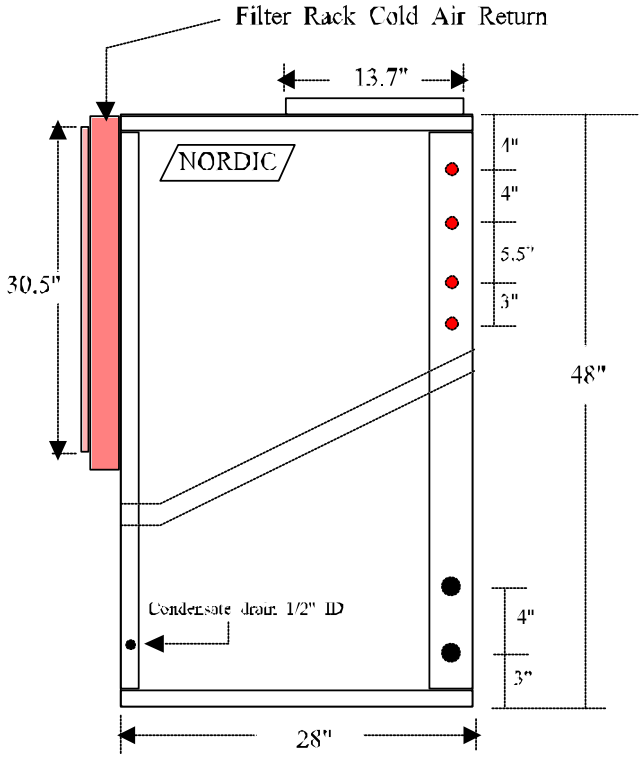


NORDIC® General Design Features

? ? Basic cabinet design is similar for all “DF” 45-55-65 series units.
? ? Cold air return measures 27” x 30.5”
? ? Hot air plenum can be attached at any point on top of the unit except within 6” of the filter rack. (To protect air coil below) See line at left marked “A”.
? ? The filter rack is removeable to facilitate easy entry to the building and is reversible so that the filter can be removed from either side.
? ? Blower opening (outlet) is for a G-12 blower in models 55 and 65.
? ? Model 45 units have a G-10 blower with dimensions 11.5” x 13.5” centered similar to the G-12 unit shown.



Right Side View

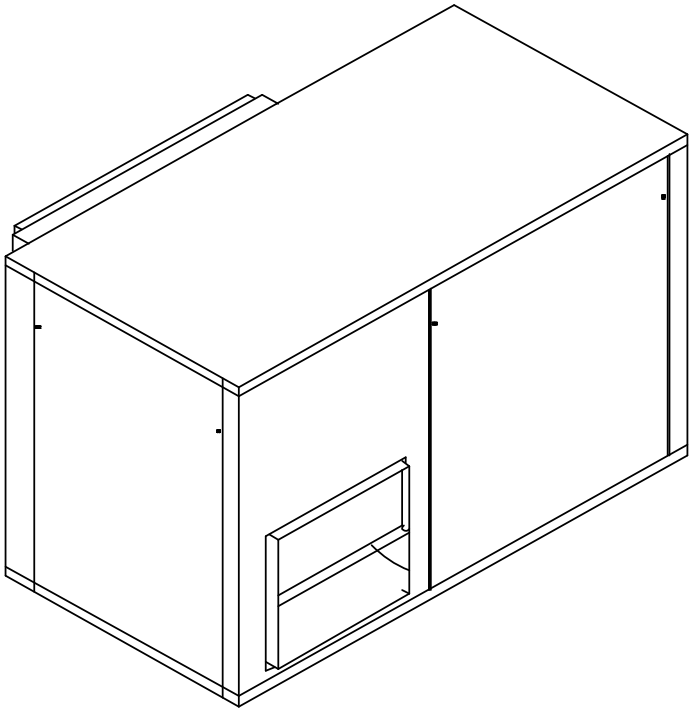


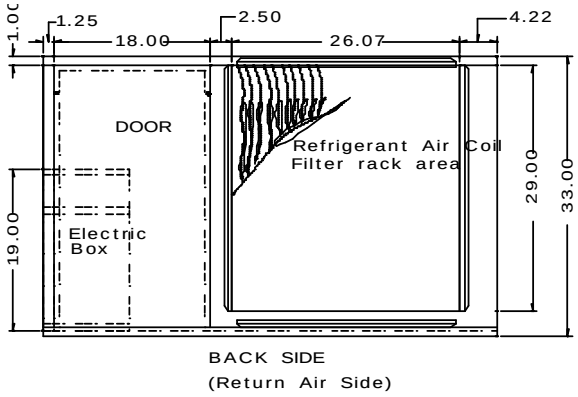
Front View

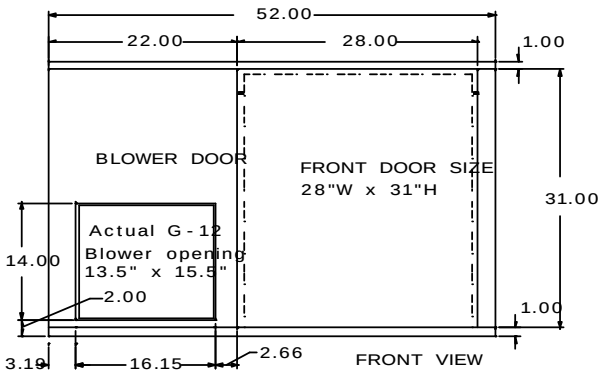
? ? Unit cabinet constructed of 22 gauge satin galvanized material. Floor and electrical box are 20 gauge satin galvanized. Condensation tray is 20 gauge hot dipped galvanized.
? ? Reinforcing devices are placed in all high stress areas for additional strength during transport.
? ? Durable baked enamel finish.
? ? All components easily acessible through three full length removeable doors.
? ? Cabinet is fully insulated with flame retardant accoustic material.

