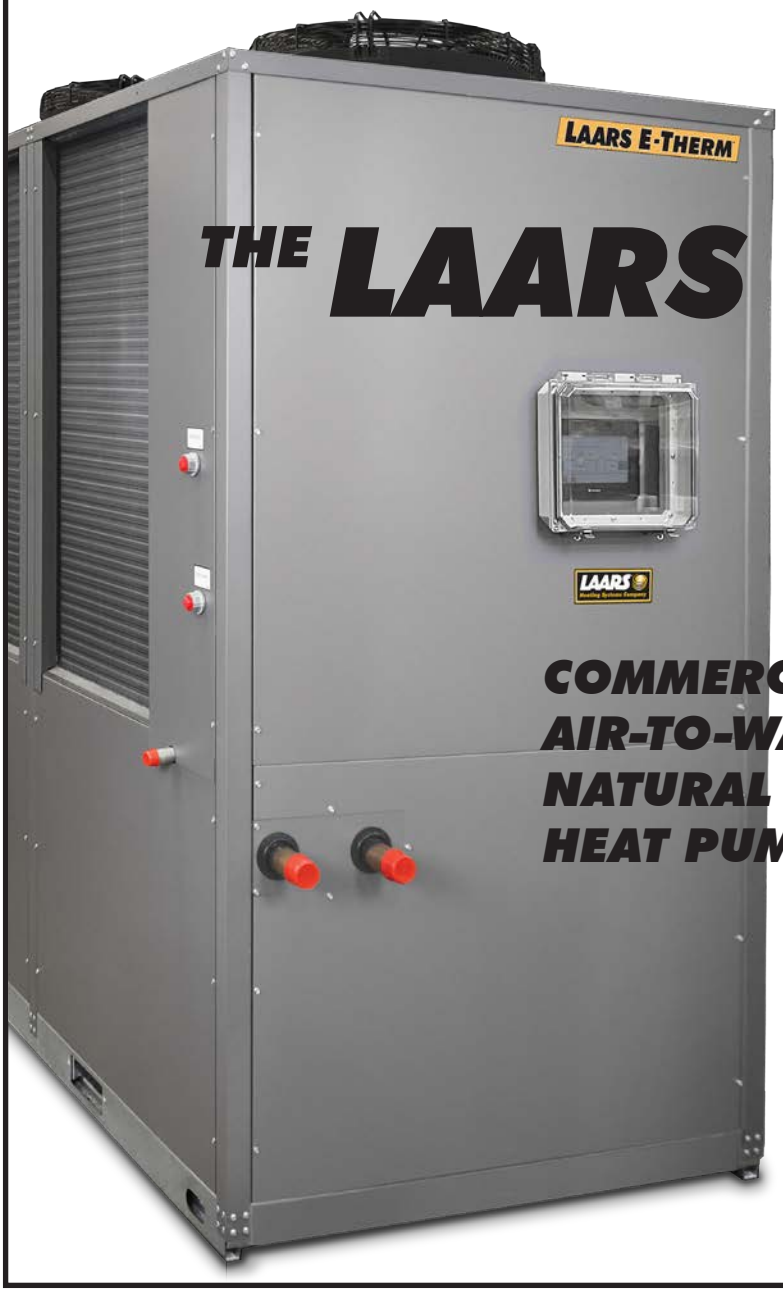


Installation and Operation Instructions for

THE LAARS E-THERM®

ECHV0325

COMMERCIAL AIR-TO-WATER NATURAL REFRIGERANT HEAT PUMP WATER HEATER

C ETL US LISTED Intertek

FOR YOUR SAFETY: This product must be installed and serviced by a professional service technician, qualified in hot water heater installation and maintenance. Improper installation and/or operation could cause serious injury, property damage, or death. Improper installation and/or operation will void the warranty.

⚠ WARNING	⚠ AVERTISSEMENT
Installer must comply with startup and installation instructions to avoid a dangerous situation.	**D'installation doit se conformer aux instructions d'installation et de démarrage pour éviter une situation dangereuse.**

H2422300C

LAARS® Heating Systems Company

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SECTION 1 Safety

1.A Safety Notes

Safety Notes are used throughout this manual to bring attention to the presence of hazards with various risk levels and to offer important information concerning the life of this product. There are 3 basic types.

1	⚠ WARNING	Indicates an imminently hazardous situation which, if not avoided, can or will result in death or serious injury and can or will result in catastrophic property damage.
2	⚠ CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in moderate injury and/or property damage.
3	NOTE:	Indicates instructions that are important to that topic but not related to personal injury or property damage.

