

Maritime Geothermal Ltd.

Installation Manual

NORDIC® models DX-45-55-65

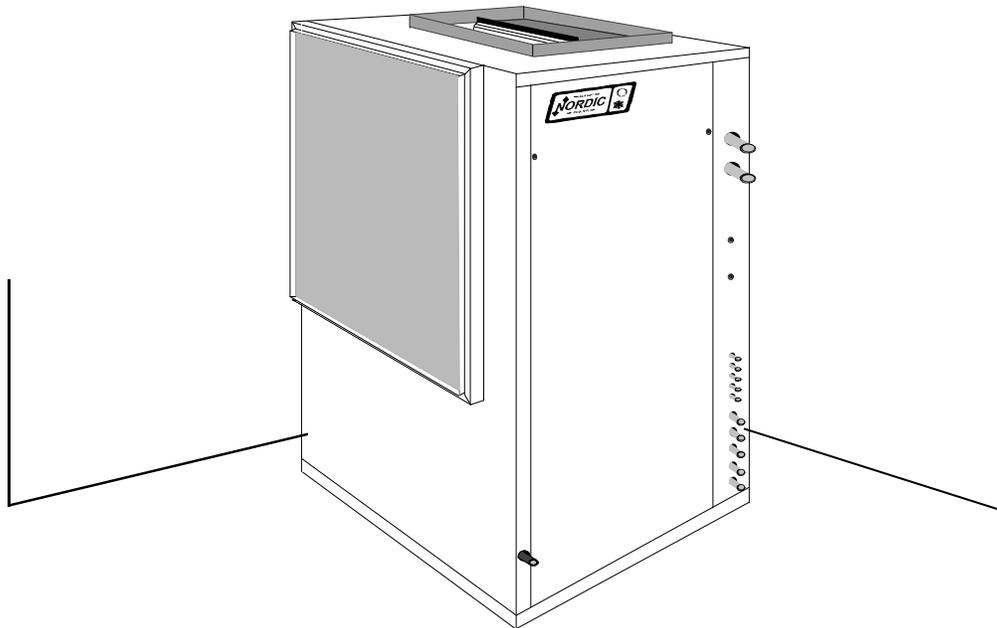
Revision 1.4

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High Efficiency Direct Expansion Geothermal Heat Pumps

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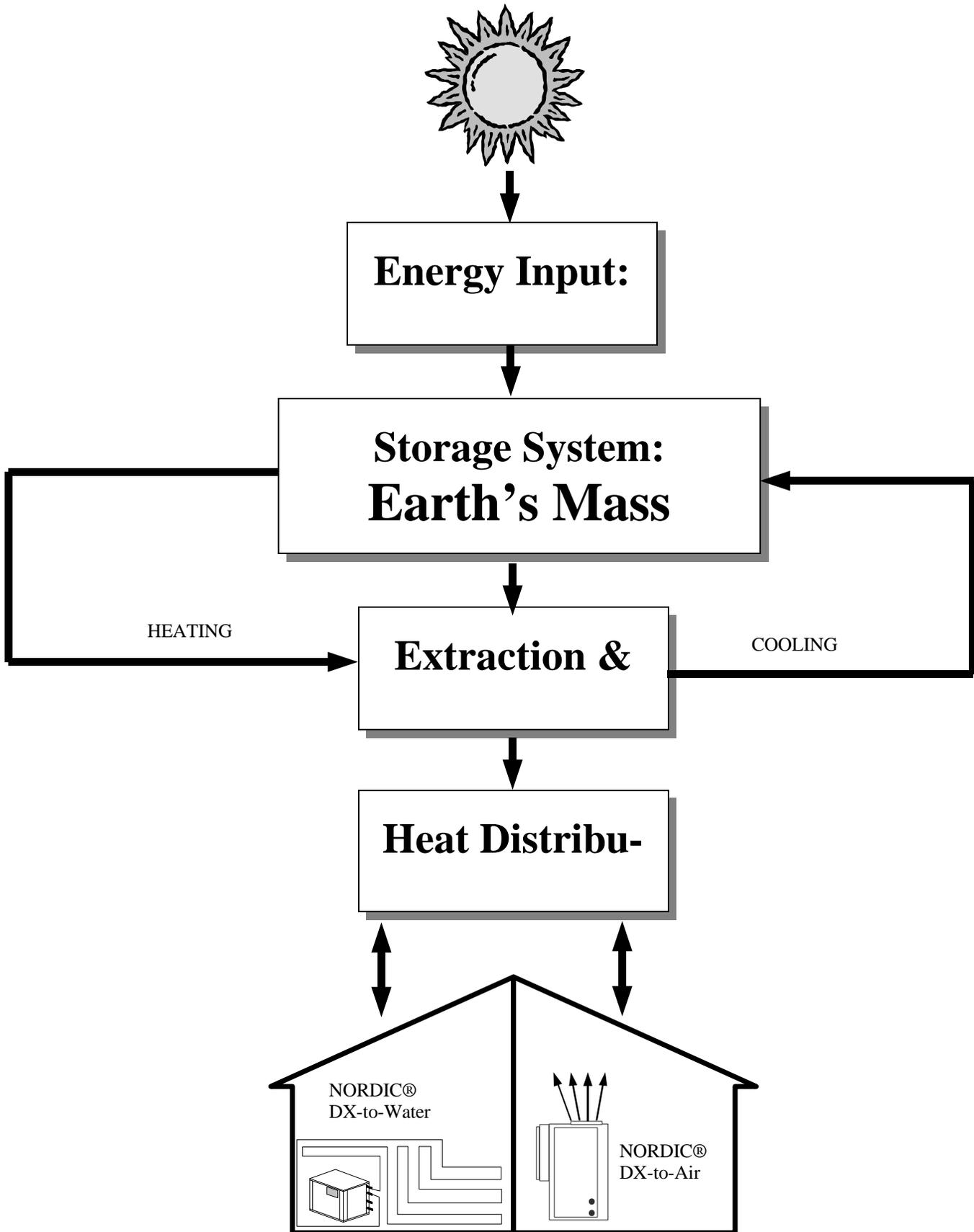


Refrigerant Filled Copper Heat Exchanger Loop

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A NORDIC® Direct Expansion Heat Pump System



NORDIC® DX Heat Pump System Prerequisites

There are four specific parts or sub-systems to a DX heat pump installation:

1. The source of energy Solar & Geothermal
2. The storage media The Earth's mass
3. Converting the energy to a useable form Heat Pump
4. Distributing the heat Ductwork / radiant slab

Horizontal Loop Fields

The successful application of a DX heat pump depends on sizing the machine correctly for the home or area to condition and providing enough land area or volume of earth from which to extract or reject heat.

DX heat pumps react with the earth much like a **conventional reversing heat pump and closed loop plastic earth heat exchanger**. Heat that is available to the unit must travel through the earth and therefore the conduction capability of the earth in the location of the heat exchanger is very important. A unit used entirely or primarily for heating will have no problem with conduction and heat transfer since it will be cooling the loop during heating mode which draws moisture towards the

moisture present in the loop field area during the summer, a **soaker hose** is recommended in all horizontal trench systems which will be used for air conditioning purposes.

Vertical Bore Systems

Vertical bores (3" x 100 ft. holes) provide an alternate method of installing a DX unit. A high water table in the borehole area (20 to 30 ft.) will

Nordic® DX-45 will heat up to 1500 sq.ft.
 Nordic® DX-55 will heat up to 2000 sq.ft.
 Nordic® DX-65 will heat up to 2500 sq.ft.
 Assuming at least R-20 walls and R-40 ceiling

insure that there is adequate conduction with the earth and although the loop length per ton is shorter than the horizontal design, the vertical orientation and moisture in the boreholes provides very uni-

Model	# of Loops	Area Req'd	Trench Layout
Nordic DX-45	(3) x 350'	8,000 ft ²	4' x 175'
Nordic DX-55	(4) x 350'	10,000 ft ²	4' x 175'
Nordic DX-65	(5) x 350'	12,500 ft ²	4' x 175'
Note: These are minimum loop field requirements based on an earth temperature of 45° F.			

Air Flow Available from each heat pump	
Nordic® DX-45 models	1600 cfm
Nordic® DX-55 models	1900 cfm
Nordic® DX-65 models	2100 cfm
@ 80°F DB / 67°F WB and static pres of .2" H ₂ O	

coils because they are colder than the surrounding ground. Horizontal loop fields should be laid out so that the copper coils have good cross-sectional influence on the minimum areas listed above. As a general rule, wider spacing between the loops so that they do not influence one another, will result in improved performance of the heat pump.

Unless you are sure there will be sufficient

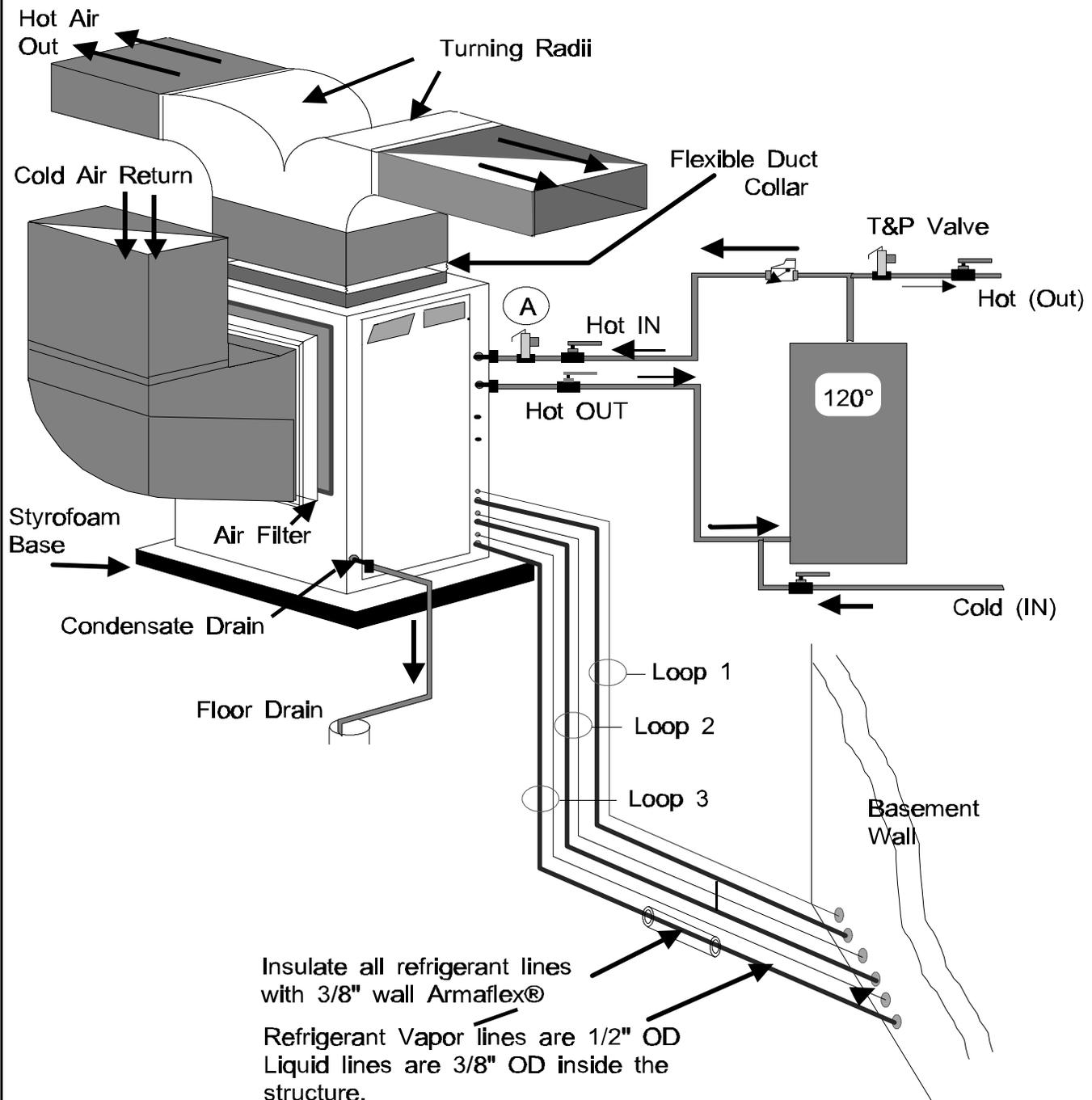
form conduction both winter and summer.

Air Flow

The charts above and below are general guidelines in selecting a DX-to-Air heat pump for residential application. A detailed heat loss analysis should be performed to determine the actual loads on the building and to assist in sizing ductwork for

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

NORDIC® "DX" Series Typical Plumbing & Ductwork



NOTE:

If (2) valves are installed on the hot water lines as shown in this diagram then a pressure relief valve (set at 75 - 100 psig.) must also be installed to prevent the build-up of pressure which may result in bursting of the circulator pump housing if the unit is operated while both valves are shut. (See point "A" marked above)

Nordic® DX (All Models)

- Hot water lines are 1/2" ID copper.
- Insulate both hot lines and all refrigerant lines.
- Use ball or gate valves on hot water lines.
- Set hot water thermostats in tank to 120°F.
- Use flexible duct collars to eliminate vibration and noise.

Introduction to “DX” Technology

Direct earth coupled heat pump or “DX” heat pump is one that has its refrigerant evaporator / condenser in direct thermal contact with the earth from which heat is either extracted *from* during the heating mode or introduced *to* during the cooling mode of operation.

The general refrigeration cycle of our DX machine is similar in nature to a conventional water-to-air or water-to-water heat pump in that there exist a compressor, expansion device, reversing valve, and refrigerant-to-air heat exchanger.

Conventional technology concerned with heat pumps relies upon the transfer of heat from the ground by means of a secondary heat exchanger system and working fluid, e.g., water, which is pumped to the geothermal unit located in the heated structure. The conventional heat pump has it’s own internal primary heat exchanger which extracts heat (heating mode) or rejects heat (cooling mode) from this water, which is then pumped back to the earth to be reheated or cooled.