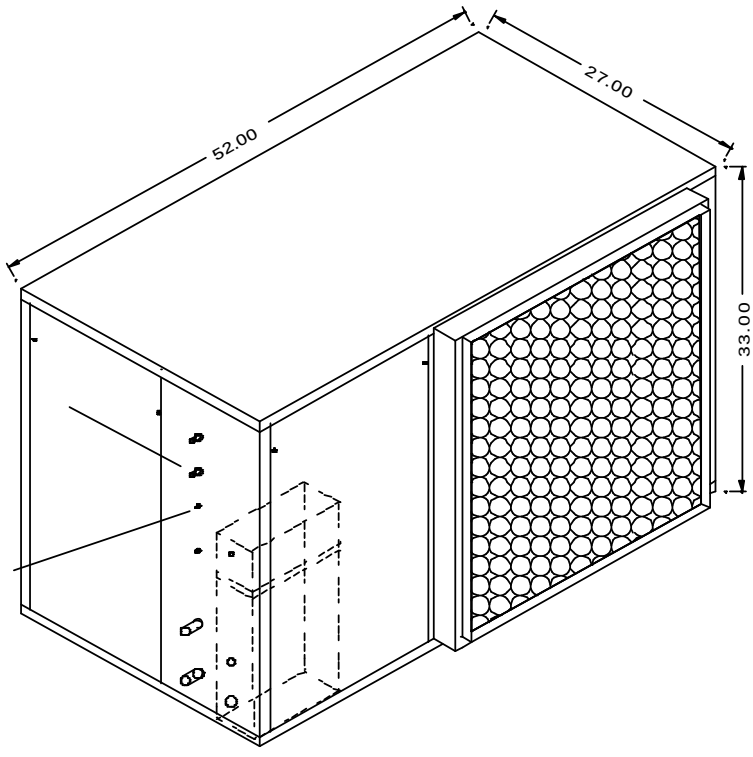
LR 56328

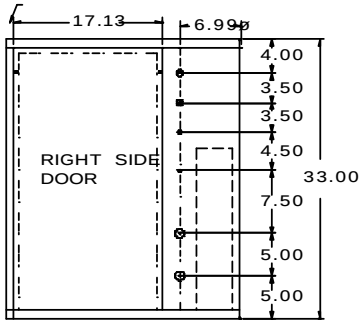
Maritime Geothermal Ltd.		Revision 1.0	Color: Caissie Grey
Liquid -to-Air Heat Pumps		Models: TF-45-55-65	Style: Horizontal
Date: June 1999	Drawn By: G.Kaye	Title: Cabinet & Piping Layout	

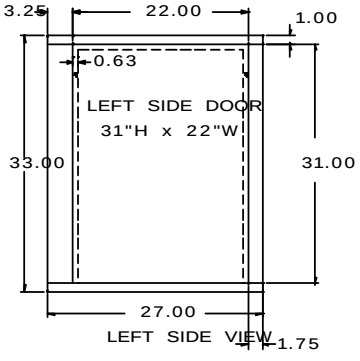


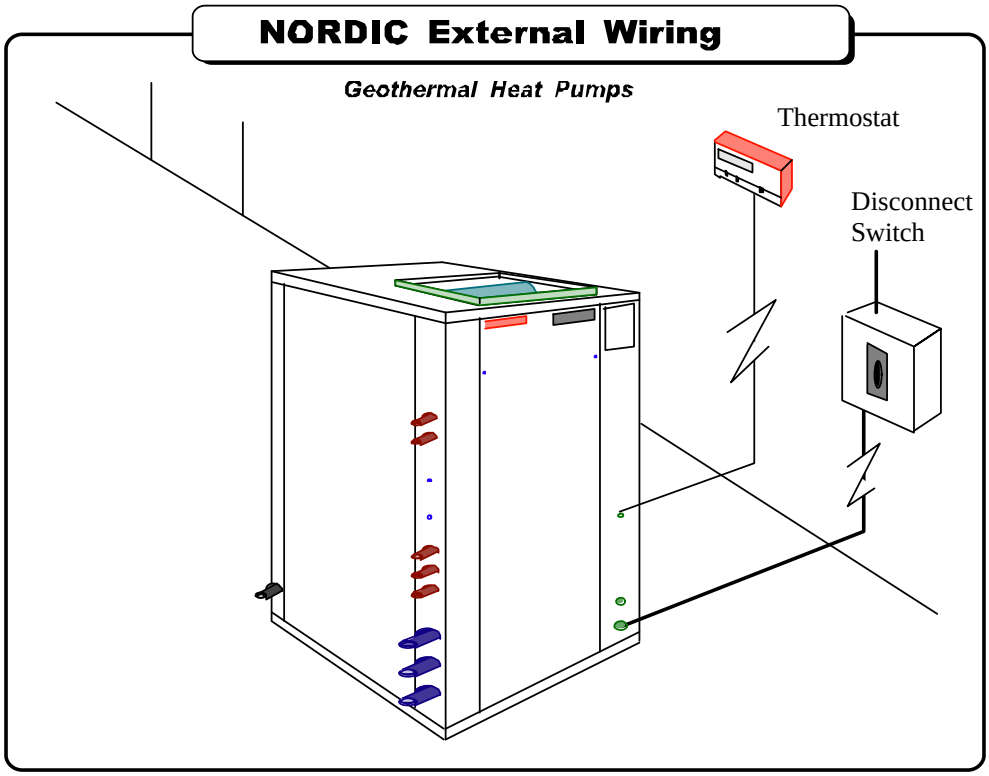












Electrical Supply and Thermostat Wire Sizes

Model	TF-45	TF-55	TF-65
Nominal BTU output	**45,000**	**55,000**	**65,000**
Min. circuit ampacity	29	32	37
Minimum wire size	# 8-3	# 8-3	# 6-3
Max. Fuse Size	40	40	50
Max. breaker size	40	40	50
Thermostat wire size	# 18	# 18	# 18
Thermostat conductors	8	8	8
Aquastat conductors	#18-2 conductor NOTE: 18-3 conductor required if external pump relay employed.		

Domestic Hot Water Generator Specifications

Temperature (IN) °F.	Temp (OUT) °F.	Temperature Rise °F.	% of Total	TF-45 (Igal/hr)	TF-55 (Igal/hr)	TF-65 (Igal/hr)
40	150	110	20	10	11.8	14.5
45	150	105	18	9.4	11.1	13.7
50	150	100	15	8.33	9.8	12.1
60	150	90	12	7.33	8.6	10.6
75	150	75	10	7.33	8.6	10.6
90	150	60	8	7.33	8.6	10.6
110	150	40	5	6.87	5.4	10

Maritime Geothermal Ltd.		Revision 1.0	Color: Caissie Grey
Liquid-to-Air Heat Pumps		Models: TF-45-55-65	Style: Vertical
Date: June 1999	Drawn By: G.Kaye	Title: Cabinet & Piping Layout	

Premium Features - Triple Function Series

Return Air Filter

Oversize high efficiency air coil.

Belt drive blower with ball bearings.

High efficiency ball bearing, PSC style motor.

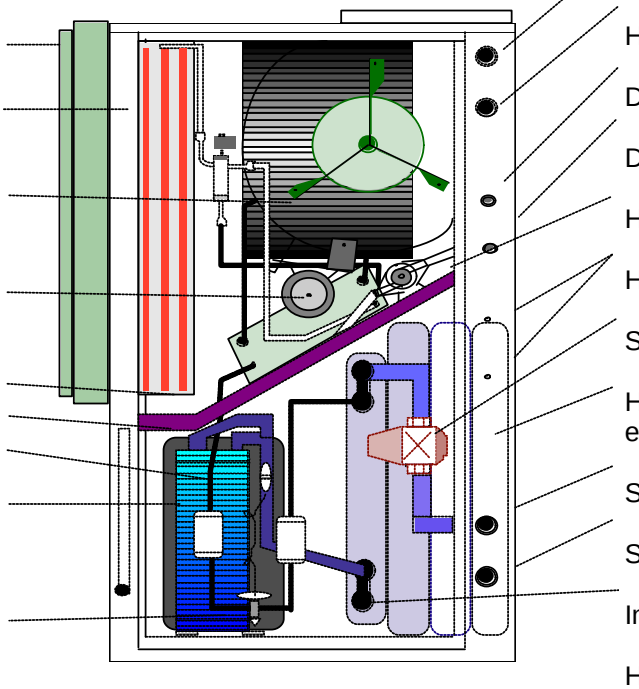
Galvanized drip tray.