NOTE: This appliance is not intended for use by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction concerning use of the appliance by a person responsible for their safety.
Children should be supervised to ensure that they do not play with the appliance.

⚠ WARNING

This unit must be installed in accordance with the procedures detailed in this manual, or the manufacturers warranty will be voided. The installation must conform to the requirements of the local jurisdiction having authority. Any modifications to this water heater, its controls, or wiring may void the warranty. If field conditions require modifications, consult the factory representative before initiating such modifications.

⚠ WARNING

This equipment contains **Refrigerant R744** which, when released in confined spaces, can cause asphyxiation. Care must be taken to prevent buildup in confined spaces as R744 displaces oxygen and thus exposure in saturated areas will lead to light headedness, unconsciousness, and possibly death from asphyxiation.

Additionally the R744 is under pressure and care must be taken when working near the compressor and the various supply lines. Ruptures to the pressurized gas system of this unit can cause serious injury and possibly death.

When servicing, only R744 may be used as a replacement refrigerant.

⚠ WARNING

CANCER AND REPRODUCTIVE HARM.
WWW.P65WARNINGS.CA.GOV.

AS REQUIRED BY THE STATE OF CALIFORNIA PROPOSITION 65.

⚠ WARNING

System contains refrigerant under very high pressure. Do not tamper with the system. It must be serviced by qualified persons only.



⚠ AVERTISSEMENT

Le système contient un frigorigéne sous très haute pression. Ne pas modifier le système. L'entretien doit être confié a une personne qualifiée.



⚠ WARNING

Electrical Shock Hazard

Electrical shock can cause severe injury, death or property damage. Disconnect the power supply before beginning installation or changing the wiring to prevent electrical shock or damage to the equipment. It may be necessary to turn off more than one power supply to disconnect.

All electrical wiring is to be done in accordance with local codes, or in the absence of local codes, with: 1) The National Electrical Code ANSI/NFPA No. 70 - latest Edition, or 2) CSA STD. C22.1 "Canadian Electrical Code - Part 1." This appliance must be electrically grounded in accordance with these codes.

⚠ WARNING

- Water temperature over 125°F (52°C) can cause severe burns instantly or death from scalds.
- Children, disabled and elderly are at highest risk of being scalded.
- See instruction manual before setting temperature at the unit.
- Feel water before bathing or showering.
- If this unit is used to produce water that could scald if too hot, such as domestic hot water use, adjust the outlet control (limit) or use temperature limiting valves to obtain a maximum water temperature of 125°F (52°C).



NOTE: All installations must be made in accordance with 1) American National Standard Z223.1/NFPA54-Latest Edition "National Fuel Gas Code" or
2) CSA B149.1 "Natural Gas and Propane Installation Code" or in Canada reference the B149.1 latest edition and with the requirement of the local utility or other authorities having jurisdiction. Such applicable requirements take precedence over the general instructions contained herein. All electrical wiring is to be done in accordance with the local codes, or in the absence of local codes, with: 1) The National Electrical Code ANSI/NFPA No. 70-latest Edition, or
2) CSA STD. C22.1 "Canadian Electrical Code - Part 1". This appliance must be electrically grounded in accordance with these codes.

⚠ WARNING

A means for main unit disconnection must be incorporated in the fixed supply power wiring in accordance with national and local codes. External main disconnect or main circuit breaker is provided by the installing contractor.

⚠ WARNING

The Repair Parts list designates parts that contain refractory ceramic fibers (RCF). RCF has been classified as a possible human carcinogen. When exposed to temperatures above 180ºF, such as during direct flame contact, RCF changes into crystalline silica, a known carcinogen. When disturbed as a result of servicing or repair, these substances become airborne and, if inhaled, may be hazardous to your health.

Do not remove or replace RCF parts or attempt any service or repair work involving RCF without wearing the following protective gear:

1. A National Institute for Occupational Safety and Health (NIOSH) approved respirator.
2. Long sleeved, loose fitting clothing.
3. Gloves.
4. Eye Protection.

SECTION 2 General Information

2.A Introduction

Air source heat pump water heaters offer the commercial hot water user a highly energy efficient means of generating potable hot water.

The HPWH uses the same common operating principle as an air-conditioner or a refrigerator to move heat from one environment to another. The difference is that it's moving the heat from the ambient air and storing it in very well insulated tanks.

This installation and operating manual includes information which will help you to install, operate, and maintain the Laars Heating Systems Commercial Heat Pump Water Heater.