DX systems similarly use a ground coil system, however, the working fluid is a refrigerant and the copper groundloop is the primary heat exchanger. Such geothermal heat exchange is an efficient and effective way of achieving heat exchange in heating and air conditioning systems, and especially heat pump type systems. Since the ground temperature is relatively constant at 48 °F at a depth 6 ft. below the frost line, the available heat is constant.

The elimination of the secondary earth heat exchanger (typically plastic in nature) and its associated working fluid reduces the temperature difference required between the ground and the evaporating refrigerant yielding a higher suction pressure than a conventional system under similar circumstances and thus a higher efficiency.

Many attempts have been made in the past to develop successful direct coupled heat pumps for residential and commercial uses. These attempts have failed adequately to meet a number of requirements associated with an economically and functionally viable system. Some of the shortcomings included:

1. Inadequate oil return to the compressor primarily in the heating mode.
2. Inadequate evaporator length and spacing for properly extracting heat from the earth resulting in low capacity and low efficiency of the systems.
3. Refrigerant charges in the range of 10 times greater than a similar capacity conventional geothermal heat pump.
4. Approximately 3 times as much refrigerant required in the cooling mode as is required in the heating mode.
5. Lack of a proper means to store additional refrigerant required during the cooling operation but not needed during the heating mode.
6. Inefficient and ineffective method to account for vastly varying condenser capability depending on ground temperature.

7. Difficulty in providing an easy to install system of earth exchanger loops.

The NORDIC® solution has been to start with a clean new concept and to design a unit from the ground up. We started by developing an evaporator system that would yield the best performance to pressure drop factor and which would impact enough area to maintain a minimum suction pressure above 40 Psig. The current horizontal groundloop comprises 350 ft. per ton of 1/2” OD copper tubing. A 3 ton system would have 3 such loops working in parallel during the heating mode. Refrigerant charge had been determined to be 5lbs. of R-22 per loop. These 1/2” copper loops maintain sufficient velocity at all times to insure adequate oil return. During cooling mode the machine automatically selects one or more loops based on discharge pressure to act as the condenser. As the discharge pressure builds to a predetermined point, the on-board computer selects the most appropriate combination of groundloops to dissipate the heat at the lowest cost to the homeowner. By intelligently controlling the manner in which the condenser is utilized our total system charge does not have to be altered nor does an excess charge have to be stored anywhere.

“DX” Better than Current Technology

There are several advantages of “DX” technology that are superior to conventional geothermal heat pumps of both the “**open loop**” and “**closed loop**” variety. Listed below are some of the reasons why “DX” technology is becoming more attractive to Homeowners, Dealers and Utilities.

More Reliable.

- Fewer parts to the system.
- Does not require a supply and return well.
- Does not require a well pump or circulation pumps.
- No water heat exchanger and associated valving to corrode, freeze and break.

More Efficient

The direct expansion principle allows the refrigerant to come directly into contact with the earth, separated only by copper tubing. During winter, maximum heat transfer takes place at higher temperature than conventional groundloop technology without the maintenance and electrical cost of circulation pumps.

Less Maintenance

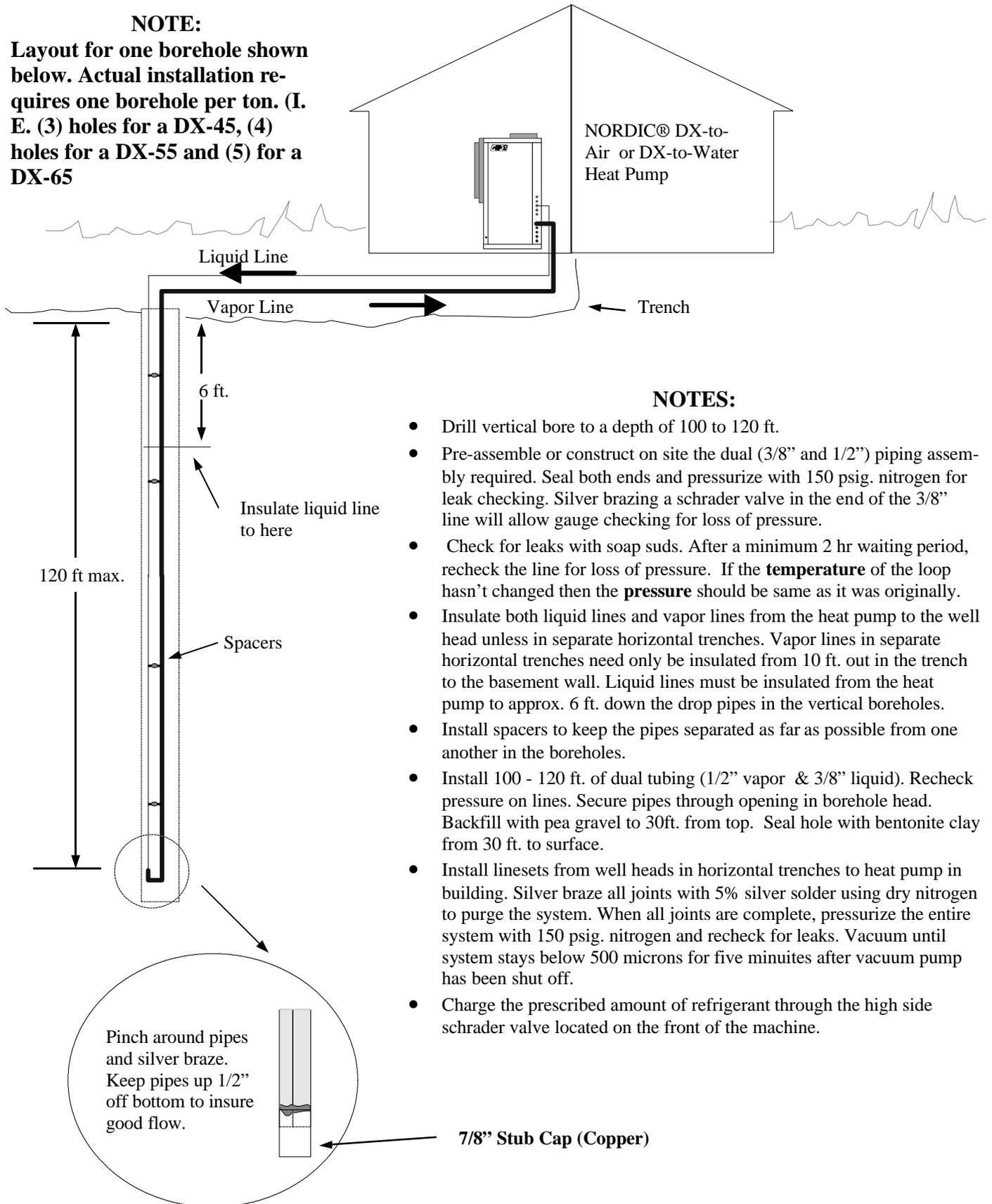
Only a sealed refrigeration circuit to maintain.

More Versatile

NORDIC® Vertical Style DX - Typical Loop design

NOTE:

Layout for one borehole shown below. Actual installation requires one borehole per ton. (I. E. (3) holes for a DX-45, (4) holes for a DX-55 and (5) for a DX-65



NOTES:

- Drill vertical bore to a depth of 100 to 120 ft.
- Pre-assemble or construct on site the dual (3/8" and 1/2") piping assembly required. Seal both ends and pressurize with 150 psig. nitrogen for leak checking. Silver brazing a schrader valve in the end of the 3/8" line will allow gauge checking for loss of pressure.
- Check for leaks with soap suds. After a minimum 2 hr waiting period, recheck the line for loss of pressure. If the **temperature** of the loop hasn't changed then the **pressure** should be same as it was originally.
- Insulate both liquid lines and vapor lines from the heat pump to the well head unless in separate horizontal trenches. Vapor lines in separate horizontal trenches need only be insulated from 10 ft. out in the trench to the basement wall. Liquid lines must be insulated from the heat pump to approx. 6 ft. down the drop pipes in the vertical boreholes.
- Install spacers to keep the pipes separated as far as possible from one another in the boreholes.
- Install 100 - 120 ft. of dual tubing (1/2" vapor & 3/8" liquid). Recheck pressure on lines. Secure pipes through opening in borehole head. Backfill with pea gravel to 30ft. from top. Seal hole with bentonite clay from 30 ft. to surface.
- Install linesets from well heads in horizontal trenches to heat pump in building. Silver braze all joints with 5% silver solder using dry nitrogen to purge the system. When all joints are complete, pressurize the entire system with 150 psig. nitrogen and recheck for leaks. Vacuum until system stays below 500 microns for five minutes after vacuum pump has been shut off.
- Charge the prescribed amount of refrigerant through the high side schrader valve located on the front of the machine.

“DX” systems can be installed in a more confined area than a conventional groundloop system, primarily because the heat exchanger coil is much more efficient at transferring heat to the refrigerant than a plastic earth exchanger. Normal loop lengths for a “DX” machine are nominally 350 ft. per ton as opposed to 450 to 500 ft. per ton for a plastic earth exchanger.

Similarly, vertical systems require only a 3” borehole to a normal depth of 100 ft. per ton.

Easier to sell

Systems can be quoted more accurately and easily since there is less outside subcontracting involved.

Excavation or drilling contractors know in advance what is required and can quote definite prices whereas with well drilling for open loop systems, the well price may eliminate the sale entirely.

NORDIC® DX Heat Pump Installation Instructions

Unpacking

When the heat pump reaches its 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 strongly 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 its rails. When the heat pump is in place the filter rack can be reinstalled with the removable end (where the filter is removed) 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 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.

Materials supplied by NORDIC®

NORDIC® supplies the DX heat pump with all internal valving and headering preassembled, pressure tested and ready to be installed to the customer's duct system and underground copper exchanger loops. The underground coil assemblies are also supplied pretested and sealed with 100 psig. nitrogen pressure. A DX system may comprise from 2 to 5 underground loops. One loop is required for each nominal "ton" of compressor capacity. The standard loops are 1/2" OD type “L” or “K” copper tubing. When the dealer unpacks the coils the integrity of the loops can easily be checked by attaching a suitable pressure gauge to the 1/4" schrader valve on the coil assembly. The pressure read at room temperature should be approx. 100 psig. (+- 5 psig.) If a loop is not within this tolerance, it should be set aside for retesting or returned to NORDIC® for replacement. Under no circumstances should a copper groundloop be used if there is any question that it may not be pressure tight.

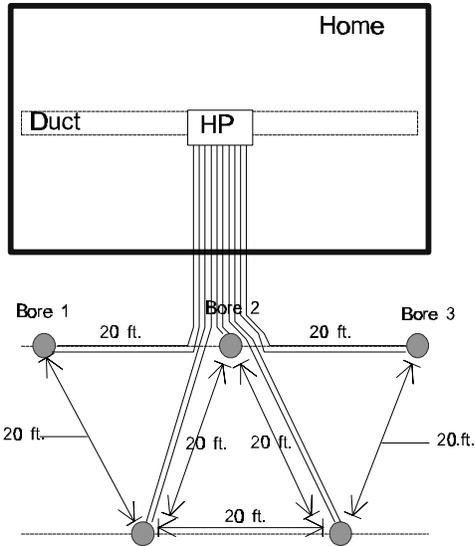
The DX heat pump unit has been high pressure tested for leaks and has a holding charge of 30 psig. (nitrogen) when the dealer receives it.

Materials you will need (inside)

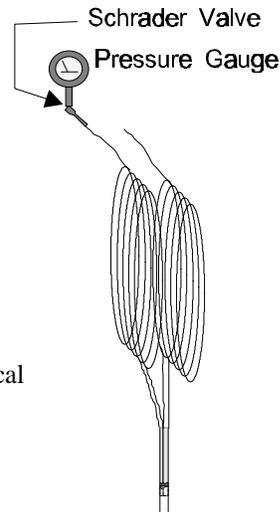
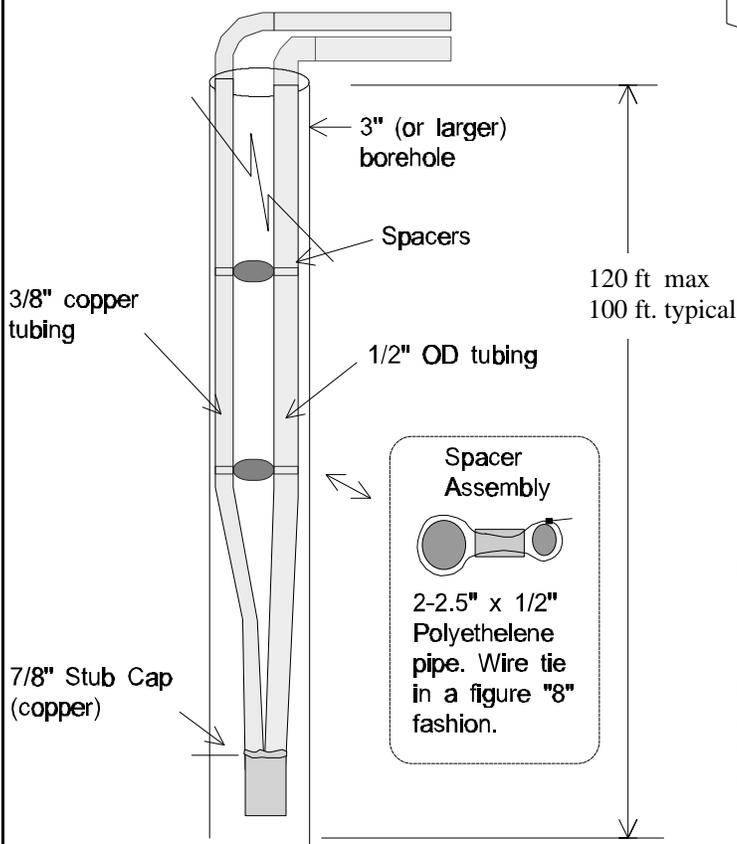
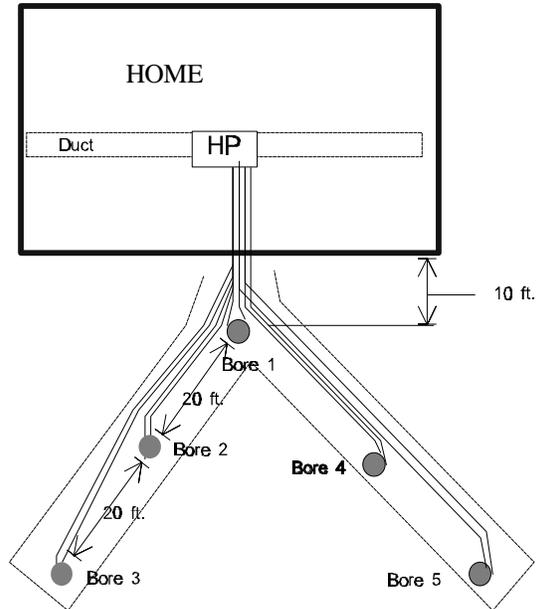
A lineset is required to connect the heat pump to the underground coils which will be installed outside the structure. This lineset consists of one 3/8" liquid line and one 1/2" gas line for each "ton" or loop installed. The dealer will be required to silver braze (5% silfos) the required indoor linesets from the point of entry to the basement or installation area to the heat pump.