Sight glass (optional)

Suction accumulator.

Bi-flow filter driers.

Thermostatic expansion valve.



Hot (Condenser Out)

Hot (Condenser In)

Domestic Hot Water (IN)

Domestic Hot Water (OUT)

Hot Water circulator

High & Low access ports.

Slow closing water valves.

High Efficiency coaxial heat exchanger.

Supply water (OUT)

Supply water (IN)

Insulated water coil.

High efficiency Tecumseh

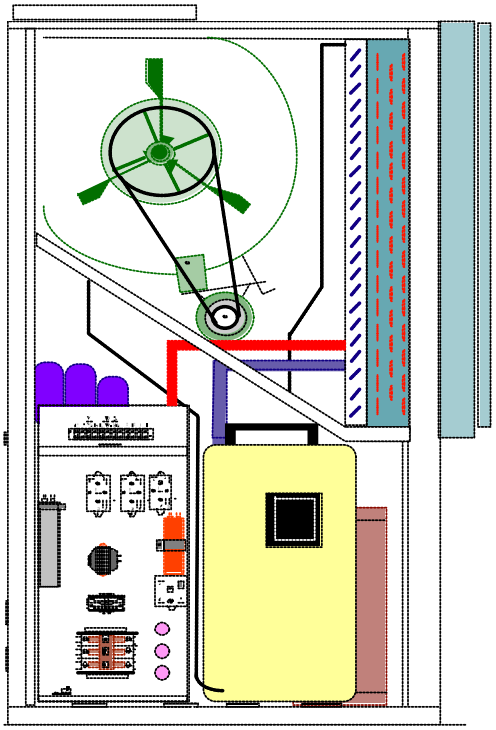
(Front) Plumbing side

Baked enamel cabinet with satin galvanized condensate tray and floor.

Components accessible from three sides.

Heavy duty electrical components.

Hard start kit on all models. Blower motor field replaceable.



Remote reset lock-out relay system. Acoustically insulated cabinet.

Cabinet spot welded together for superior strength.

Removable and reversible filter rack.

(Back) Electrical Box Side

Capacity Data Model TF-45-HAC (nominal 3 ton)

Heating (Hot Water)

EWT °F	lgpm Cold	Lpm	LWT °F	Diff °F	HAB (Btu's)	Pres Drop	EWT °F	LWT °F	lgpm Hot	Diff °F	Btu's Out	Comp Amps	Total Watts		COP	CSA COP		Suct Pres.	Disc Pres.
70	10	45.2	63	7.2	40520	2.75	104	111	12	7.5	53908	17.2	3922		3.91	3.53		70.4	289
60	10	45.2	53	7.0	38367	2.75	104	111	12	7.1	51043	17.0	3824		3.81	3.43		68.3	286
55	10	45.2	48	6.8	36328	2.75	104	110	12	6.6	48330	16.7	3728		3.70	3.33		66.2	282
50	10	45.2	44	6.6	34397	2.75	104	110	12	6.2	45762	16.5	3592		3.64	3.27		63.5	279
40	10	45.2	34	6.0	29200	2.75	104	109	12	5.7	38848	16.0	3329		3.33	3.00		57.9	269
32	10	45.2	25	6.5	23471	2.75	104	109	12	5.3	33571	15.2	2973		3.23	3.10		51.3	256

Cooling (Ducted Air)

EWT	lgpm	Lpm	LWT	Diff	Water Output	Pres Drop	EAT	LAT	Diff	Sens. cooling	Latent Cooling	Total Cooling	Comp. Amps	Comp Watts	Blower Amps	Blower Watts	Total Watts	EER	CSA EER
50	8	36	60.6	10.8	40987	5.38	79.5	64	16	30082	10549	40730	12.38	1956	4.28	407	2363	17.2	12.7
70	8	36.2	79.7	10.1	36785	5.41	79.7	65	15	29125	9103	38502	13.67	2317	4.23	407	2725	14.1	10.8
77	8	36.2	86.9	9.7	36755	5.41	80.2	65	15	29696	8211	38427	14.27	2484	4.17	407	2890	13.2	12.3
90	8	36	99.7	9.6	35813	5.35	79.9	66	14	27472	7615	34878	15.5	2821	4.16	412	3232	10.8	10.1

Comp: ZR40K1 Scroll BM: HE / .33 Marathon G-10 Blower 2 row / 6-circuit air coil BTSSC-60 water coil

Voltage: 230/1/60 Entering Air: 70DB / 60WB CFM: 1650 External Static: .15" WC BP-3 SS Hot Water Condenser

In accordance with ARI 325 & ARI 330 standards and CAN/CSA C446-M94

Capacity Data Model TF-55-HAC (nominal 4 ton)

Heating (Hot Water)

EWT °F	lgpm Cold	Lpm	LWT °F	Diff °F	HAB (Btu's)	Pres Drop	EWT °F	LWT °F	lgpm Hot	Diff °F	Btu's Out	Comp Amps	Total Watts		COP	CSA COP		Suct Pres.	Disc Pres.
70	12	54.2	62.9	7.1	48418	3.82	104	113	12	9.0	64658	20.8	4758		3.93	3.46		67.1	302
60	12	54.2	53.5	6.9	45753	3.82	104	112	12	8.5	61099	20.5	4639		3.80	3.35		65.1	298
55	12	54.2	48.4	6.6	43234	3.82	104	112	12	8.1	57735	20.2	4523		3.69	3.25		63.1	294
50	12	54.2	43.8	6.4	40853	3.82	104	111	12	7.6	54556	19.8	4352		3.62	3.19		60.5	291
40	12	54.2	34.0	5.9	34470	3.82	104	110	12	6.9	46032	19.0	4034		3.29	2.90		55.2	279
32	12	54.2	25.5	6.3	27483	3.82	104	110	12	6.4	39699	18.1	3598		3.19	3.08		48.8	265

Cooling (Ducted Air)