Please read this manual completely before proceeding with the installation. If you have any questions regarding this equipment, please contact Laars Heating Systems, or your local Laars representative. Experience has shown that most operating problems are caused by improper installation.

2.B Warranty

LAARS Heating Systems Heat Pump Water Heaters are covered by a limited warranty. The owner should complete the warranty registration at

http://www.LAARS.com

ALL WARRANTY CLAIMS must be made by an authorized LAARS Heating Systems representative. Claims must include the serial number and model (this information can be found on the rating plate). All claims must also include the installation date and name of the installer. Shipping costs are not included in the warranty coverage.

2.C Model Identification (Nomenclature)

Primary information regarding your Heat Pump Water Heater can be found on the rating plate located on the outside jacket.

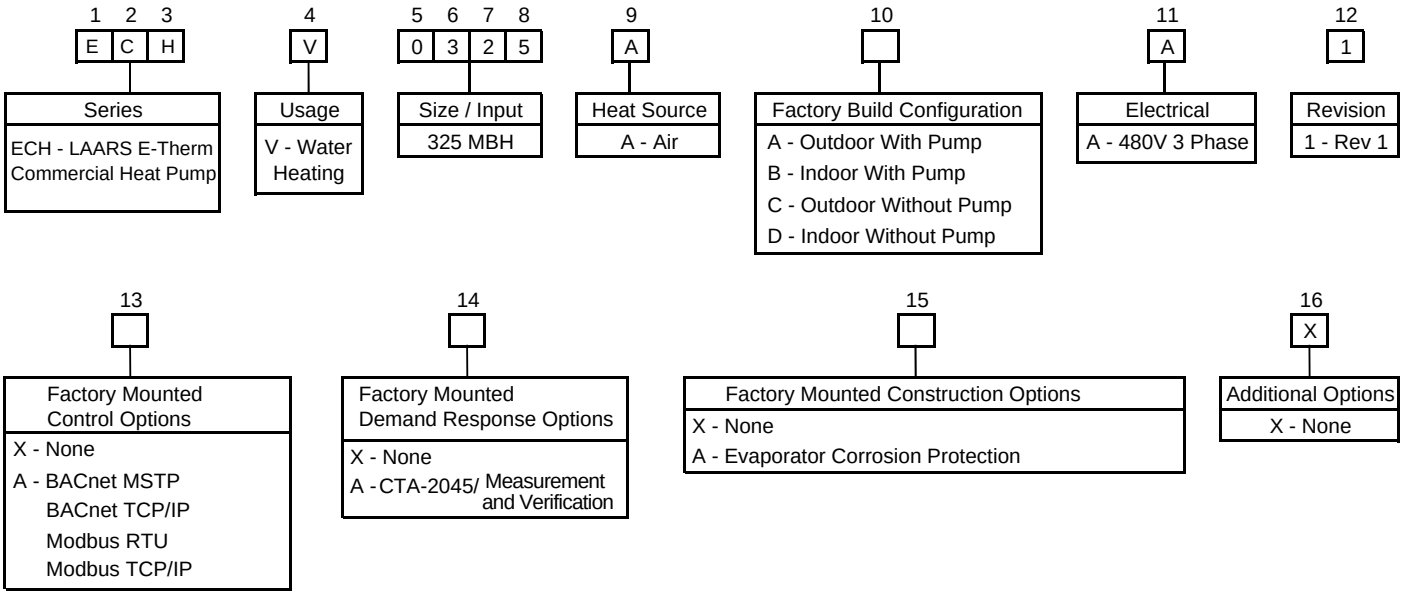


Figure 1. Model Nomenclature

NOTE: Throughout the content of this manual, the Laars E-Therm will be referred to as the 'HPWH' (Heat Pump Water Heater). HPWH = Laars E-Therm

2.D Performance Data

Nominal Heating Capacity		322 MBH	94.5 kW
Nominal COP (Performance Coefficient)	Per AHRI Standard 1300*	4.0	
Domestic Hot Water Data	Outlet Temp Range	120 to 180°F	49 to 82°C
	Flow Rate	2.8 to 15 gpm	10.5 to 57.8 lpm
Operating Conditions	Inlet Water Pressure, Maximum	150 psi	1034 kPa
	Inlet Water Pressure, Minimum	15 psi	103 kPa
	Inlet Water Temperature Range	38 to 90°F	3 to 32°C
	Entering Air Temperature Range	0 to 115°F	-18 to 46°C
	Ambient Temperature Range	0 to 115°F	-18 to 46°C
	Heat Pump	Certified to IPX4	
	Display Cover	NEMA 4X/13	
	HMI Screen	NEMA 4X	
Refrigerant	Type	R744 (CO_2)	
	Refrigerant Charge	50 lbs	22.7 kg
	Discharge Pressure, Maximum	1740 psi	120 bar
	Suction Pressure, Maximum	1088 psi	75 bar
Defrost Type		Hot Gas Bypass	
Sound Level, A-Weighted Average @ 1 Meter		76 dB(A)	
Sound Level, A-Weighted Average @ 4 Meters		67 dB(A)	
Fan	Type x Quantity	Axial (2)	
	Nominal Air Flow Range	4,000 - 26,000 cfm / 1,888 - 12,272 lps	
Gas Cooler/ DHW Heat Exchanger	Type	Double Wall	
	HX Material, Potable Side	Stainless Steel	