Piping Layout of Vertical Style DX Heat Pump System

Typical 5 ton (5 loop) Vertical System with one possible borehole layout.



Another possible borehole layout.



100 ft. pre-made loops of 3/8" liquid line and 1/2" vapor line copper tubing.

Charge to 150 psig. nitrogen. Check pressure again before inserting into borehole and after insertion.

Loops can be taken to jobsite in coiled up formation and then uncoiled just before insertion into borehole.

Boreholes should be backfilled up to approx. 30 ft. from the surface with 1/4" pea gravel, thereafter to the surface with bentonite clay.

Pea gravel is used for backfilling material because it allows any water that may be in the borehole to circulate freely thus improving the heat transfer characteristics of the hole.

The bentonite clay seals the top 30 ft. of the hole from surface contamination thus posing no problem to the aquifer.

Horizontal Trench Requirements

The DX heat pump requires one groundcoil or "loop" per nominal ton of capacity.

Trenching for the DX heat pump can be best accomplished with a tracked excavator equipped with a 44" to 48" bucket. If a wider bucket is available and you can afford the extra cost, the trenches could be wider for improved performance. *The object, of course, is to allow the copper loops to contact earth which has not been influenced by the proximity of another loop.* The trenches are dug from 5 to 6 ft. deep to a total length of 180'. Each of the DX loops is 350' long and when laid in the form of a U down each side of the trench the turn at the end will occur at 175' allowing for a small degree of error by the excavator operator. Take special care that the bottom of the trench is kept as smooth as possible to reduce the chance of pinching or crushing the copper tubing when backfilling the trench. If rocky conditions are encountered it is recommended that the bottom of the trench, especially the corners where the pipe will lay, be covered by hand with limestone tailings, or some other heavy dense material to provide a relatively smooth resting place for the copper pipe. Unlike plastic pipe, the copper tubing will stay where you put it when unrolled rather than arguing with you, as plastic does, on a cool day. Once the pipe has been unrolled and placed, backfilling by hand to a depth of 4-6" with fill as described above will ensure that the pipe is protected from falling rock etc. during the machine backfilling procedure.

Other excavating devices such as a ditch-witch (chain digger) or a regular back-hoe can be used if ground conditions permit however you will have to dig a U shaped trench with spacing 5 ft. to 10 ft.. We have found that the greater speed of the tracked excavator in most soil conditions and the fact that you only have to dig one trench (which is excellent width for a man to work in) more than compensates for it's extra rental or operational costs.

An alternative technique for burying the underground copper tubing would be to dig a large shallow pit with a bulldozer. This pit would have to be large enough to accommodate all the loops required in the system. The copper tubes should have a spacing of at least 6 ft. minimum. A wider spacing would lead to slightly greater efficiency.

Entering dwelling

The copper groundloops must enter the dwelling at some location typically through the concrete foundation just above the poured floor. An alternate method would be to run the pipe (insulated) up the outside wall making a 90 degree turn above ground and entering the dwelling between the floor joists just below the first floor. These pipes should be insulated with a minimum of 3/4" of closed cell weatherproof insulation. There will be two 1/2" OD copper tubes for each

nominal ton of capacity of the heat pump being installed. For example a 3-ton unit would have 3 groundloops and thus 6 ends to go through the concrete wall. We recommend that you drill these holes to a diameter large enough to allow for the insertion of a plastic sleeve, (see drawing) and the tubing with it's insulation jacket. Suitable measures must be taken to seal the installation from water penetration before the trench is backfilled.

Unrolling & placing the Tubing

Each 50' roll of tubing is taped both individually and to the next roll in the group so that at any one time only 50' of the 350' is free to unroll. This allows for easier unrolling and prevents kinking the pipe. Observe how the taping is done so that you know which side of the loop to start unrolling first.

To begin, unroll approximately 12' of copper tubing. Slide two 6' lengths of armax closed cell insulation with wall thickness of at least 1/2" over the end of the tubing and insert it through the plastic sleeve of hole # 1 approximately 8" into the basement. It is good practice to label this line "**loop 1 - gas**" to identify it when interconnecting linesets inside the building. Unroll the copper tubing down one corner of the trench. When 175 ft of tubing has been laid out make your turn and proceed back the other side of the trench to the foundation of the building. Slide two 6' lengths of armax insulation onto the tubing and insert the stub end through hole # 2 in the wall to match the other end of the loop. Label this end of the line "**loop 1 - liquid**" so that the complete loop can be identified later. Manually backfill the loop with fill to a depth of 4 to 6" for protection during the machine backfill process. Duplicate the process described above applying labels to identify the two ends of successive loops (loop 2,3,4 etc.) until all required loops are in place.

Insulation placement near foundation

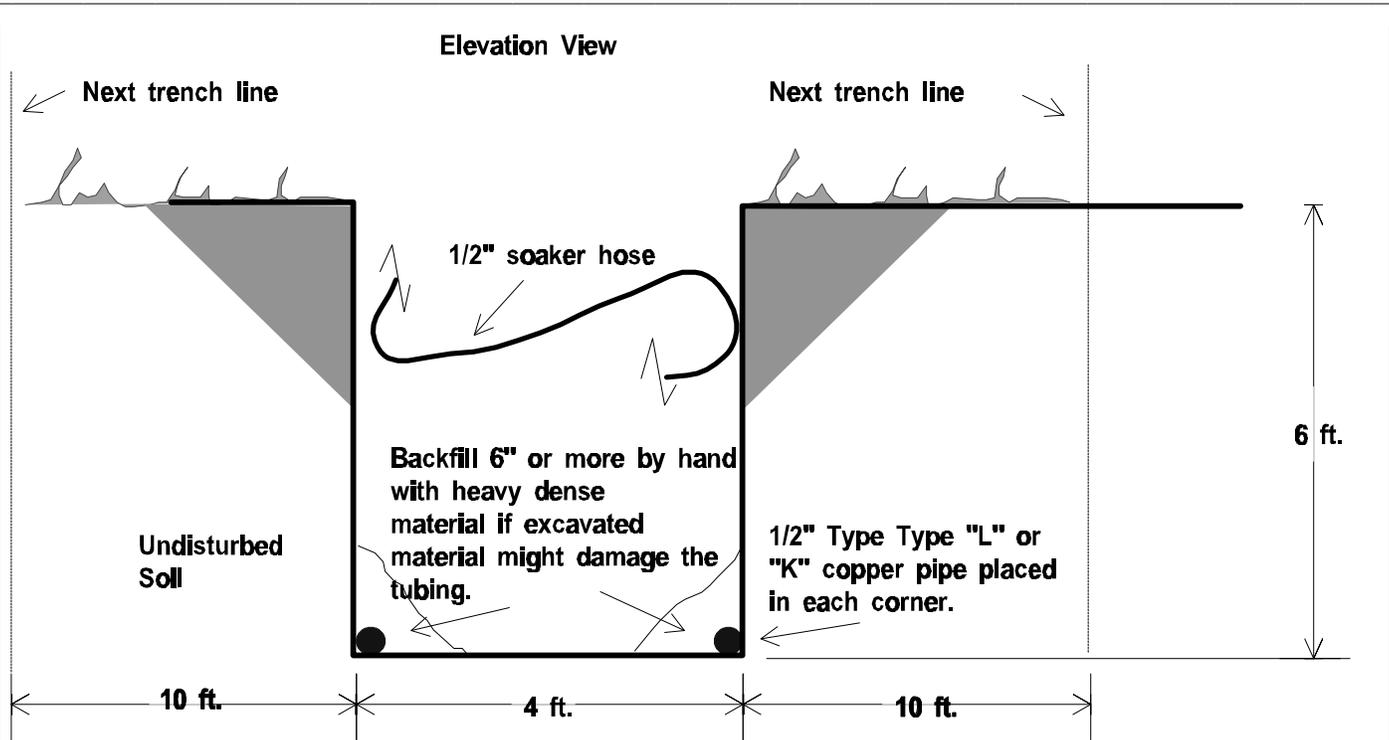
It is important to apply closed cell insulation to the copper groundloops as they come within 12' of the building to prevent the possible build up of ice near the foundation of the home. Applying 1/2" wall closed cell waterproof insulation to the tubing as described above will insure that very little heat is absorbed from the ground near the basement wall thus avoiding possible frost damage to the structure.

Pressure testing linesets

Using the 1/4" schrader valve supplied on each loop the installer can again check the pressure on each lineset with his refrigeration gauge set before releasing the pressure and cutting the loop stubs coming into the basement to the proper lengths.

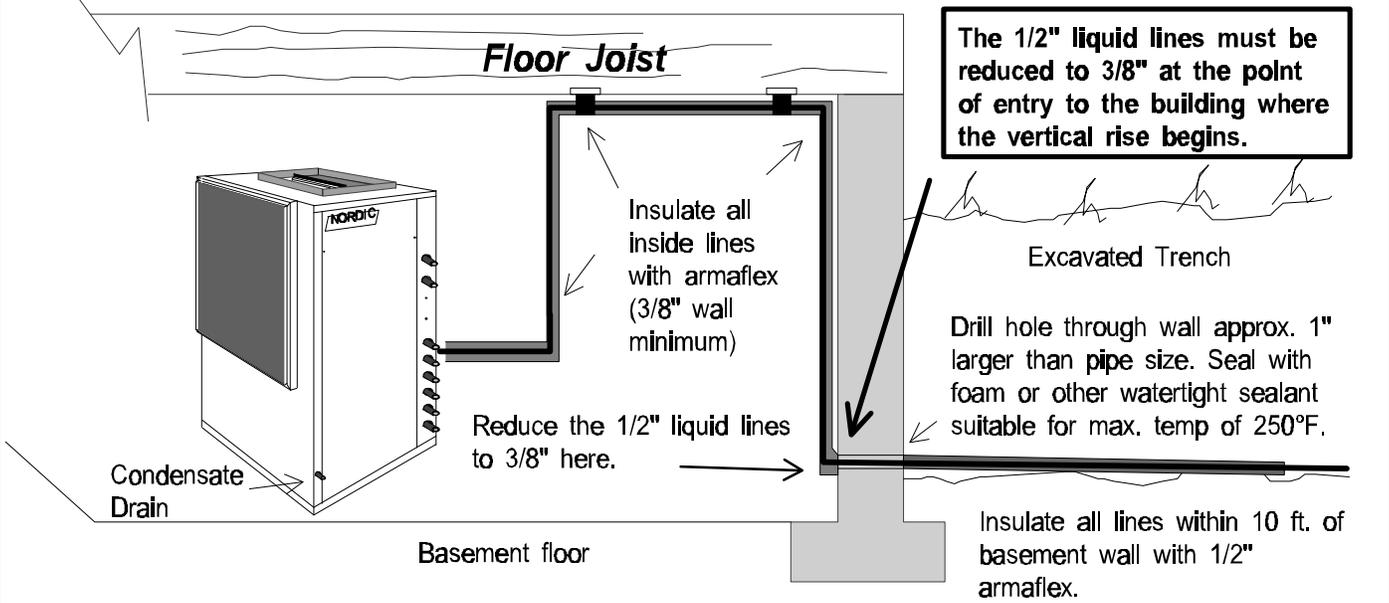
Interconnecting tubing

NORDIC® DX Horizontal Trench Design



IMPORTANT NOTES:

- Horizontal style pipe runs should be placed 6' deep x minimum of 48" wide trench as shown above. Hand backfilling in the area just over the copper pipe is recommended to prevent crushing or pinching of the pipe during backfilling operations. Individual trenches (1 per ton) should be spaced a minimum of 10 ft. apart to allow the best performance of the groundfield.
- Install a "Soaker hose" in all trenches as per the diagram to assist in initial compaction around the copper loops and also to heat conductive moisture to the ground during cooling mode if required by the system.
- Experience has shown that groundloop fields with the piping laid in a relatively horizontal fashion or with a slight incline uphill will have better performance in the cooling mode due to considerations concerning the flow of liquid refrigerant back to the air handler when cooling.



Once the outside loops have been installed it is necessary to interconnect the "gas" and liquid lines of each loop coming into the building to its corresponding line on the heat pump. Each set of two pipes is labelled on the DX heat pump as "loop 1 liquid", "loop 1 vapor", etc. depending on the tonnage of the heat pump. The larger of the two pipes is the "gas" line (1/2" OD) while the smaller line is the "liquid" line (3/8" OD).