EWT	lgpm	Lpm	LWT	Diff	Water Output	Pres Drop	EAT	LAT	Diff	Sens. cooling	Latent Cooling	Total Cooling	Comp. Amps	Comp Watts	Blower Amps	Blower Watts	Total Watts	EER	CSA EER
50	8	36	64.9	14.9	59450	5.8	80.1	56	25	38410	21940	61107	14.8	3104	3.39	330	3434	17.8	14.3
60	8	36.3	74.1	14.4	56902	5.83	80.4	57	24	36618	20729	58064	15.81	3363	3.36	324	3686	15.7	12.8
70	8	35.8	84	14	53146	5.56	80.1	58	23	35149	18045	54121	17.01	3636	3.4	340	3976	13.6	11.2
77	8	36.2	91	13.8	52035	5.65	80.4	58	22	34326	18545	53513	17.79	3832	3.38	334	4165	12.8	10.7

Comp: AV5549G BM: .5 Marathon G-12 Blower 4 row / 12-circuit air coil BTSSC-84 water coil

Voltage: 230/1/60 Entering Air: 70DB / 60WB CFM: 1800 External Static: .15" WC BPC-5 SS Heat

In accordance with ARI 325 & ARI 330 standards and CAN/CSA C446-M94

Capacity Data Model TF-65-HAC (nominal 5 ton)

Heating (Hot Water)

EWT °F	lgpm Cold	Lpm	LWT °F	Diff °F	HAB (Btu's)	Pres Drop	EWT °F	LWT °F	lgpm Hot	Diff °F	Btu's Out	Comp Amps	Total Watts		COP	CSA COP		Suct Pres.	Disc Pres.
70	12	54.2	61.6	8.4	57246	3.82	104	114	12	10.7	76986	24.2	5783		3.84	3.48		66.1	312
60	12	54.2	52.3	8.1	54094	3.82	104	114	12	10.1	72747	23.9	5639		3.73	3.38		64.1	308
50	12	54.2	42.6	7.6	48302	3.82	104	113	12	9.1	64958	23.1	5360		3.50	3.17		59.6	300
45	12	54.2	37.9	7.4	45642	3.82	104	112	12	8.8	61381	22.8	5226		3.39	3.07		57.8	296
40	12	54.2	32.9	7.0	40755	3.82	104	112	12	8.3	54809	22.2	4968		3.19	2.89		54.4	289
32	12	54.2	24.3	7.5	32494	3.82	104	111	12	7.6	47268	21.0	4432		3.08	2.98		48.1	274

Cooling (Ducted Air)

EWT	lgpm	Lpm	LWT	Diff	Water Output	Pres Drop	EAT	LAT	Diff	Sens. cooling	Latent Cooling	Total Cooling	Comp. Amps	Comp Watts	Blower Amps	Blower Watts	Total Watts	EER	CSA EER
50	8	36.3	67.8	17.6	66472	3.21	80.1	58	23	43189	25046	69127	23.85	3962	8.0	433	4395	15.7	14.1
60	8	36.2	77.7	17.3	63497	3.09	80.4	58	23	43215	21873	63497	25.09	3952	8.4	459	4411	14.4	13.2
70	8	36.3	87.1	16.6	59391	3.18	79.7	58	21	41381	20041	62109	26.36	4111	8.3	453	4564	13.6	12.1
77	8	35.6	93.6	16.8	58296	3.38	79.5	59	20	38988	19792	59457	27.28	4233	8.4	457	4690	12.7	11.6

Comp: AV5558G BM: HE / .5 Marathon G-12 Blower 4 row / 12-circuit air coil BTSSC-84 water coil

Voltage: 230/1/60 Entering Air: 70DB / 60WB CFM: 2050 External Static: .2" WC BPC-5 SS Brazed

In accordance with ARI 325 & ARI 330 standards and CAN/CSA C446-M94

Water Flow Vs. Pressure drop Tables

BTSSC-60 Turbotec® Exchanger		
(lgpm)	*(Psig)*	*(Psig) c/w valve*
12	6.71	12.2
10	4.35	8.65
8	2.85	5.41
6	1.92	2.97
4	1.10	1.35

BTSSC-84 Turbotec® Exchanger		
(lgpm)	*(Psig)*	*(Psig) c/w valve*
12	6.88	12.5
10	4.85	8.83
8	3.15	5.83
6	2.0	3.65
4	1.35	2.0

Air Flow Vs. External Static Pressure

G-10 Delhi Blower	
External Static Pres.	*CFM available*
.10	1966
.15	1885
.20	1777
.25	1657
.30	1581

G-12 Delhi Blower	
External Static Pres.	*CFM available*
.10	2182
.15	2092
.20	1972
.25	1839
.30	1755

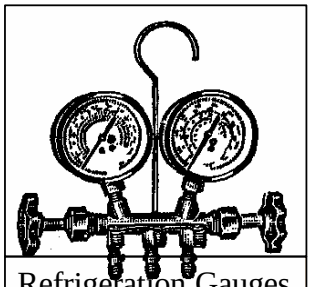
NORDIC® "TF" Series Trouble Shooting Guide

Fault	Possible Cause	Verification	Recommended Action
Compressor not operating	Power Failure	Electric circuit test shows no voltage on the line side of compressor contactor.	Check for blown fuse at heat pump's disconnect box or blown fuse
	Disconnect switch open	Voltmeter shows no voltage on the line side of the compressor contactor.	Determine why the disconnect switch was opened, if all is OK close the switch.
	Fuse blown	At heat pump disconnect box, voltmeter shows voltage on the line side but not on the load side.	Replace fuse with proper size and type. (Time-delay) type "D" Check total load on system.
	Low voltage	Voltmeter shows abnormally low voltage (Below 210 v) at heat pump disconnect switch.	Call power company.
	Burned out motor	Ohmmeter shows no resistance between common and run terminals or between common and start terminals. Note: Be sure compressor overload has had a chance to reset. If comp. is hot this may take several hours.	Determine cause and replace motor.
	Thermal overload on compressor tripped.	Ohmmeter shows reading when placed across R and S terminals and infinity between C & R or C & S. Make sure the internal overload has had time to reset.	If windings are open or overload is faulty, replace compressor.
	Faulty compressor contactor.	Voltage on line side with contactor held closed, but no voltage on one or both terminals on the load side. Points pitted or burned.	Replace contactor.
	Seized compressor due to locked or damaged mechanism.	Compressor attempts to start but trips it's internal overload after a few seconds.	Attempt to "rock" compressor free. If normal operation cannot be established, replace compressor.
	Faulty run capacitor.	Check with ohmmeter for shorts, open etc.	Replace if faulty.