*AHRI Standard 1300 test condition of 70°F inlet and 120°F outlet water temperature at 80.6°F incoming air temperature.

2.E Configurations and Options

2.E.1 Indoor Unit Configuration Includes:

- PRV (pressure relief valve) vent manifold for venting CO_2. There is a connection on the top of the unit. The installer shall pipe from this connection to a safe discharge point per local code.
- The contractor is responsible for providing a mechanical system that provides ambient air to the evaporator coils and exhaust evaporator fan discharge air to ambient, and to all monitoring and control of these customer-supplied mechanical systems.

2.E.2 Factory Configurations Without Water Pump includes:

- 0 - 10VDC Pump speed control signal.
- Dry contacts for pump enable signal.
- Pump alarm contacts.

2.E.3 Evaporator Coil Corrosion Protection Configuration includes:

- Consists of coated evaporator coils, for coastal applications or corrosive environments.

2.G.1 Field Installed Snow Shields / Weather Hoods Kits include:

- Protection for the evaporator coils and fans from rain, snow, sleet and ice.
- Assembly instructions.
- Two outlet hoods (fan protection).
- Four inlet shields (evaporator coil protection).
- Mounting hardware.

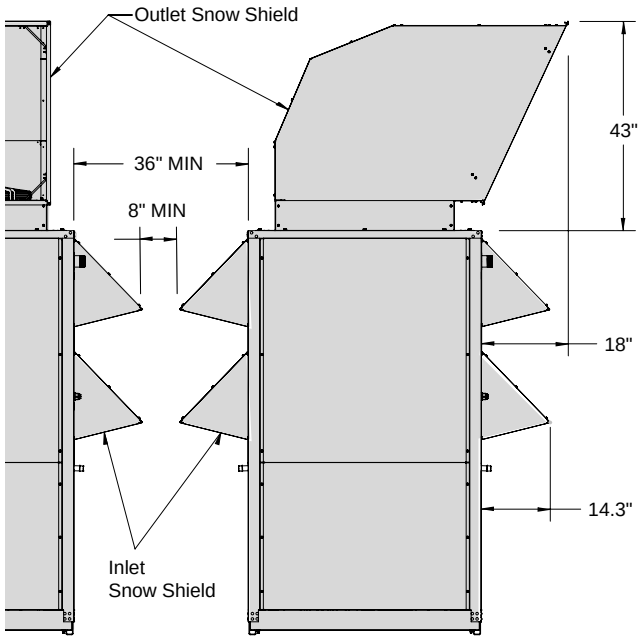


Figure 2. Optional Snow Shields Overall Dimensions

2.F Unit Overview

The HPWH is a closed loop R744 refrigerant (CO_2) system. This system is meant to provide years of service without need to monitor or otherwise access the refrigerant. In the event that access is needed, only technicians trained in R744, are authorized to proceed in the service of the refrigerant circuit.

The HPWH utilizes CO_2, a natural refrigerant, and electricity, to efficiently produce up to 180˚F domestic hot water. The HPWH utilizes a unique and highly efficient heat pump cycle to produce multiple times the energy in heat than would be produced from only electricity.

The HPWH is ideal for high volume, domestic water applications such as multi-family homes, hotels, dormitories, healthcare facilities, industrial processes, and many more. CO_2 as a refrigerant is non-toxic, non-flammable and has a low Global Warming Potential of 1. It also allows for ultra high coefficients of performance to be achieved.

Figure 3 on page 9 provides a simplified process schematic. The compressor pressurizes the refrigerant creating a high temperature gas which is used to heat incoming water in a gas cooler. The gas cooler is a highly efficient refrigerant to water heat exchanger. At the conditions within the heat exchanger, the CO_2 has properties of both a liquid and a gas which enhances the heat transfer to the water. The gas cooler is fabricated with double wall construction, eliminating the potential of refrigerant entering the water. This also ensures that potable water can be heated directly, without the need for an additional heat exchanger.