The dealer must install a 1/2" OD "gas" line from each of the gas lines on the heat pump to the corresponding gas lines of each groundloop. Similarly a 3/8" OD "liquid" line must be run from each heat pump "liquid" line to the corresponding liquid line of each groundloop.

Note that there is a transition in size from 3/8" to 1/2" as the liquid line attaches to the groundloop stub coming into the basement. A suitable reducing coupling can be purchased from any refrigeration wholesaler.

The tubing used for this procedure must be refrigeration tubing (cleaned & dehydrated) suitable for the job. Every effort must also be made to insure that the tubing does not become contaminated during installation. We recommend that caps be placed on the open ends of tubing immediately after cuts are made and that these caps are only removed after all bends have been made and the pipe fixed in its permanent location ready to make the silver soldered joints. It is very important to keep a refrigeration system perfectly clean and dry therefore removing the caps just prior to silver soldering will insure that the tubing is exposed for a minimal time to the atmosphere and the associated moisture contained therein.

Insulating linesets

All tubing inside the basement must be insulated with 3/8" wall armaflex or equivalent insulation to prevent condensation and sweating during winter operation.

Silver soldering linesets

Once all the tubing runs have been routed, insulated and fastened in place the caps can be removed, couplings applied (or alternately the tubing can be "swaged") and the joints silver soldered with 5% silfos. **NORDIC® absolutely requires that dry nitrogen be bled through the system during all silver soldering procedures so that no oxidation occurs on the inside of the copper tubing.**

Vacuuming system

When silver soldering is finished the entire system should be pressurized to 100 psig. with dry nitrogen and all joints made by the installer checked for leaks using soap suds or some other technique that the installer feels comfortable with. It is important not to bypass this step since vacuuming the system with a leak will be impossible and attempting to do so will introduce moisture to the system making the process take much longer to vacuum after the leak has been found and repaired.

Vacuum the system until the reading on an electronic vacuum gauge stays below 500 microns for a period of 5 minutes after the vacuum pump is shut off and the system sealed.

Charging system

Once the system has been vacuumed refrigerant can be added by weighing in 1/3 of the prescribed refrigerant charge into the low side of the system. Start the heat pump in the heating mode and continue to add refrigerant as a liquid at a rate of no more than 1 lb. per minute until the prescribed charge is reached.

Alternately, before the machine is started, the entire charge can be weighed into the system through the high side schrader valve.

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 to insure proper lubrication of the circulator 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. 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.

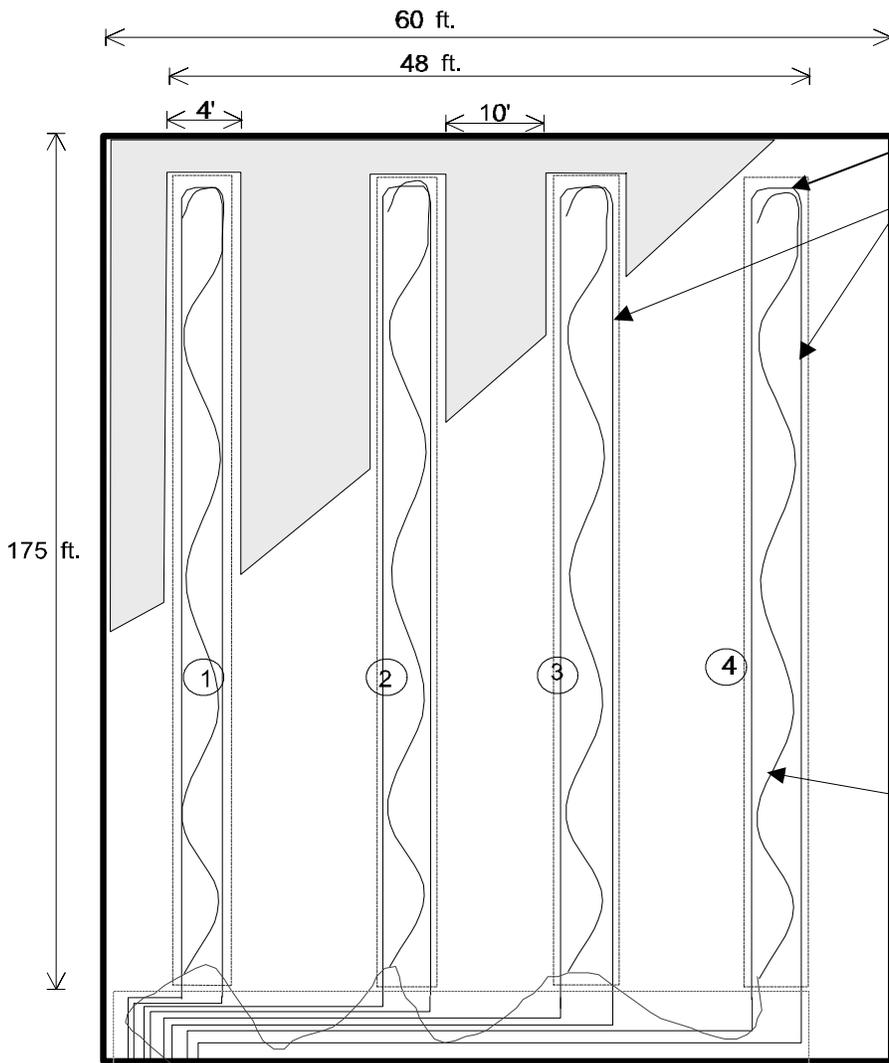
The thermostats on the hot water tank should be set to 120 °F. since the heat pump has an internal thermostat set at a low of 130 °F. By setting the tank thermostats as described, the heat pump will try to keep the tank above the cut-in point of the electric element settings thus generating hot water from the heat pump only. During periods of high demand, the electric elements will energize to help make hot water.

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 vapour 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 15-25 gallons of water formed. Care should be taken in the spring to insure that this pipe is not plugged with dust that has formed during the winter since the water formed will overflow into the bottom of the heat pump.

Safety Controls

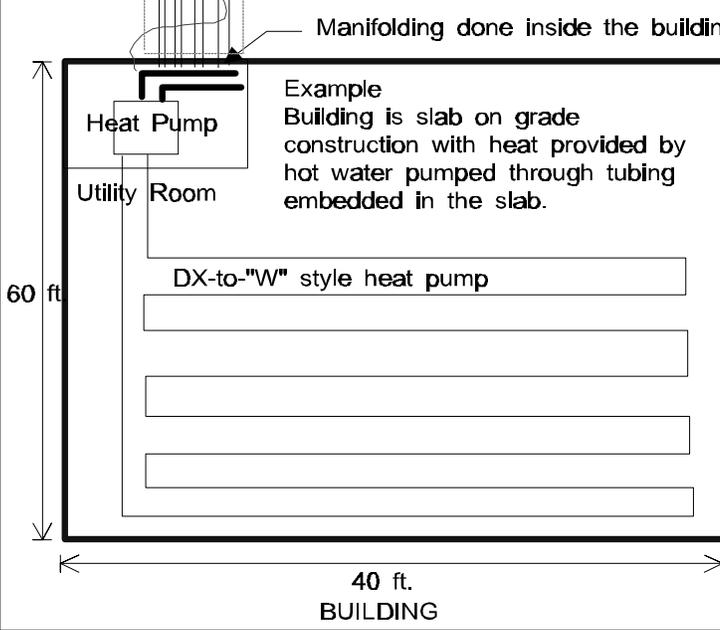
NORDIC® Horizontal DX Heat Pump System (Plan View)



(4 ton system shown)

- Coiled copper 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 350 ft. of 1/2" OD type "L" copper tubing.
- Allow a minimum of 10 ft. between each trench and preferably 15 - 20 ft. if space is available.

IMPORTANT
Install 1/2" plastic perforated soaker hose 2 to 4 ft. below grade.



- Insulate all tubing within 12' of the structure with 1/2" 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.

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 pressure control

The low pressure control is designed to shut the unit down if the refrigerant evaporating pressure drops below 20 psig. Some possible causes for a trip out on low pressure are:

1. Ruptured or broken groundloop coil
2. 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.

Electrical

The NORDIC® unit is supplied with an opening for 3/4" conduit nipple on the right side of the unit. An additional 1/2" knock-out is also supplied to accommodate accessories which may be attached to the heat pump's relays (such as electronic air filters humidifiers etc.). Above the accessory knock-out is another 3/8" hole for the thermostat wire. A wiring diagram is located on 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.

Ductwork

Ductwork layout for a 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 95° to 105° 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 pres-

sure 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.

Starting the Heat Pump

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

1. Check all high voltage field wiring and electrical connections inside the control box for good connection.
2. Check all low voltage thermostat to make sure they are connected properly. Place thermostat HEAT-OFF-COOL switch in the OFF position.
3. 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.
4. Turn on the water supply to the hot water generator and check all plumbing for leaks.
5. Check the hot water tank to be sure it is filled with water before energizing the circuit. 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.
6. Make sure the air filter is clean and in place.
7. 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.
8. Make sure the unit is sitting level so that condensate water will not overflow the catch pan.
9. Make sure the proper time-delay fuse has been installed in the fuse box.
10. Have the following tools on hand and know how to use them.
 - A refrigeration gauge set.
 - An electronic or other accurate thermometer.
 - An amprobe.
1. Connect your refrigeration gauge set.
2. After the 4 hour warm-up period place the thermostat function switch in the HEAT position, turn up the thermostat. The compressor, blower and hot water circulator will start.
3. Observe the readings on the high and low pressure gauge set. When the home reaches a temperature of 65° to 70° F. the suction pressure (blue gauge) should be approximately 54 to 58 psig. while the head or discharge pressure (red gauge) should be in the area of 225 to 275 psig. Record this information on the warranty test card.
4. Record the return air temperature by drilling a small hole in the return air plenum approximately 2 ft. from the filter rack and inserting the thermometer's sensing device.
5. Similarly record the discharge air temp. There should be a rise across the air exchanger of from 25° to 35° °F.
6. At the electrical disconnect switch place the amprobe

jaws around the supply wires and record the current in each.

7. Place the thermostat function selector in the COOL position. Placing the selector in this position energizes the reversing valve and loop 1 solenoid valves. Next turn down the stat to a temperature that will cause the air-conditioning to begin. The blower and compressor should operate. The outlet temperature will be approx. 15° to 25° 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 however a DX heat pump is relatively maintenance free and only one item will need attention as follows:

- Change the air filter when required.

Theory of Operation

The DX heat pump utilizes a typical vapor compression refrigeration cycle similar to many other common appliances. The only difference between a Direct Expansion heat pump and a conventional geothermal unit is the fact that the NORDIC® unit has its heat exchanger embedded in the ground.

Due to some engineering obstacles involved with remote parallel evaporators some special equipment and techniques which are described below are required to allow such a system to work effectively.

4-Ton System Description Heating Mode

All NORDIC® DX systems utilize multiple earth loops to transfer heat to and from the ground. One loop per ton of capacity is normally required and during the heating mode all the loops are active.

Liquid refrigerant passes from the air handler section through the bi-flow filter-drier and through the cooling TX valve which is fully open by virtue of its equalizer line being connected to the common suction inlet line and its controller bulb attached to the vapor inlet line (hot in heating mode) of the air handler. Liquid refrigerant then travels towards the liquid line header, solenoid valve and check valve assembly. Solenoid valve "A" is a normally open valve and is de-energized during the heating mode thus refrigerant can travel unrestricted through the heating check valves (B,C,D, E) towards the inlet of all the heating TX valves.

Each heating TX valve is equipped with a small bypass capillary tube which allows approximately 1/2 ton of refrigerant to flow regardless of the position of the TX valve. This by-pass is intended to perform 2 functions:

- Limits the amount of hunting done by the TX valve due to the long evaporator length.

- Prevents the heat pump from tripping out on a high pressure limit if all the heating TX valves decide to close at the same time.

The TX valves control the flow of liquid refrigerant to its loop by virtue of the sensing bulbs being attached to each respective return vapor line and all the equalizer lines connected to the common suction inlet line. The sensing bulb of each TX valve is located just below the connection to the 3-way valves on the gas line header assembly.

The liquid refrigerant coming in contact with the warm earth vaporizes to a gas and flows back to the heat pump via the 1/2" OD copper return vapor lines. System oil is entrained in by the velocity of the return gas and is continuously swept back towards the compressor. Refrigerant vapor normally picks up from 5° to 12°F superheat as it returns to the heat pump. Refrigerant vapor enters the 3-way valve header assembly at ports "F", passes straight through the valve to ports "G" where it exits to the vapor line header. From the vapor line header the refrigerant gas enters the reversing valve at point "H" and exits to the common suction line "I" where it travels to the accumulator and onward to the compressor. Hot, high pressure refrigerant gas enters the desuperheater coil, on units so equipped, where a small portion of its heat is removed in the production of hot water. The hot refrigerant then enters the air coil where the refrigerant vapor is condensed by the process of cool household air flowing across the air-to-refrigerant coil. Further sub-cooling of the refrigerant liquid takes place as the refrigerant reaches the bottom of the coil and begins another cycle.

General Operation - Cooling Mode

During the cooling mode of operation the NORDIC® DX heat pump takes control of the earth condenser coils and allows the most efficient transfer of heat to the ground via an onboard computer which monitors the conditions under which the heat pump is operating and stages the earth loops into the system as required.

When the heat pump thermostat signals for cooling three items are energized:

- ⇒ The reversing valve.
- ⇒ The liquid line solenoid valve.
- ⇒ One or more of the vapor line 3-way valves.

Refrigerant is directed to one or more loops based on loop temperature and stored information in the embedded controller. Each of the loops can be used independently or in conjunction with one or more of the others. The controller makes decisions based on preset information concerning system capacity, horizontal or vertical configuration, amount of heating and cooling runtime, etc.