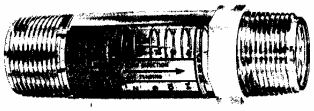
Fault	Possible Cause	Verification	Recommended Action
Compressor not operating	Open control circuit.	?? Thermostat not calling for heat. ?? High or low pressure limit open. ?? Lock-out relay energized.	Locate open control and determine cause. Replace faulty control if necessary.
	Compressor repeatedly locks out on it's LOW pressure safety control.	Open contacts on low pressure safety limit switch. Lock out relay energized. Water heat exchanger frozen.	Check for "low" or "no" water. Restore proper water flow. Thaw out heat exchanger.
Compressor "short cycles"	Intermittent contact in electrical control circuit.	Normal operation except too frequent starting and stopping.	Check anticipator in thermostat. Make sure setting is for "longest cycle" or max. amps.
Unit trips off on "LOW" suction pressure control.	Low water flow	Manually open water valve and measure water flow with a flowmeter.	Check well pump for proper operation. Check water valve for proper operation. Replace.
	Water supply too cold.	Measure temperature of water. Check flow rate with spec. sheet to determine if proper gpm is available.	Increase flow to proper gpm.
	Ambient air too cold.	Measure return air temp. Should be above 60°F.	Restrict air flow temporarily until room comes up to temperature.
	Faulty low pressure ctrl. Faulty low "temp" ctrl.	Refrigerant pressure control should open on drop at approx. 45 psig. Temp. ctrl. will open in about 1 minute if water flow is interrupted or if unit is run with suction pressure below 50 psig.	Both controls should reset automatically. Heat pump can then be restarted by resetting the lock-out relay. (Turn power off then back on) Replace faulty control if it will not reset.
	Low refrigerant charge.	Check water temp. and flow. Clean heat exchanger. If suction is still low check return air temp. Normal suction is 50-60 psig.	Add refrigerant slowly. Check for possible leaks.
Low or "no" air conditioning	No water flow. Unit trips out on it's high pressure limit.	Check flow with flowmeter or other method.	Check water pump operation.
	Reversing valve "stuck" in the heating mode.	Unit works well in the heating mode but there is no loud rushing sound when unit is quickly switched to cooling mode.	Check or replace valve solenoid and if necessary replace entire reversing valve assembly.

Fault	Possible Cause	Verification	Recommended Action
Low or “no” air conditioning	Open control circuit	Thermostat not set to signal operation	Turn room thermostat down.
	Reduced air flow or return air temperature too cold. Unit trips out on low suction pressure control.	Check for: 1. Dirty air filter. 2. Fan belt slipping. 3. Broken blower belt. 4. Inoperative blower motor.	1. Replace filter 2. Tighten blower belt. 3. Replace belt. 4. Replace blower motor.
Insufficient hot water	Circulator pump not operating.	Visually inspect the pump to see if shaft is turning. Use an amprobe to measure current draw.	Replace if faulty.
	Blockage or restriction in the water line or hot water heat exchanger.	Check water flow and power to pump. Check water lines for obstruction	Remove obstruction in water lines. Acid treat the domestic hot water coil.
	Thermostat limit is open.	Check contact operation. Should close at 120°F and open at 140°F.	Replace thermostat if faulty.
	Disconnect switch open, or fuse blown in electrical supply to hot water tank.	Check both line and load sides of fuses. If switch is open determine why.	Replace blown fuse or breaker or close switch.
	Reset button tripped on hot water tank.	Check voltage at elements with multimeter.	Push reset button.
	Thermostat on hot water tank set too low. Should be set at 120°F.	Visually inspect the setting.	Readjust the setting to 120°F.
	Heat pump not running enough hours to make sufficient hot water.	Note the amount of time the heat pump runs in any given hour.	Temporarily turn up the tank thermostats until colder weather creates longer run cycles.