Upon leaving the gas cooler the pressure of the refrigerant creates a two phase mixture of liquid and gas with a corresponding reduction in temperature. This mixture then enters an evaporator where it is heated using ambient air, transitioning to a vapor. The air is drawn through the evaporator using highly efficient axial fans and exits the evaporator at a 15ºF to 25ºF lower temperature.
Before returning to the compressor to complete the cycle, a portion of the refrigerant passes through another heat exchanger (recuperator) to ensure that the refrigerant returning to the compressor is all gas.
The process is controlled with a proprietary control system and logic. The controller maintains system flow rates, pressures and temperatures at their optimum conditions taking into account ambient air temperature, incoming water temperature and desired water supply temperature.

When outdoor conditions are cool and humid, frosting of the evaporator coils will occur. This restricts air flow and heat transfer and interferes with normal operation and hot water production. The HPWH will automatically switch to the required defrost mode of operation and automatically return to normal operation when the defrost cycle is complete.

2.G How Defrost Works

The HPWH continuously monitors the evaporator coils and ambient conditions to determine when defrost is required. In defrost mode the HPWH will temporarily shut off the fans and use the heat generated by the operating compressor to redirect hot refrigerant to the evaporator coils. This warms the fins of the evaporator evenly to melt the frost in an efficient manner. Once the HPWH detects that the evaporator coils have been adequately cleared of frost, it will switch back to normal operation. The HPWH ships pre-configured with parameters that work for most regions, but these can be adjusted to suite conditions of specific installations. See section 6 Control Operation for more detail on how to adjust defrost parameters.

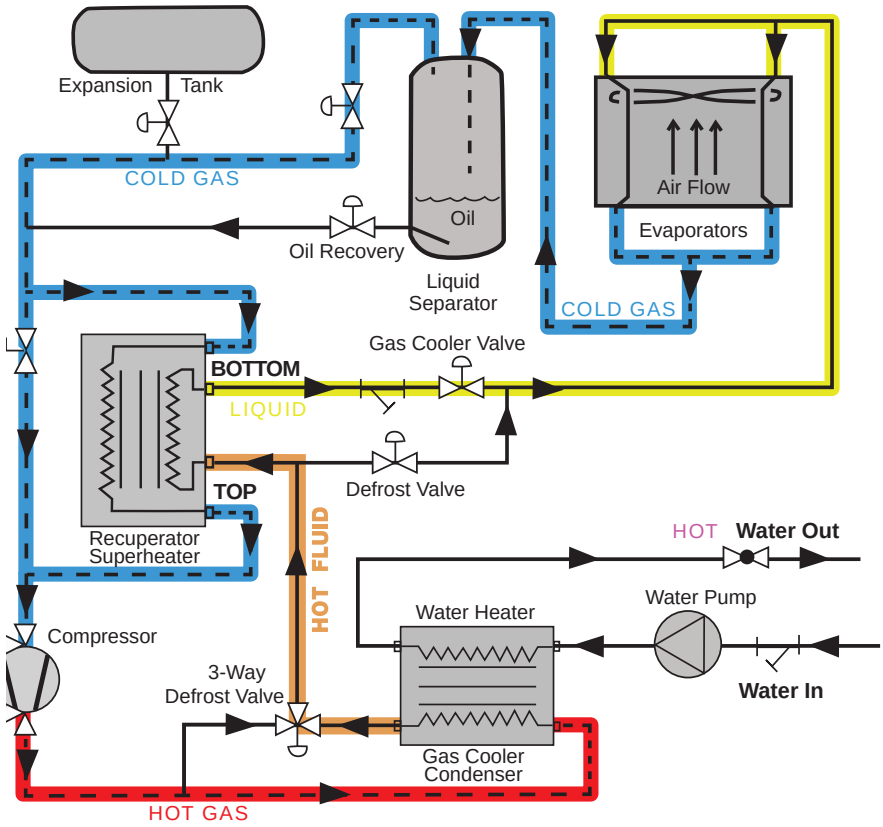


Figure 3. Simplified Process Schematic (Water Heating)