Refrigerant leaves the compressor and enters the desuperheater coil as in the heating mode which removes a small portion of the heat available to make hot water. The gas then flows to the reversing valve and onwards towards the refrigerant vapor header. The 3-way valves which are powered "ON"

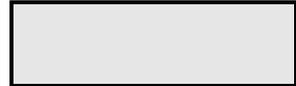
by the controller board, allow refrigerant to flow into the earthloops to which they are attached. Valves which are de-energized remain closed at port "G" however flow is "OPEN" between ports "F" and "H" allowing refrigerant to be "scavenged" from the groundloops not in use. Within a few minutes all the liquid refrigerant in the idle cooling loops is rerouted to the one, or more cooling loops that are in use at the time.

Being able to select the the correct percentage of ground-loop to engage and scavenging the refrigerant from the idle loops is important for several reasons:

1. It allows the to operate in both modes with one charge, allowing us to disable most of the groundloop system when it is cold and reintroduce it on a predetermined basis as the field warms up.
2. It allows the machine to switch from heating to cooling mode without shut-off on it's low pressure control since refrigerant pressure is supplied to the intake of the compressor by the idle loops while the refrigerant is being repositioned to operate in another loop or loops.

Once the refrigerant enters the groundloop(s) it condenses giving up its heat and returns to its liquid state. Oil and liquid refrigerant are swept along the underground copper lines back to the liquid line header assembly where it flows through the cooling check valve(s) connected to the respective liquid lines and onward towards the cooling TX valve which meters refrigerant into the air coil as required. Liquid cannot enter any of the other liquid lines because of the orientation of the cooling checkvalves nor can it enter the heating section of the liquid line header by virtue of liquid line solenoid valve "A" being energized (closed) while in the cooling mode.

NORDIC® Series DX-45-55-65

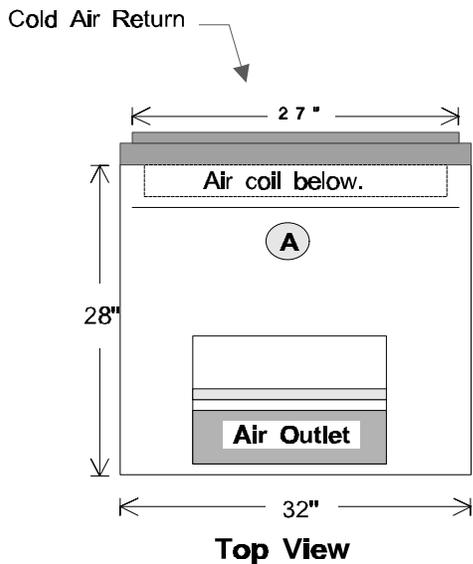


Engineering and Performance Data



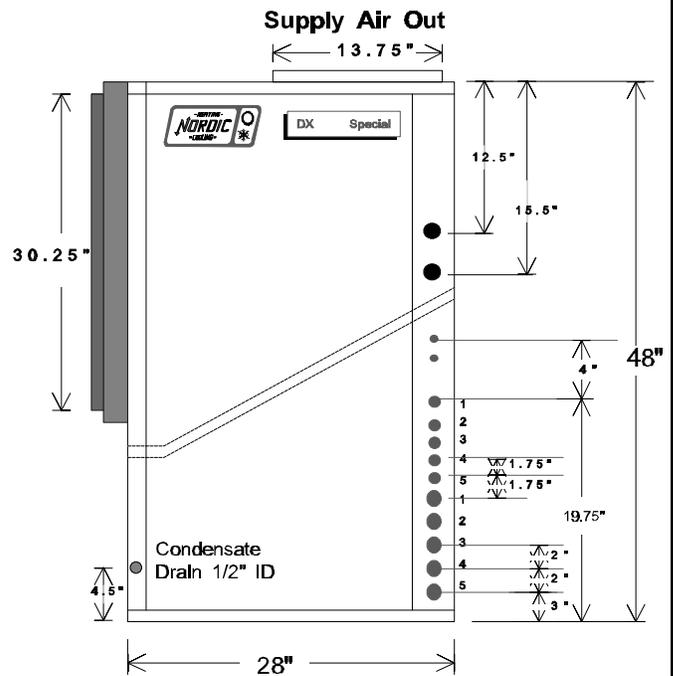
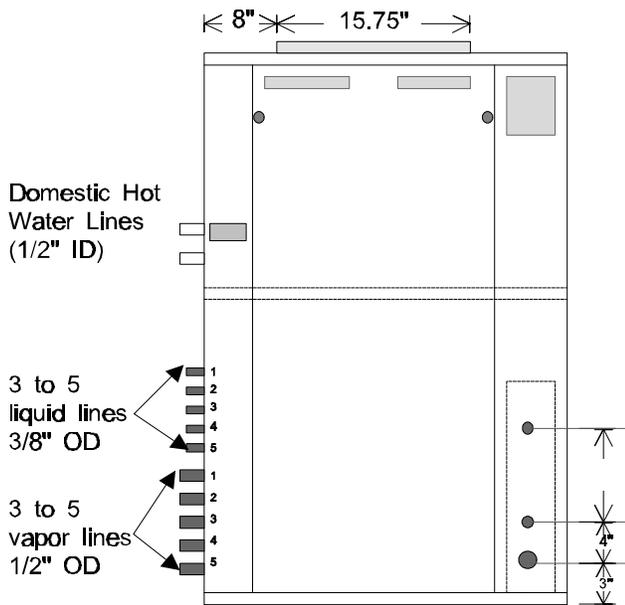
June 1997

Maritime Geothermal Ltd.		Revision 1.35	Color: Caissie Grey
Direct Expansion-to-Air Heat Pumps		Models: DX-45-55-65	Style: Vertical
Date: June 1997	Drawn By: G.Kaye	Title: Cabinet & Piping Layout	



Supply & Return Duct Sizes

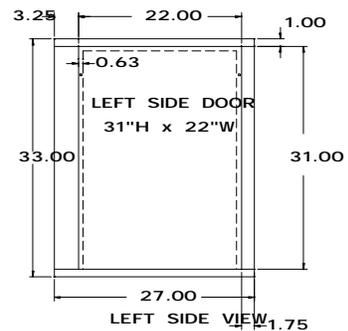
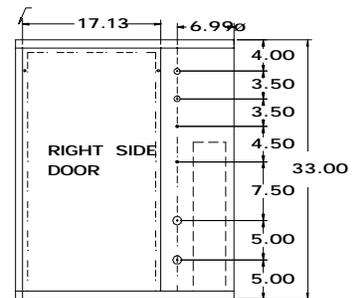
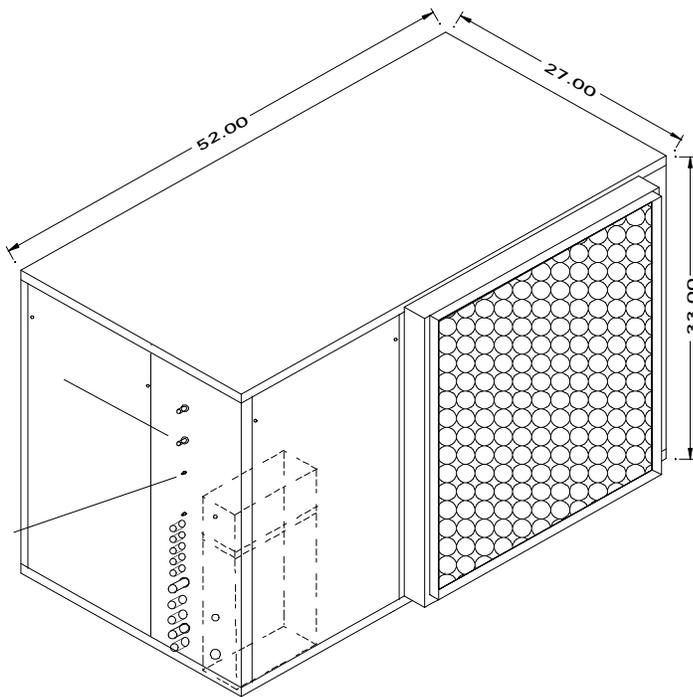
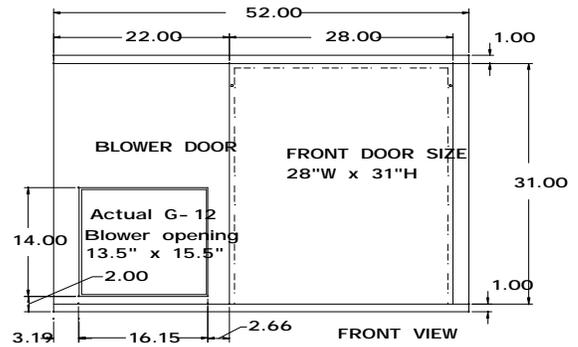
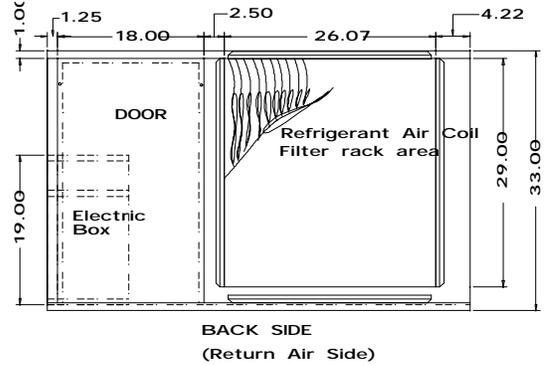
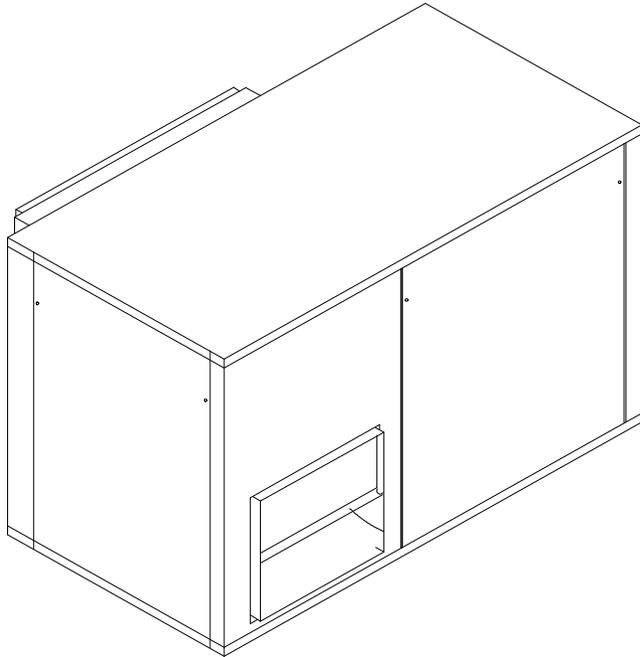
- Basic cabinet design is the same for all DX models 45-55-65.
- Cold air return measures 27" x 30.5"
- Hot air plenum can be attached to any point on top of the unit except within 6" of the filter rack. (To protect the air coil below) See the line marked "A" at left
- Filter rack is removeable to facilitate easy entry to the building and is reversible so that the filter can be removed from either side.
- Blower opening (outlet) shown is for a G-12 blower (models 55 & 65)
- A G-10 blower is used for Model 35 & 45 units with dimensions 11.5" x 13.5" centered similar to the G-12 unit shown.

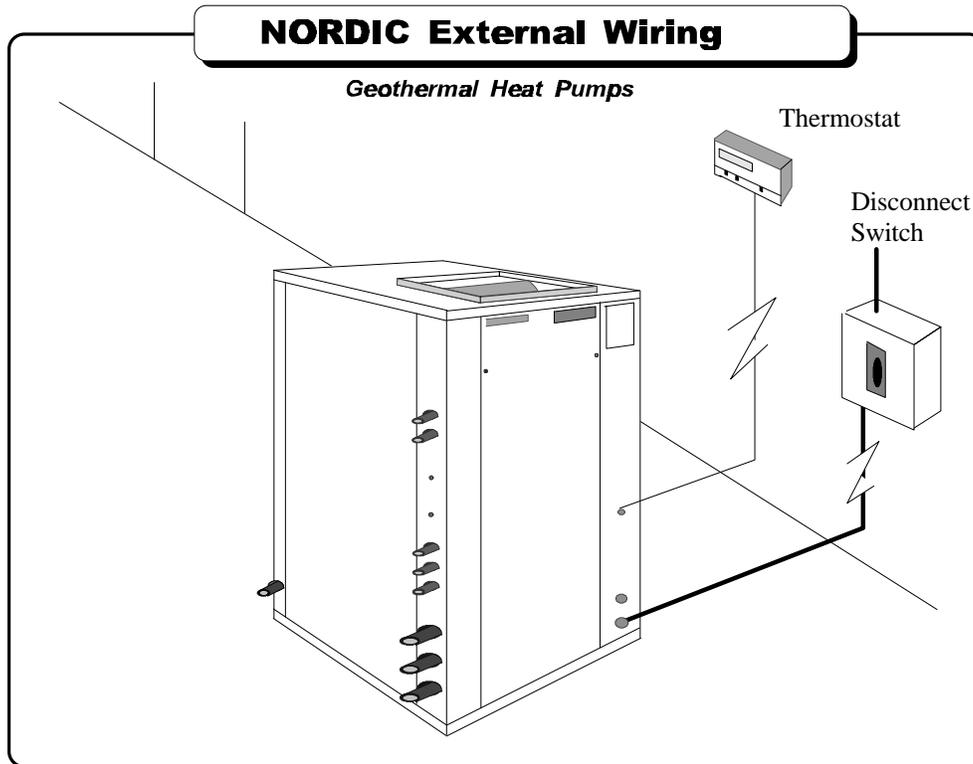


General Features

- Cabinet constructed of 22 gauge satin galvanized material with baked enamel finish. Base and electrical box are 20 gauge material.
- All components are easily accessible through three full length removeable doors.
- Cabinet is fully insulated with flame retardant accoustic material.