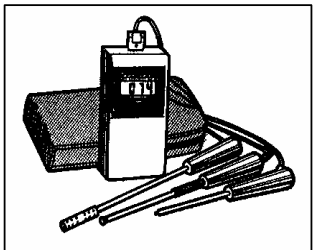
Trouble Shooting Tools



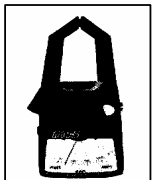
Refrigeration Gauges



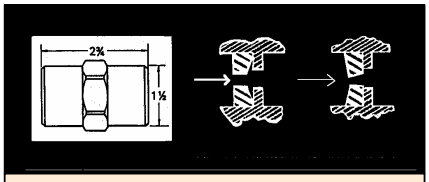
In-line Flowmeter



Digital Thermometer



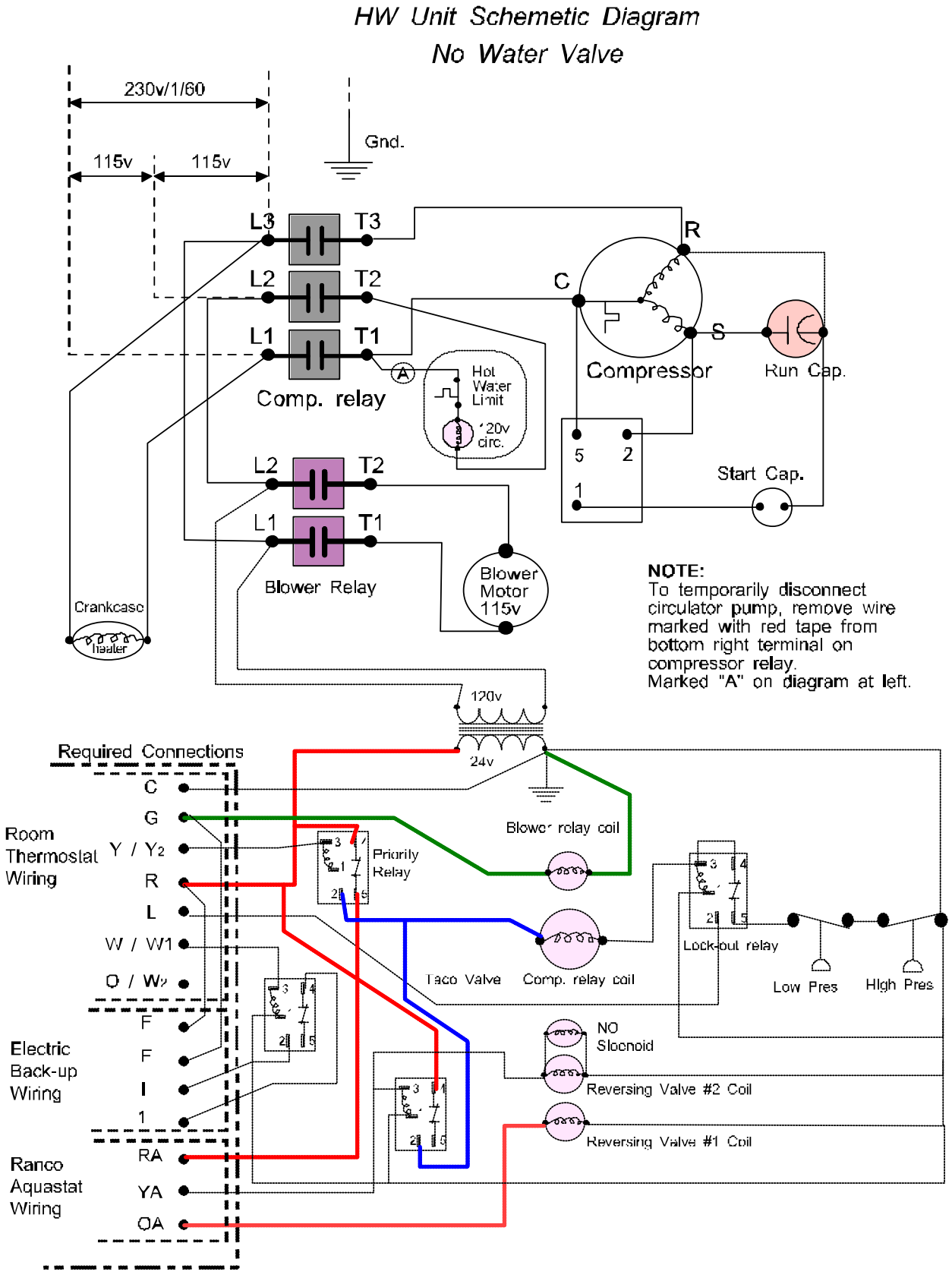
Amprobe



Dole flow control Valve

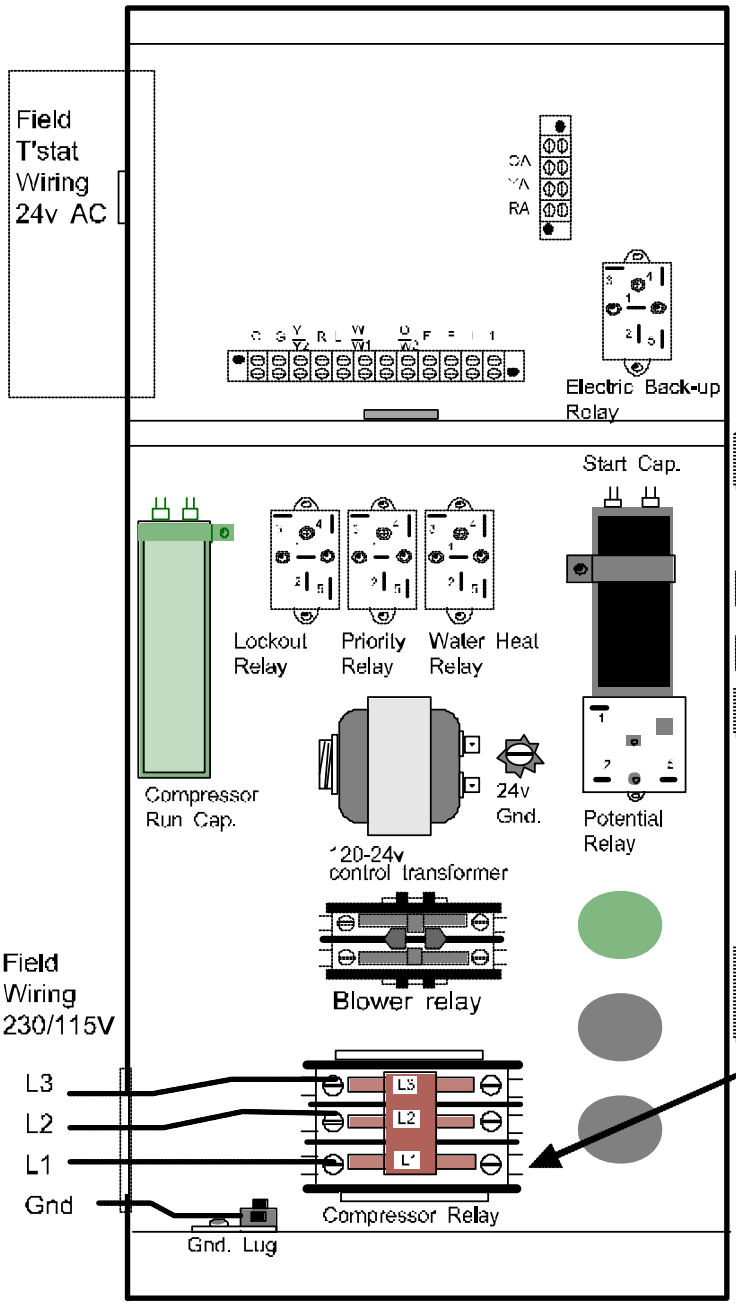
The Dole® flow control is a simple, self-cleaning device designed to deliver a constant volume of water from any outlet whether the pressure is 15 psig or as high as 125 psi. The controlling mechanism consists of a flexible orifice that varies it’s area inversely with pressure so that a constant flow is maintained.

NORDIC® "TF" Series - Schematic Wiring Diagram



NORDIC® "TF" Series Electrical Box Connections

Electrical Box Block Wiring Diagram - Field Wiring



Low Voltage Wiring

Use an 18-8 conductor cable.
Connect C, G, Y/Y2, R,L W/W1, O/W2 in terminal box to the corresponding letters on the thermostat supplied.
C- common
G- blower
Y/Y_2- compressor
R- hot supply
L- Compressor lock-out light
W/W_1- Plenum heater relay
O/W_2- Reversing Valve

Plenum Heater Wiring

Use an 18-4 wire to connect:

FF to FF in heater

I 1 to I 1 in heater

Aquastat Wiring

Use a 18-5 wire to connect C, O/W2, RA, YA, OA from terminal strip to terminals in aquastat. See following diagram for details

Hot water Circulator Pump Special Instructions

Note: If heat pump is to be operated without the hot water circulator connected to the water tank and flooded with water, remove the wire marked with "RED" tape located here. This pump is water lubricated and must **not be run dry.**