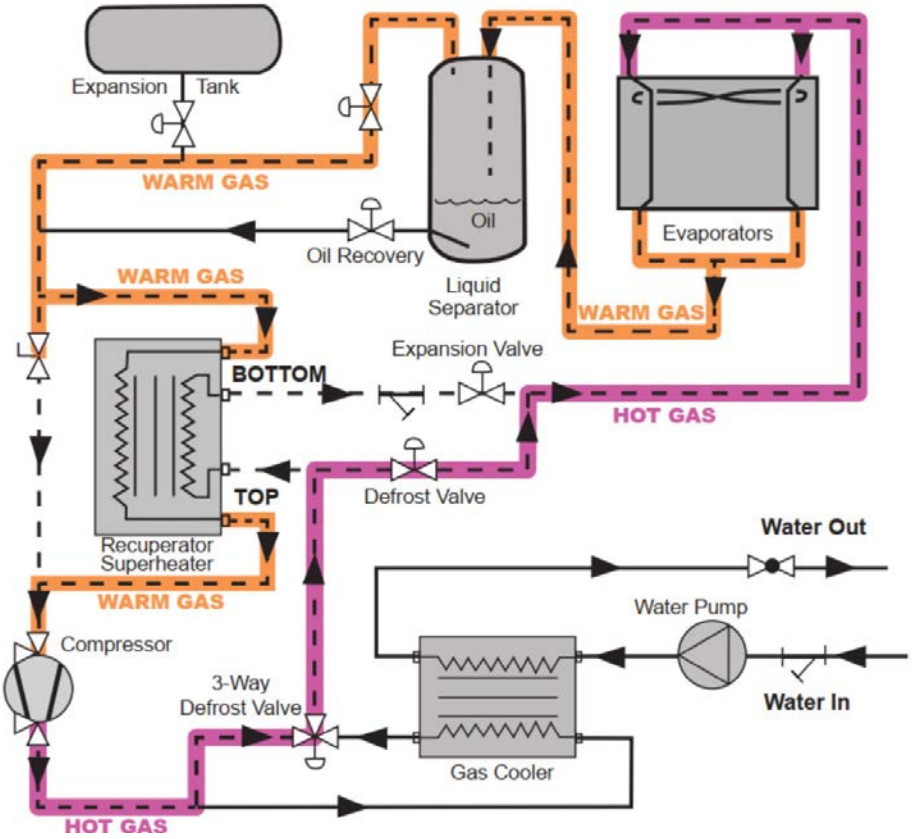


Figure 4. Simplified Process Schematic (Defrosting Evap Coil)