Maritime Geothermal Ltd.		Revision 2.35	Color: Caissie Grey
Direct Expansion-to-Air Heat Pumps		Models: DX-45-55-65	Style: Horizontal
Date: June 1997	Drawn By: G.Kaye	Title: Cabinet & Piping Layout	





Electrical Supply and Thermostat Wire Sizes

Model	DX-45	DX-55	DX-65
Nominal BTU output	45,000	55,000	65,000
Min. circuit ampacity	29	32	37
Minimum wire size	# 8-3	# 6-3	# 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

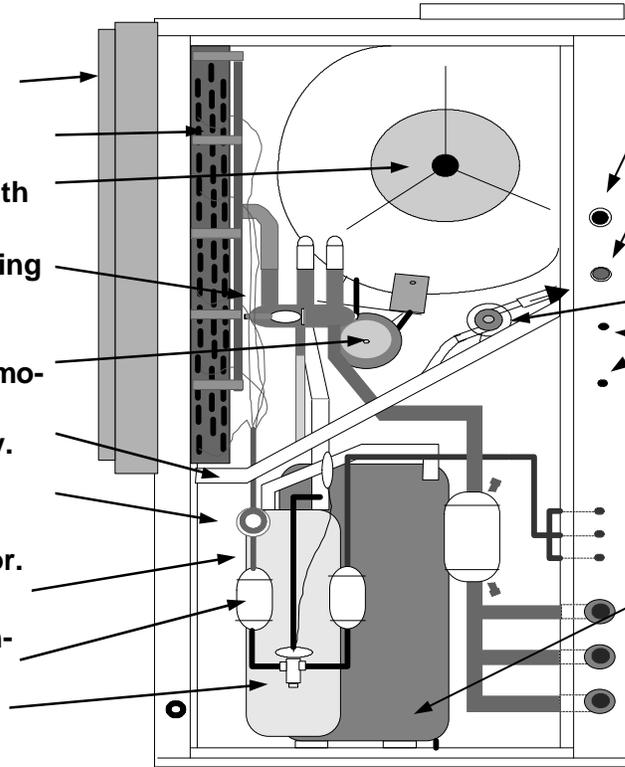
Domestic Hot Water Generator Specifications

Temperature (IN) °F.	Temp (OUT) °F.	Temperature Rise °F.	% of Total	DX-45 (Igal/hr)	DX-55 (Igal/hr)	DX-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. NORDIC® “DX” - Series

Premium Features - Direct Expansion-to-Air Units

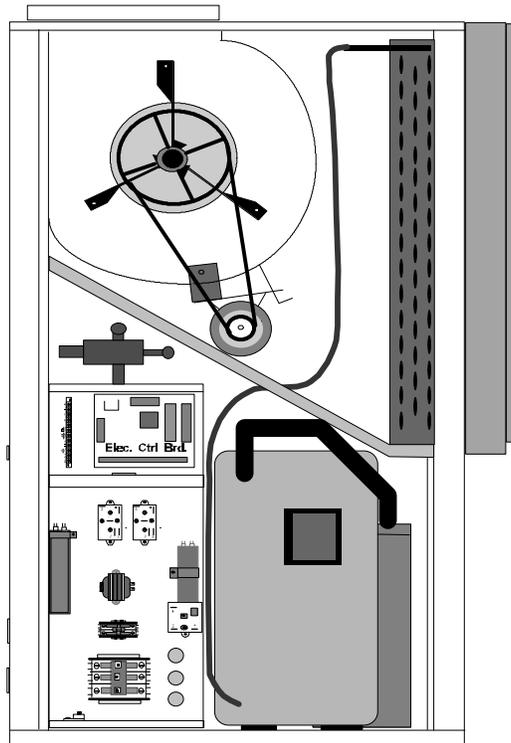
- Return Air Filter
- Oversize high efficiency air coil.
- Belt drive blower with ball bearings.
- Non sticking reversing valve.
- High efficiency ball bearing, PSC style motor.
- Galvanized drip tray.
- Sight glass (optional)
- Suction accumulator.
- Bi-flow filter driers.
- Thermostatic expansion valve.



- Domestic Hot Water (IN)
- Domestic Hot Water (OUT)
- Bronze head Magnetically driven Hot Water circulator.
- High & Low access ports.
- Microprocessor controlled operation.
- Electronic thermostat.
- Auto changeover from HEAT to COOL.
- High efficiency Tecumseh compressor

(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 DX-45-HAC (nominal 3.5 ton)

Heating

Ground Temp.	Heat of Absorbtion	EAT	LAT	Diff	Btu's Out	Comp Amps	Comp Watts	Blower Amps	Blower Watts	Total Watts	COP	Suct	Disc Pres
70	45163	70.2	109.0	38.8	59556	19.4	3640	4.2	405	4045	4.3	88	282
60	40104	70.5	105.9	35.4	53285	18.7	3489	4.1	407	3896	4.0	75	267
55	37560	70.2	104.0	33.8	51532	18.4	3393	4.4	410	3803	4.0	68	258
50	34335	70.2	102.7	32.5	48670	17.9	3296	4.4	401	3697	3.9	62	250
45	32607	69.8	100.5	30.7	45594	17.3	3178	4.4	406	3584	3.7	57	240
41	30635	69.8	99.3	29.5	43956	17.4	3129	4.4	414	3543	3.6	54	234
35	26674	69.6	96.4	26.8	38008	16.6	2963	4.6	415	3378	3.3	45	219
30	22677	69.6	95.0	25.4	35919	16.6	2877	4.5	424	3301	3.2	39	210

Cooling

Ground Temp.	EAT	LAT	Diff	Sens. cooling	Latent Cooling	Total Cooling	Comp. Amps	Comp Watts	Blower Amps	Blower Watts	Total Watts	EER	Suct	Disc Pres
50	79.7	61.0	18.7	29000	9064	38064	12.8	2102	4.29	412	2515	15.1	68	156
60	79.9	62.2	17.7	27121	8817	35938	14.1	2483	4.09	410	2893	12.4	70	202
70	79.7	61.7	18.0	27911	7929	35840	14.8	2650	4.2	412	3062	11.7	70	219
80	80.2	62.5	17.7	26992	7277	34269	16.0	2988	4.15	409	3397	10.1	72	258

Comp: AV5542G Recip. BM: HE / .33 Marathon G-10 Blower 2-row / 6-circuit air coil 1/2" x 210 ft loops @ 41° Heating
 Voltage: 230/1/60 Entering Air: 70DB / 60WB CFM: 1550 External Static: .15" WC 1/2" x 210 ft loops @ 77° Cooling

In accordance with CAN/CSA C748-M94 performance standard for DX geothermal heat pumps.

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

Heating

Ground Temp.	Heat of Absorbtion	EAT	LAT	Diff	Btu's Out	Comp Amps	Comp Watts	Blower Amps	Blower Watts	Total Watts	COP	Suct	Disc Pres
70	60745	70	111.4	41.6	70897	23.0	4780	3.4	318	5089	4.1	84	302
60	50181	70.5	110.9	40.4	61739	20.7	4356	3.5	325	4673	3.9	72	276
55	46173	70.2	108.4	38.2	58374	19.5	4132	3.5	324	4447	3.8	65	262
50	42875	70.2	105.2	35.0	53868	18.8	3943	3.4	356	4288	3.7	60	250
45	38208	69.8	102.6	32.8	49602	18.4	3764	3.4	329	4083	3.6	54	240
40	35795	69.8	100.2	30.4	46611	17.6	3594	3.5	338	3923	3.5	50	230
35	31942	69.6	97.6	28.0	42399	16.5	3410	3.6	338	3738	3.3	44	220
30	29447	69.6	95.8	26.2	40126	15.9	3256	3.6	335	3581	3.3	41	212

Cooling

Ground Temp.	EAT	LAT	Diff	Sens. cooling	Latent Cooling	Total Cooling	Comp. Amps	Comp Watts	Blower Amps	Blower Watts	Total Watts	EER	Suct	Disc Pres
50	80.2	52.7	27.5	38549	20002	58550	16.3	3490	3.4	341	3830	15.3	68	171
60	80.1	53.5	26.5	35828	18517	54345	17.6	3749	3.4	328	4077	13.3	70	193
70	79.9	54.4	25.4	34484	17432	51916	18.4	4013	3.5	335	4348	11.9	72	217
77	80.2	55.2	25.0	34023	17456	51479	19.8	4267	3.4	338	4605	11.2	74	240

In accordance with CAN/CSA C748-M94 performance standard for DX geothermal heat pumps.

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

Heating														
Ground Temp.	Heat of Absorbtion	EAT	LAT	Diff	Btu's Out	Comp Amps	Comp Watts	Blower Amps	Blower Watts	Total Watts	COP	Suct	Disc Pres	
70	62860	70	114.7	44.9	84730	31.8	6551	4.2	414	6965	3.56	80.4	274.0	
65	60207	70	113.5	43.5	82080	30.5	6299	4.3	420	6719	3.58	74.7	266.0	
60	56347	70	110.6	40.8	76542	29.2	5990	4.3	415	6405	3.50	68.2	255.1	
55	50459	71	108.5	38.0	70659	27.8	5721	4.2	413	6134	3.37	62.8	245.9	
50	46511	70	105.7	35.7	67164	26.7	5428	4.1	414	5842	3.37	57.2	234.1	
45	42117	70	103.0	33.2	62200	25.4	5173	4.1	415	5588	3.26	52.4	224.9	
40	38521	70	100.6	31.0	58167	24.1	4904	4.2	410	5314	3.21	47.5	215.0	
34	33010	69.8	98.3	28.5	53759	23.0	4611	4.1	412	5023	3.14	41.9	207.2	
30	30341	70	96.7	26.7	49725	22.2	4491	4.2	412	4903	2.97	38.8	203.5	

Cooling														
Ground Temp.	EAT	LAT	Diff	Sens. cooling	Latent Cooling	Total Cooling	Comp. Amps	Comp Watts	Blower Amps	Blower Watts	Total Watts	EER	Suct	Disc Pres
50	79.9	56.7	23.155	42405	22950	65355	25.9	4342	4.5	415	4757	13.7	66.7	185.7
60	79.9	58.1	21.797	39878	23849	63727	27.4	4415	4.4	420	4835	13.2	70.0	211.6
70	79.5	58.2	21.203	38940	19443	58383	28.4	4515	4.3	415	4930	11.8	69.8	234.8
77	80.1	58.9	21.124	38682	17626	56308	29.6	4630	4.3	415	5045	11.2	71.6	255.5

Comp: AH5561E BM: HE / .5 FHP G-12 Blower 4 row / 12-circuit air coil
 Voltage: 230/1/60 Entering Air: 70DB / 60WB CFM: 2000 External Static: .2" WC

In accordance with CAN/CSA C748-M94 performance standard for DX geothermal heat pumps.

Air Flow Vs. External Static Pressure

G-10 Delhi Blower	
External Static Pres.	CFM available
.10	1769
.15	1695
.20	1600
.25	1491
.30	1423

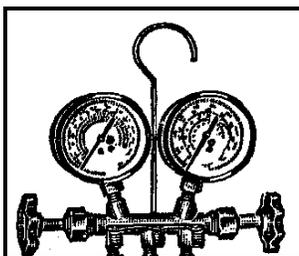
G-12 Delhi Blower	
External Static Pres.	CFM available
.10	2182
.15	2092
.20	1972
.25	1839
.30	1755

NORDIC® DX Heat Pump Trouble Shooting Guide

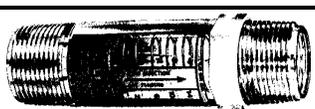
Fault	Possible Cause	Verification	Recommended Action
Compressor not operating	Power Failure	Electric circuit test shows no voltage on the line side of compressor contactor.	Check for blown fuse at heat pump's disconnect box or blown fuse
	Disconnect switch open	Voltmeter shows no voltage on the line 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.	<ul style="list-style-type: none"> • Thermostat not calling for heat. • High or low pressure limit open. • Lock-out relay energized. • Control board shows hi or low pres. permanent lock-out. 	Locate open control and determine cause. Replace faulty control if necessary. Microcontroller board shows "RED" high pres. or "GREEN" low pres. lockout flashing or glowing steadily.
	Low refrigerant level. Compressor repeatedly locks out on it's LOW pressure safety control.	Refrigeration gauges show suction pressure dipping below 20 psig.	Check refrigerant level.
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. HEATING	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.	Refrigerant pressure control should open on drop at approx. 20 psig.	Control 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 return air temp. Normal suction is 40-60 psig.	Add refrigerant slowly. Check for possible leaks. Normal charge is 3 to 3.5 lbs. per ton.
	Faulty TXV's	Check individual suctions to verify that each TXV opening and closing cycle is approximately the same.	Replace TXV(s) if not operating properly.
Low or "no" air conditioning	Refrigerant not returning to air coil.	Check discharge pressure and gas temp. Only the gas line(s) that are in use (indicated by the controller) should be HOT. Feel liquid line check valves	Verify refrigerant flow path and check cooling TXV for proper operation. Check temp. difference across coil to verify refrigerant returning.
	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 re-turn 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.