Heat Pump Electrical Service Requirements

1 phase / 60 Hz. @ 230v AC

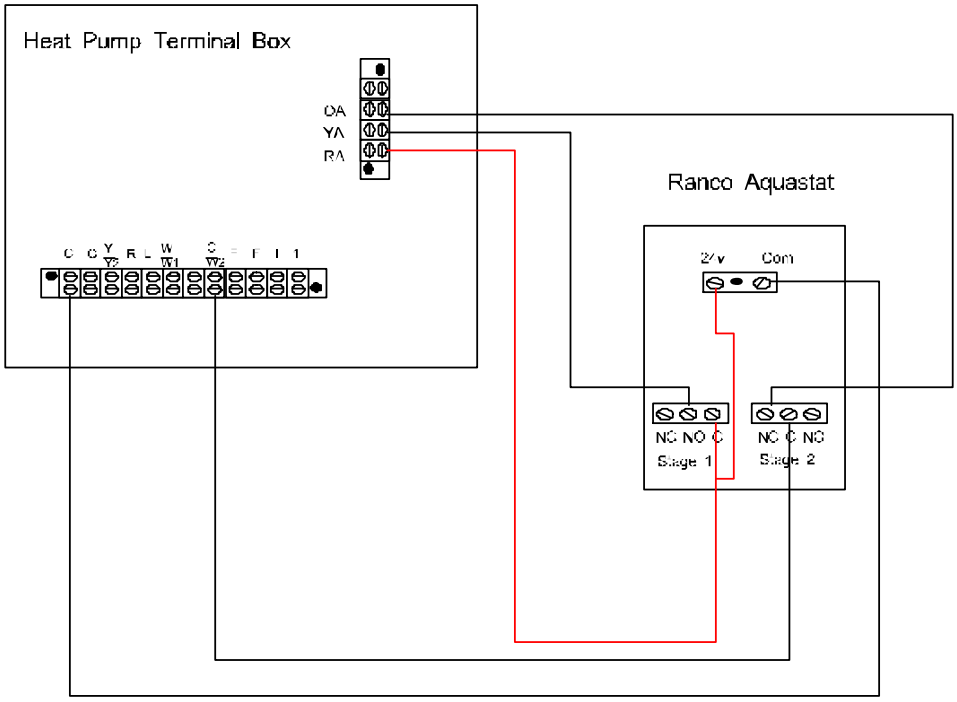
Model	Min. Circuit Ampacity	Supply Wire	TD fuse or Breaker	Thermostat Wire
TF-45	23	10-3	30	18-8
TF-55	30	8-3	40	18-8
TF-65	35	6-3	50	18-8

230v / 115v Connections

Compressor relay:
Connect L3 to "Black"
Connect L2 to "Neutral"
(middle terminal as shown at left)
Connect L1 to "Red"
Connect "Gnd" to gnd. lug

NORDIC® "TF" Series Aquastat Wiring

Aquastat Wiring - Theory of Operation



Connections Required

Connect C from HP terminal box to COM in aquastat
Connect O/W2 from HP terminal box to C of stage 2 in aquastat
Connect RA from HP terminal box to C of stage 1 AND 24V terminal in aquastat
Connect YA from HP terminal box to NO of stage 1 in aquastat
Connect OA from HP terminal box to NC of stage 2 in aquastat

Aquastat Settings

When setting aquastat setpoints, stage 1 (S1) and stage 2 (S2) settings **MUST** be set at the same temperature setpoint with the same differential. The reason for this is reversing valve #1 must be disconnected in order to allow the discharge gas of the compressor to go the water heat exchanger.

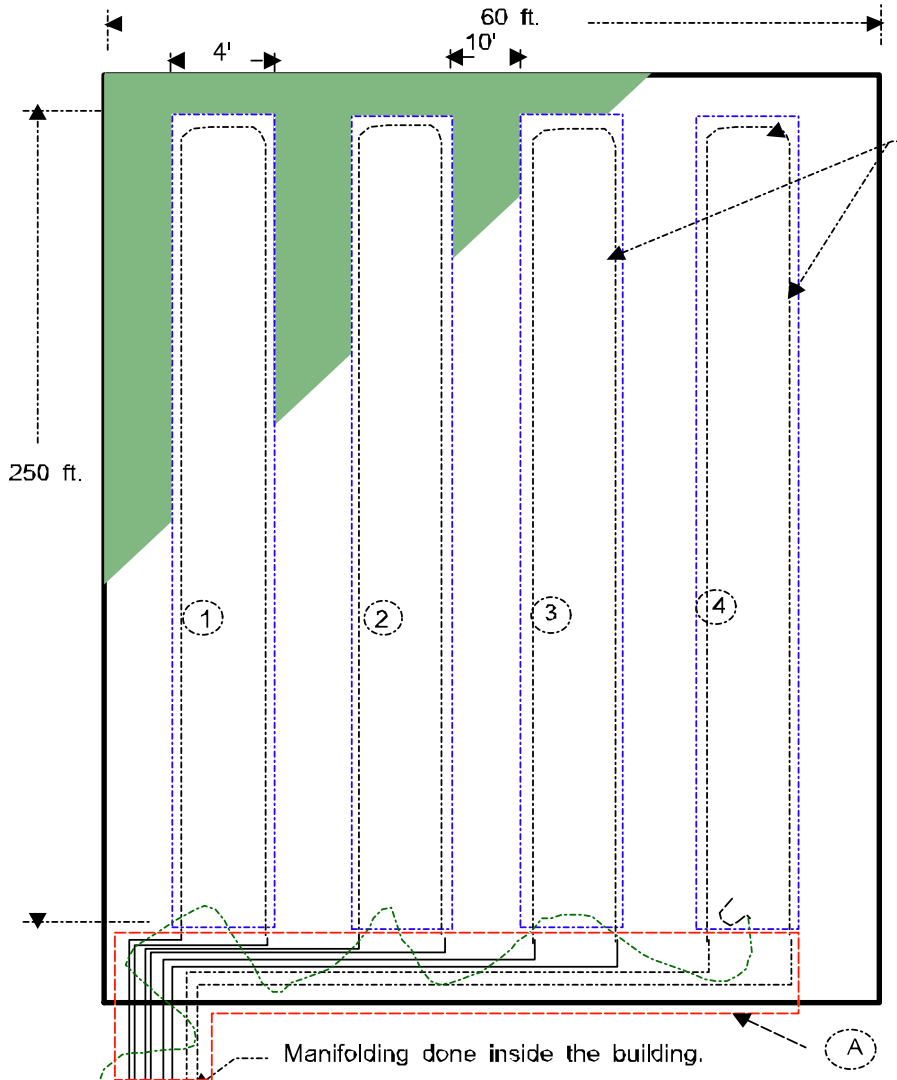
Priority of Operation

The TF series is designed to give priority to the air thermostat. Whenever the air thermostat is calling for heating or cooling, the aquastat is disconnected. It is reconnected once the air temperature has been satisfied.