2.H Components

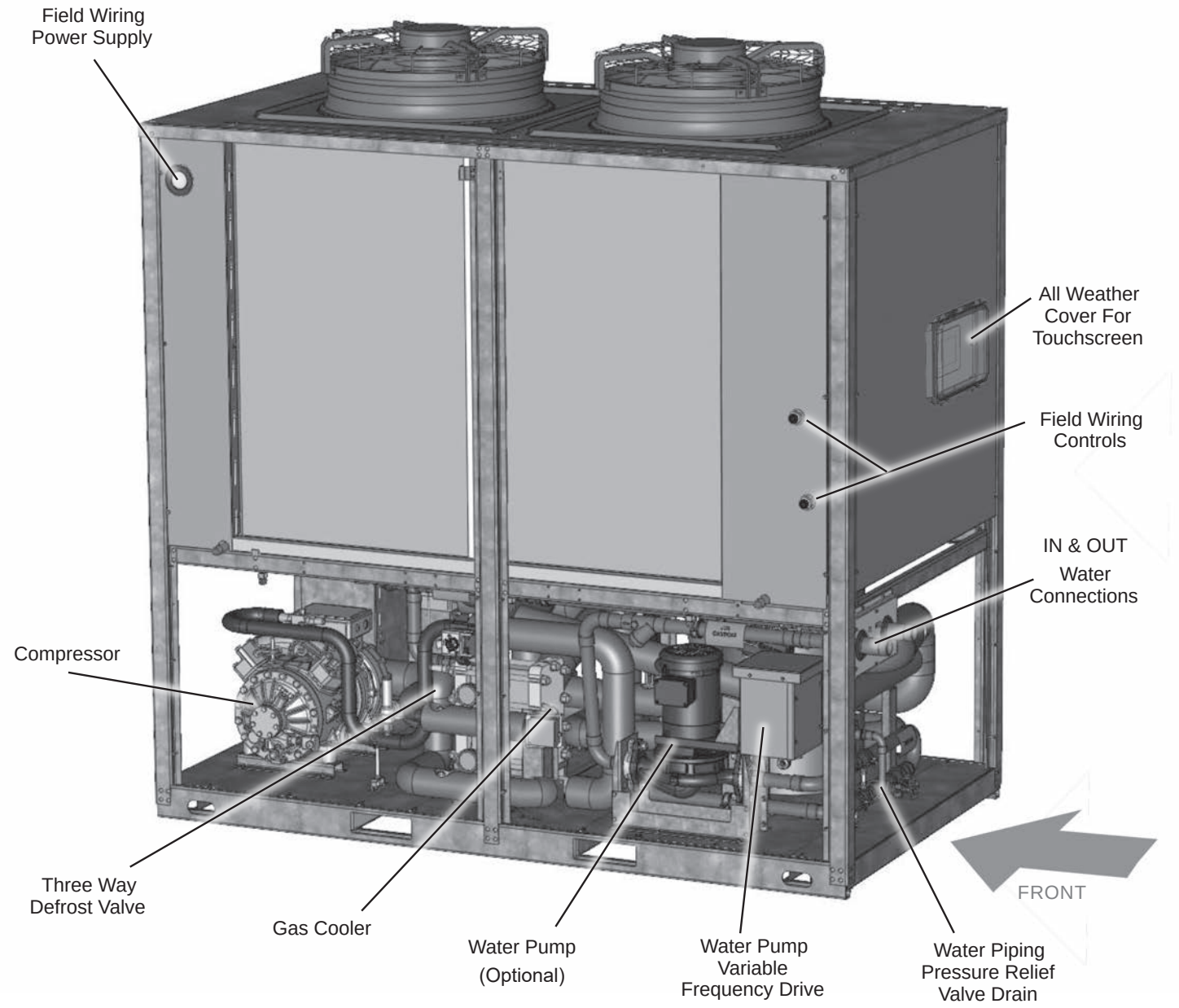


Figure 5. Left Side (lower panels removed for visual purposes)