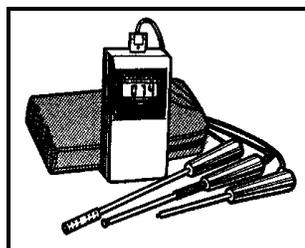


Refrigeration Gauges



In-line Flowmeter

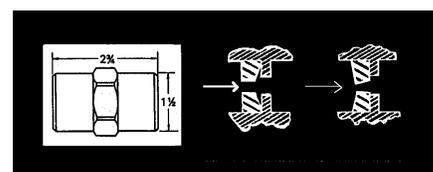
Trouble Shooting Tools



Digital Thermometer



Amprobe

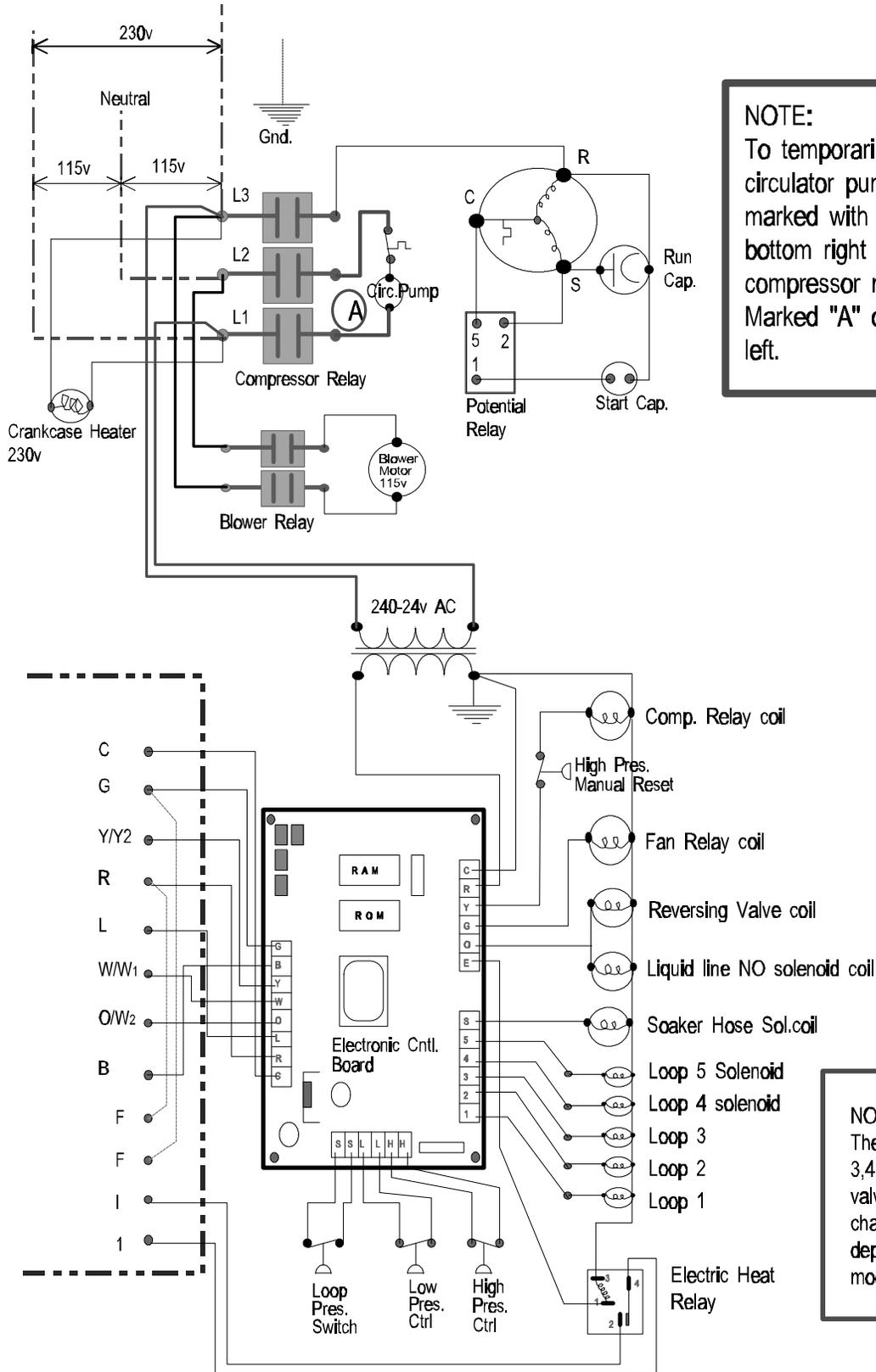


Dole flow control Valve

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 its area inversely with pressure so that a constant flow is maintained.

NORDIC® "DX" Series - Schematic Wiring Diagram

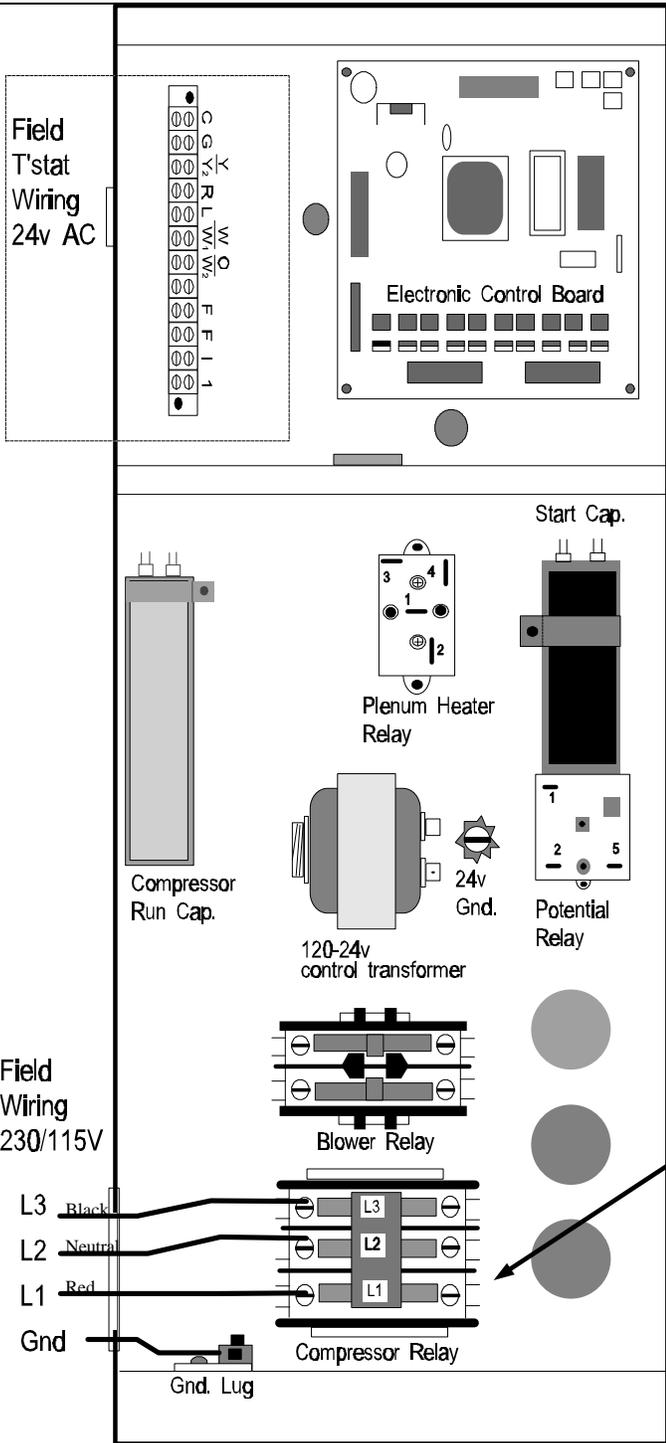
Package Unit Schematic Shown



NOTE:
 To temporarily disconnect circulator pump, remove wire marked with RED tape from bottom right terminal on compressor relay. Marked "A" on diagram at left.

NOTE:
 There may be: 3, 4, or 5 solenoid valves for cooling changeover depending on the model.

NORDIC® “DX” Series Electrical Box Connections



Low Voltage (24v) Wiring

Use an (18-8) thermostat cable. Connect C, G, Y/Y₂, R, L, W/W₁, O/W₂, B in terminal box to the corresponding letters on the thermostat supplied.

- C- common
- G - blower relay
- Y/Y₂ - compressor
- R - 24v hot supply
- L - compressor lock-out light
- O/W₂ - reversing valve
- B - heating mode

Plenum Heater Connections

(use 18-4 t'stat wire)
 “FF” to “FF” in heater (fan on/off)
 “I 1” to “I 1” in heater (heat on/off)

Hot Water Circulator 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.

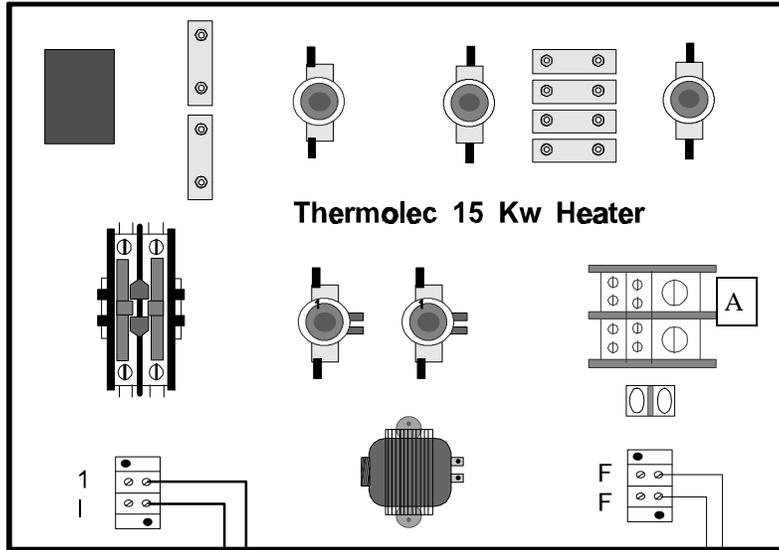
This pump is water lubricated and must not be run dry.

230/115v / 1 / 60 connections

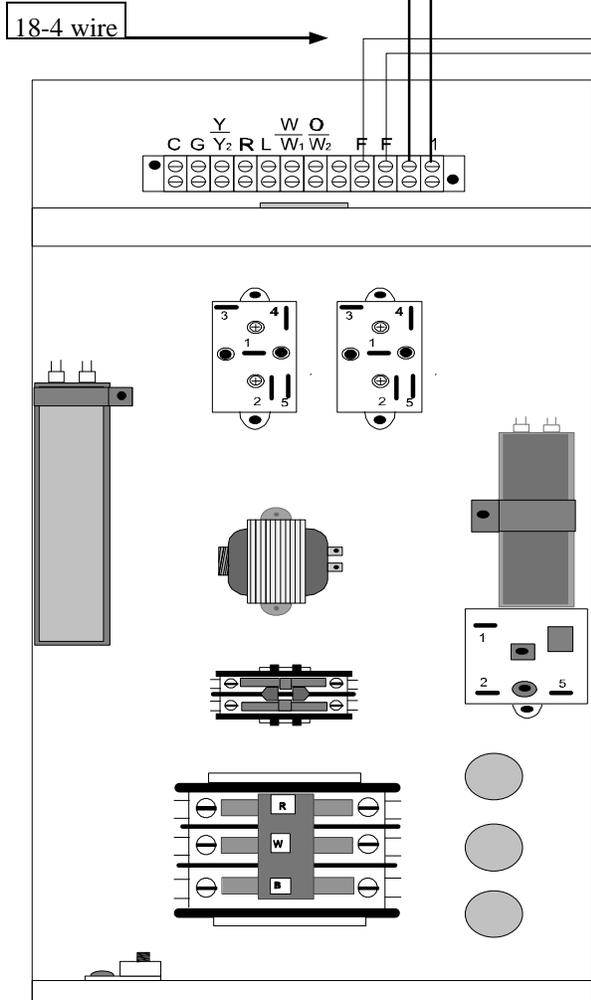
- Wire to lugs on compressor relay:
- Connect L3 to (Black)
 - Connect L2 to (White) neutral
 - Connect L1 to (Red)
 - Connect GND to GND lug.

Heat Pump Electrical Service Requirements - 230v / 1ph / 60Hz.					15 KW
Model	Minimum Circuit Ampacity	Recommended Wire Size	TD Fuse or Breaker	Thermostat Wire	Plenum Heater 230 / 1 / 60
DX-45	29	8-3	40	18-8	61.5 Amps
DX-55	32	8-3	40	18-8	@ 230 v AC
DX-65	37	6-3	50	18-8	

NORDIC® Thermolec® Plenum Heater Connections



- ### Electrical Connection to a NORDIC® Heat Pump
1. Connect the proper electrical supply with a suitable breaker to the main terminal block shown. ("A" at left)
 2. Using 2 conductors in a length of 18-4 thermostat wire, Connect "T" and "1" in the control section of the heat pump's electrical box to "T" and "1" terminal strip in the plenum heater as shown.
 3. Using the remaining 2 conductors, connect "F" and "F" in the heat pump's electrical box to "F" and "F" in the plenum heater.

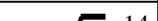
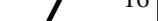


Thermostat Operation

The NORDIC® heat pump comes supplied with a 2-stage heating / 1-stage cooling auto change-over digital thermostat.

The heat pump is already prewired for this stat and requires only the connections mentioned above for full operation.

The thermostat operates the heat pump as the first stage of heat bringing the electric backup on only if required. There is a 2° differential between the first and second stage of heat. The thermostat automatically changes between heating and cooling as required by the building.

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

NORDIC® Electronic Control Board

Theory of Operation

The Nordic DX heat pump operates on the principle of a buried multi loop condenser / evaporator assembly to exchange energy to and from the earth as required by the season.

When heating is required the heat pump uses all loops (typically 1 per ton) in parallel to extract heat from the ground. During the cooling mode when the buried loops are acting as a condenser, the number of loops in operation at any one time must be controlled in accordance with their temperature for proper operation of the heat pump.

To accomplish this Maritime Geothermal Ltd. has designed an electronic control board to monitor and control all aspects of the DX heat pump operation.

The NORDIC CONTROLLER BOARD (hereinafter called NCB) has been designed to operate the heat pump with the highest reliability and efficiency without the main micro-processor being directly connected to the heat pump and it's associated AC noise which can cause erratic operation. We have isolated all INPUTS, OUTPUTS and the POWER SUPPLY from the AC supplies in the heat pump so that AC noise is not a problem.

All the inputs for thermostat functions are optically coupled to the NCB where they are transferred to a +5v or 0v signal for the microprocessor. The NCB reads the voltage on each of it's inputs and determines what functions are required based on this information.