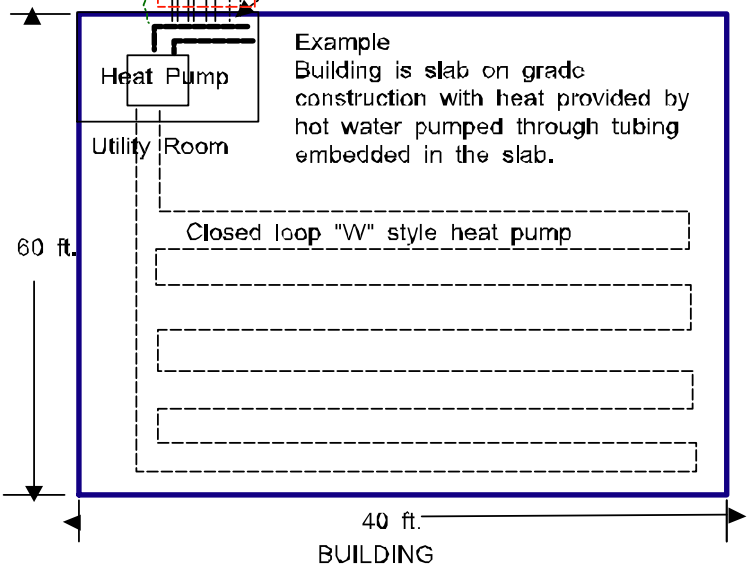
Duct Sizing Guide

Required CFM	Diameter in inches	Rectangular Equivalents						Return Air Diameter	Required CFM
37	5	2.25 x 10	3 x 8	3.5 x 6	4 x 5.5	5 x 5	`	5	37
63	5	2.25 x 10	3 x 8	3.5 x 6	4 x 5.5	5 x 5		6	63
100	6	3.25 x 10	4 x 8	5 x 6	5.5 x 5.5	6 x 6		7	100
152	7	3.25 x 14	4 x 11	5 x 8.5	6 x 7	6.5 x 6.5		8	152
212	8	4 x 15	5 x 12	6 x 10	7 x 8	8 x 8		9	212
226	8	4 x 15	5 x 12	6 x 10	7 x 8	8 x 8		10	226
277	9	5 x 15	6 x 12	7 x 10	8 x 9	8.5 x 8.5		10	277
304	9	5 x 15	6 x 12	7 x 10	8 x 9	8.5 x 8.5		12	304
393	10	6 x 15	7 x 13	8 x 11	9 x 10	9.5 x 9.5		12	393
411	12	7 x 18	8 x 16	9 x 14	10 x 12	11 x 11		12	411
655	12	7 x 18	8 x 16	9 x 14	10 x 12	11 x 11		14	655
680	14	8 x 22	9 x 19	10 x 17	11 x 15	12 x 14	13 x 13	14	680
995	14	8 x 22	9 x 19	10 x 17	11 x 15	12 x 14	13 x 13	16	995
1325	16	8 x 30	10 x 22	12 x 18	14 x 16	15 x 15		18	1325
1450	16	8 x 30	10 x 22	12 x 18	14 x 16	15 x 15		20	1450
1750	18	8 x 40	10 x 30	12 x 24	14 x 20	16 x 17	16.5 x 16.5	20	1750
2000	18	8 x 40	10 x 30	12 x 24	14 x 20	16 x 17	16.5 x 16.5	22	2000
2250	20	10 x 38	12 x 30	14 x 26	16 x 22	18 x 19	18.5 x 18.5	22	2250
2600	20	10 x 38	12 x 30	14 x 26	16 x 22	18 x 19	18.5 x 18.5	24	2600
2900	22	12 x 36	14 x 30	16 x 26	18 x 23	20 x 20		24	2900
3400	22	12 x 36	14 x 30	16 x 26	18 x 23	20 x 20		26	3400
3600	24	14 x 38	16 x 32	18 x 28	20 x 25	22 x 22		26	3600
4300	24	14 x 38	16 x 32	18 x 28	20 x 25	22 x 22		28	4300
5250	26	16 x 38	18 x 32	20 x 30	22 x 24	24 x 24		30	5250
6125	28	18 x 38	20 x 34	22 x 30	24 x 28	26 x 26		32	6125
6500	28	18 x 38	20 x 34	22 x 30	24 x 28	26 x 26		34	6500
7250	30	20 x 40	22 x 38	24 x 32	26 x 30	28 x 28		34	7250
7800	30	20 x 40	22 x 38	24 x 32	26 x 30	28 x 28		36	7800
8500	32	22 x 40	24 x 38	26 x 34	28 x 32	30 x 30		36	8500
9200	32	22 x 40	24 x 38	26 x 34	28 x 32	30 x 30		38	9200
9800	34	24 x 42	25 x 40	26 x 38	28 x 34	30 x 32	31 x 31	38	9800
10900	34	24 x 42	25 x 40	26 x 38	28 x 34	30 x 32	31 x 31	40	10900
		28 x 40	30 x 36	32 x 34	33 x 33				
		30 x 42	32 x 38	34 x 36	35 x 35				
		30 x 45	34 x 40	36 x 38	37 x 37				

Example Piping Layout of Horizontal Closed Loop Heat Pump System (4 ton system shown)



- Type 3408 PE tubing
- Excavated trenches minimum 4' wide x 6' deep.
- Note: Trenches will be backfilled with material which will maximize the thermal conductivity of the adjacent earth.
- Each loop consists of 500 ft. of 3/4" type 3408 PE 160 psig (SDR 11) geothermal heat pump polyethelene tubing.
- Allow a minimum of 10 ft. between each trench and preferably 15 - 20 ft. if space is available.



- Insulate all tubing within 12' of the structure with 3/4" closed cell armaflex insulation.
- Piping that is laid in a header trench should be insulated to a point where each loop branches to it's individual trench.
- Loop 4 shown above could be left uninsulated to pick up heat in the header trench as long as the header trench is more than 12' out from the building.

L I M I T E D W A R R A N T Y

MARITIME GEOTHERMAL LTD. warrants that the heat pumps manufactured by it shall be free from defects in materials and workmanship for a period of (1) ONE YEAR after the date of installation or for a period of (1) ONE YEAR AND (60) SIXTY DAYS after the date of shipment, whichever occurs first. In addition MARITIME GEOTHERMAL LTD. warrants that the compressor shall be free of defects in materials and workmanship for an additional period of (48) FORTY-EIGHT MONTHS from said date.

MARITIME GEOTHERMAL LTD. shall, at it's option repair or replace any part or parts covered by this warranty which shall be returned to MARITIME GEOTHERMAL LTD., transportation charges prepaid, which, upon examination proves to be defective in materials or workmanship. Replacement or repaired parts and components are warranted only for the remaining portion of the original warranty period.

This warranty is subject to the following conditions:

1. The NORDIC® heat pump must be properly installed and maintained in accordance with MARITIME Geothermal LTD.'s installation and maintenance instruct ions.
2. The installer must complete the "**Installation Data Sheet**", have it endorsed by the owner and return it to Maritime Geothermal Ltd. within 21 days after the installation of the unit.

3. It is the responsibility of the building or general contractor to supply temporary heat to the structure prior to occupancy. These heat pumps are designed to provide heat only to the completely finished and insulated structure. Start-up of the unit shall not be scheduled prior to completion of construction and final duct installation for validation of this warranty.
4. It is the customer's responsibility to supply the proper quantity and quality of water.

If the heat pump, manufactured by MARITIME GEOTHERMAL LTD. fails to conform to this warranty, MARITIME GEOTHERMAL LTD. 's sole and exclusive liability shall be, at it's option, to repair or replace any part or component which is returned by the customer during the applicable warranty period set forth above, provided that (1) MARITIME Geothermal LTD. is promptly notified in writing upon discovery by the customer that such part or component fails to conform to this warranty. (2) The customer returns such part or component to MARITIME GEOTHERMAL LTD., transportation