Thermostat INPUTS

NOTE: The thermostat chosen should be a good quality 2-stage heating, 1-stage cooling heat pump style thermostat. If the stat is a mercury bulb style unit the heating and cooling anticipators must be set completely out of the circuit so that they will not affect the run time of the DX heat pump

By allowing the 24vAC thermostat to operate the controller board instead of the heat pump's controls directly we improve reliability in two ways:

1. The stat does not have to handle any current from compressor relays, loop solenoids etc. In our system, direct connection to the stat could put loads on the stat which would shorten it's life. With the 24v signal we send, only a few milliamps of current are required.

2. It is impossible to for the installer to short anything during the installation of the thermostat. Crossed connections etc. would only activate the compressor or blower etc. in some erratic manner but would not damage the control-

ler board.

The NCB has all the time delay functions of a conventional electronic thermostat built into its program and all indicator lights function normally.

The (8) terminals going to the thermostat from the NCB are as follows:

3. G - indicates blower required
2. B - indicates mode switch in (HEATING)
5. Y - compressor operation required
4. W - indicates (ELECTRIC HEAT) required
6. O - indicates mode switch in (COOLING)
7. L - Lock-out indicator light.
1. R - has 24v hot signal continuously.
1. C - common

For example: When the mode switch (cool/off/heat/EM heat) is set to OFF the NCB does not see 24v on either "B" or "O" terminals and therefore knows the system is in the OFF position.

If the NCB sees a signal on "B" it knows the mode switch is set to HEAT and will bring on the compressor when the thermostat is turned up and the thermostat makes a contact with the "Y" terminal.

If there is no "B" terminal on your thermostat or if the unit is a DX-to-Water machine

Similarly by moving the selector switch COOL, a 24v signal on the "O" terminal indicates that COOLING mode has been entered which activates the reversing valve, the NO liquid line solenoid and 1 cooling loop. When "Y" is made by a contact closure of the stat the compressor is activated.

A 24v signal on "G" will activate the system fan (FAN switch set to "ON")

A 24v signal appearing at "W" (terminal designated as second stage heating) during any time except when the MODE selector is in COOLING will bring on the supplementary heat.

There are adjustable time delay's built into for every function that the NCB looks after. These time delays can be changed in the field by a serviceman with a laptop computer and a serial cable. (A list of printouts available from the NCB are included in appendix.)

High & Low Pres. Controls and Loop Pressure Limit Switch INPUTS

NORDIC® DX Solid State Control Board

Diagram A

Selects the No. of loops that
The board controls (2 – 5)

Thermostat Connection Block

Short Pins to Reset

Restore
Defaults

Jumper if no "B"
terminal

Loop Switch
Activating LED

Loop Switch

Low Pres. Ctrl.

High Pres. Ctrl.

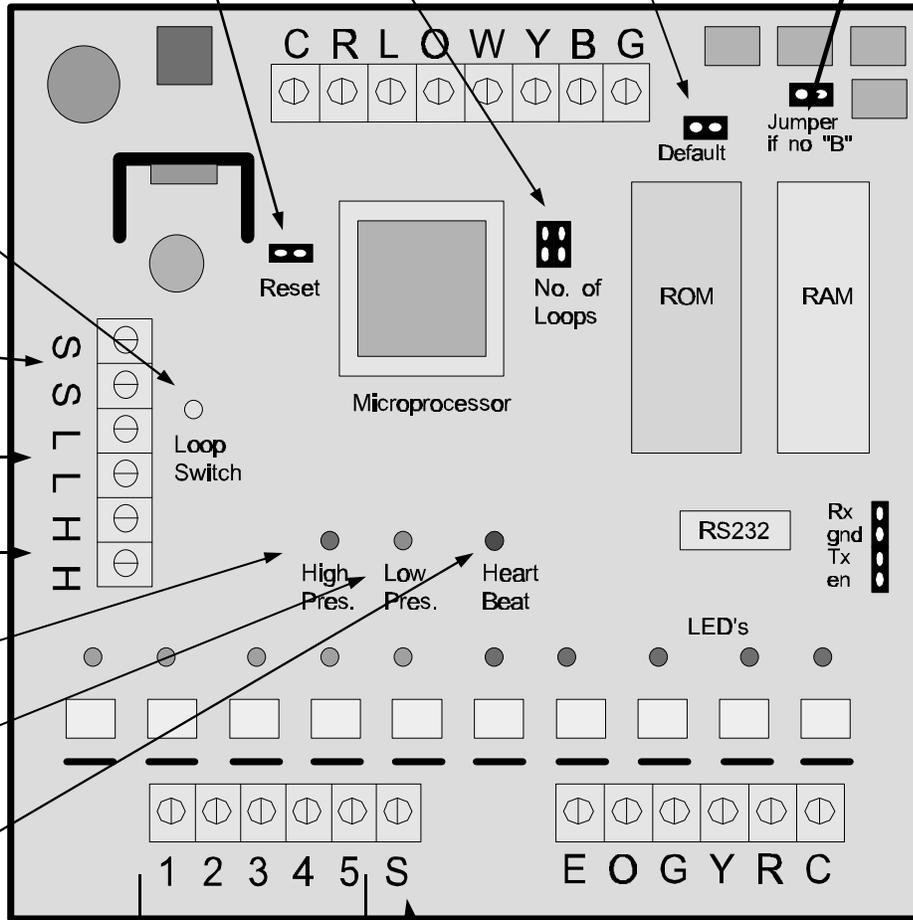
High Pres.
Lockout LED

Low Pres.
Lockout LED

Working
Properly LED

Activates loop 1 through 5
Cooling loop solenoids

Soaker Hose



- E – Emergency Heat
- O – Reversing Valve
- G – Blower
- Y – Compressor
- R – 24v Hot
- C – Common (24vAC)

The NCB has another terminal block on the middle left side which accepts inputs from the high & low refrigerant pressure controls as well as the loop maximum pressure switch. These connections are pre-wired at the factory and the installer need not concern himself with the connections unless he is replacing the board for some reason.

The connections are marked:

H/H - To and from the normally closed HIGH refrigerant pressure switch.

L/L - To and from the normally closed LOW refrigerant pressure switch.

A +5v DC signal is sent out continuously on one side of each of these controls. If the NCB does not see +5v coming back it knows the pressure control has opened and takes action to shut down the compressor.

S/S

A +5v DC signal is sent out continuously to one side of this Normally Open pressure switch. The NCB is normally looking for a 0 voltage on the return lead. If +5v is seen on the return lead then the NCB knows the switch has closed because of a limit pressure condition in the groundloop and will take action to switch loops. There is an LED indicator light which will light when the loop pressure switch is closed. This light will go out when the heat pump changes loops and loop pressure drops back below the reset pressure of this switch.

Other INPUTS

Initial setup of the NCB requires that the board know, during the cooling mode, whether it is on a 2, 3, 4, or 5 loop system. The NCB can then decide which loops to cycle and in what order. This is accomplished by setting the position of two shunt style jumpers located between the microprocessor and the ROM chip. (See diagram A)

Possible settings are:

1. Both jumpers removed - 2 loop system
2. Left jumper only - 3 loop system
3. Right jumper only - 4 loop system
4. Both jumpers installed - 5 loop system

These jumpers are normally set at the factory and would only be altered by a dealer in the case of an initial setup of a replacement control board etc.

Outputs

In keeping with the philosophy above of keeping the 24v ac control power out of the NCB, the outputs of the controller board are optically coupled to solid state switches so that the worst malfunction in wiring etc. would produce only minor damage if at all to the output section of the control board. There are 12 output connections at the bottom of the NCB located on (2) two 6-terminal connectors. Terminal designations are as follows:

(Left to Right) (Left Block)

1. Cooling Loop # 1
2. Cooling Loop # 2

3. Cooling Loop # 3
4. Cooling Loop # 4
5. Cooling Loop # 5
- 6 . Soaker Hose

(Left to Right) (Right Block)

7. Electric Heat
8. Reversing Valve
9. Blower
10. Compressor
11. "R" "HOT" side of control transformer.
12. "C" "COMMON" side of control transformer.

NOTE: Observe location of "R" and "C" -- they must not be reversed.

Indicator LED's

There are 14 LED indicator lights on the NCB which show the status of ON/OFF functions being controlled by the board. Each of the first 5 outputs (loop solenoids) has a green LED light to indicate which loops are being operated at any one time. Terminals 6 through 10 above have a red LED.

Three additional LEDs are located near the center of the board which are (from left to right):

1. High pressure lockout indicator.
2. Low pressure lockout indicator.
3. Heartbeat - Heartbeat (1 per second) flashes continuously whenever the board is powered up to indicate normal system operation.

One additional yellow LED located near the upper right corner of the NCB will light whenever the loop pressure limit switch closes.

Method of Operation - Heating Mode Checkout

When the thermostat has been connected and the system powered up, move the selector switch to heat mode and turn up the thermostat. The compressor will come ON followed by the BLOWER after a short delay.

The system will remain on until the thermostat is satisfied or the MODE switch is changed. During the heating cycle the AUX. HEAT can come on to assist the heat pump in one of two manners.

1. If the system is ON for more than 30 minutes (adjustable) the AUX. HEAT will come on to assist reaching the room setpoint. (Follows 1st stage contact.)
2. Second stage contact closes sending a signal to "W".

Once the thermostat is satisfied the compressor will shut OFF followed by the blower after a 10 second delay. (adjustable) If the AUX. HEAT has been on then the delay will be 60 seconds before the blower shuts off. (adjustable)

A short cycle timer will keep compressor OFF for 2 minute (adjustable)

High / Low Pressure control operation

If a high or low pressure situation occurs within the system at any time the NCB will shut down the compressor for 5 minutes (adjustable) During the time that the pressure control is actually "OPEN" (contacts open) the LED will flash at a rate of once per second. When the control "CLOSES" the LED will go out but the compressor will remain off until the timer has expired before compressor operation resumes. The NCB keeps track of the number of times that the system has locked out and after 3 lock-outs (adjustable) with automatic resets the NCB will lock the system out permanently. When a permanent lock-out has occurred the appropriate LED indicator will be ON CONTINUOUSLY. The system can be reset from a permanent lockout by moving the SYSTEM MODE switch to OFF and then back to HEAT or by resetting the main breaker.

Both the OFF cycle time delay on lock-out and the number of automatic resets before permanent lockout are adjustable individually for the HIGH and LOW pressure controls.

EG: You could have 1 auto reset LOW pres. and 4 for HIGH. Delays are separately adjustable.

The lock-out counter will reset itself to 0 after a predetermined time (set 8 hours adjustable)

so that (1) lock-out in August and (2) in September will not cause a permanent lock-out a month later on the (1) lock-out which occurs at that time.

The NCB will ignore a low pressure condition for a preset time on initial start-up. This feature allows refrigerant to reposition itself and begin to circulate in the system without producing a lock-out in the unit.

On DX to air units the preset is five minutes but on DX-to-Water units this setting is changed at the factory to 0 minutes delay so that the water heat exchanger would not be frozen and damaged if circulation was lost during water chilling mode.

AUX. HEAT will work normally when compressor is locked out, if required.

If no "B" terminal

Method of Operation - Cooling Mode Checkout

The NCB was designed to handle the unique situation of multiple parallel groundloops which occurs in the NORDIC® direct expansion system and as such incorporates features which are unique to our controller board.

Move the SYSTEM selector switch to the COOL position. The reversing valve, NORMALLY OPEN liquid line solenoid and # 1 groundloop will activate followed by the blower.

If the system has been in the HEAT mode there will be a delay as the MODE switch timer keeps the compressor OFF for 5 minutes (adjustable). The compressor will start and be-

gin to cool using only 1 of the possible loops available. (MODE 1) The controller board keeps track of the actual run-time hours and stores this information in non-volatile memory. Eventually the head pressure will build up in # 1 loop and activate the loop pressure limit switch which will close and send a signal to the NCB to switch to loop # 2. This procedure will be repeated until all the loops have been used once. If a further pressure signal is received then the NCB calculates the average run time on the loops used. If the average is less than the MODE switch time (15 minutes factory set - adjustable) the controller board will advance to MODE 2 which will begin to use 2 loops at a time.

If the advancement to MODE 2 produces a low pressure lock-out situation the NCB will automatically shut the compressor off for a predetermined period of time, back up one MODE and try again after the timer has run out.

NOTE: The number of automatic resets & time delays on low and high pressure in the cooling mode is adjustable, the default is 3.

The NCB will always advance to loops which have been unused the longest.

Similarly if MODE 2 cannot reject the heat pump's heat to the ground without tripping the loop pres. limit switch then the NCB will advance to MODE 3 which turns on the soaker hose in a horizontal loop situation.

The SOAKER HOSES provide increased cooling of the field by increasing the moisture content and thus the conduction of the loop field. Water is controlled via a 24 volt AC solenoid valve attached to city or well water.

NOTE: Soaker hoses should be installed on all horizontal groundloop fields as per the manufacturers instructions. The soaker hose will stay on continuously for a predetermined period of time (set 12 hours - adjustable) even if the system is turned to HEAT and then back to COOL.

Memory Functions

1. Switching from HEAT to COOL will not affect the MODE the heat pump was in during the cooling mode. The unit will return to the same loops in which it was operating before the switch occurred.

2. After a period (set at 2 weeks - adjustable) if cooling has not been used the NCB will reset the cooling MODE to MODE 1 automatically.

3. Retains loop settings and run time on each loop or set of loops as per the MODE setting.

4. Stores all lock-out information and resets lock-out counter automatically.

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 instructions.

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.

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 charges prepaid, within (30) thirty days of failure, and (3) MARITIME GEOTHERMAL LTD. 's examination of such component shall disclose to it's satisfaction that such part or component fails to meet this warranty and the alleged defects were not caused by accident, misuse, neglect, alteration, improper installation, repair or improper testing.