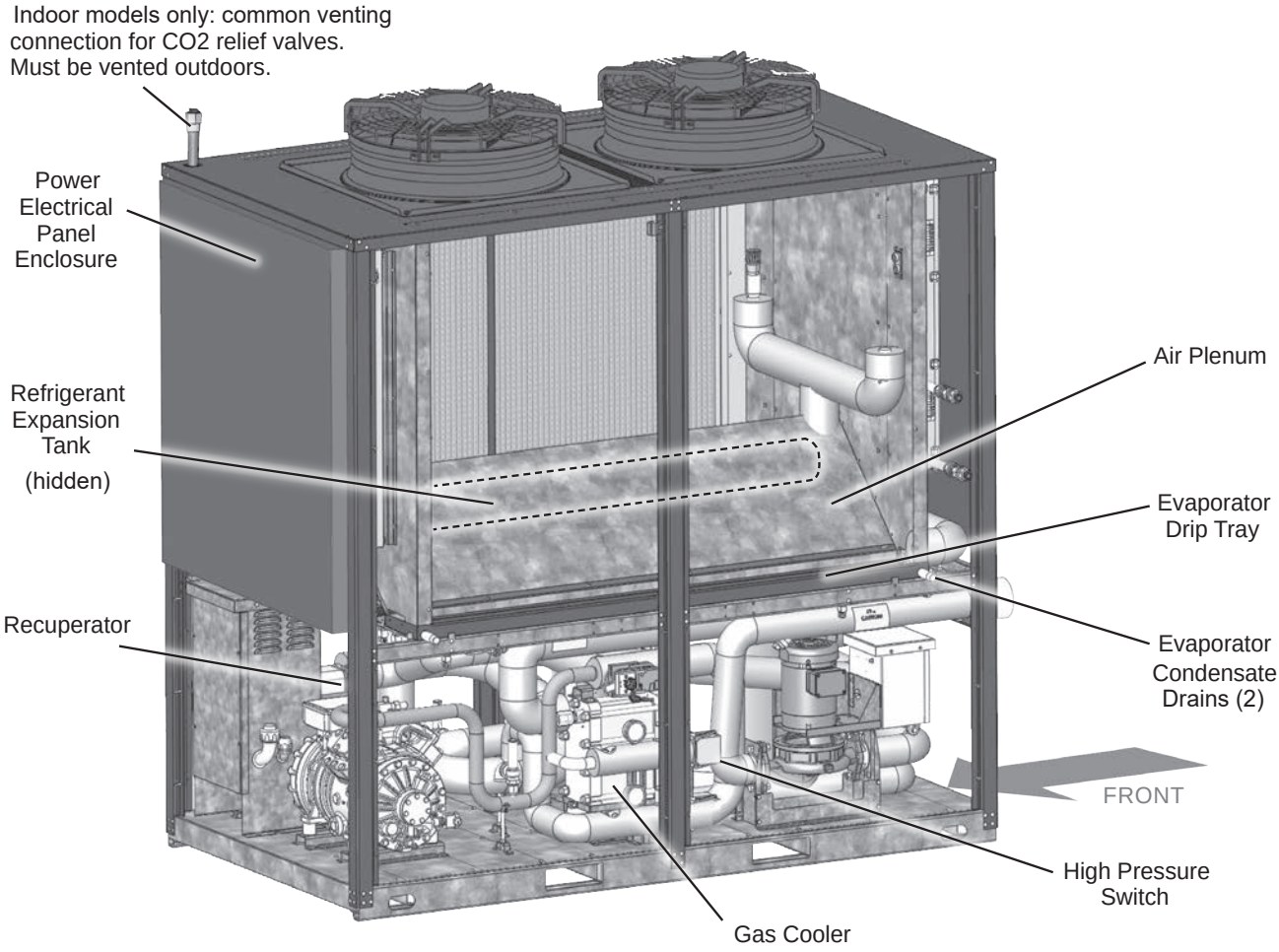


Figure 6. Left Side with evaporator hidden (and several panels removed for visual purposes)

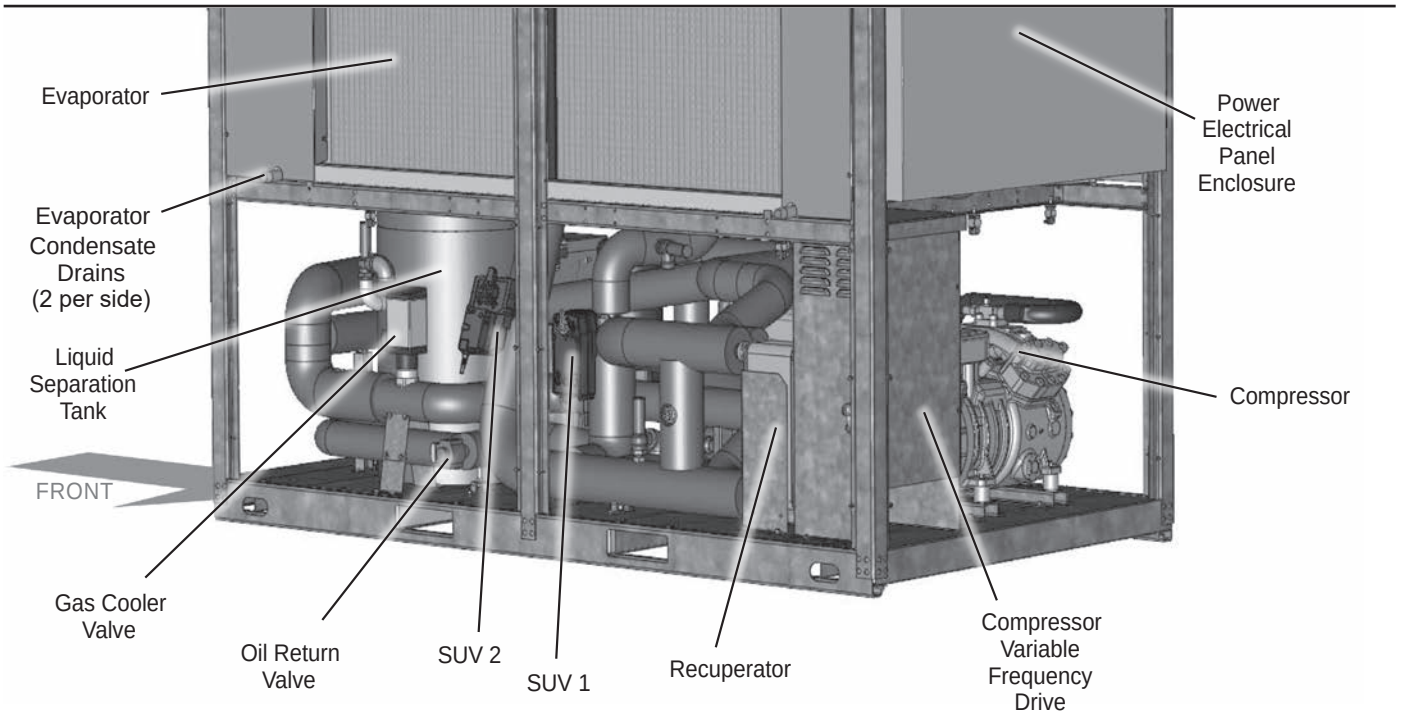


Figure 7. Right Side View (lower panels removed for visual purposes)

2.I Dimensions

Product Weight	Operating Weight	3080 lbs	1397 kg
	Shipping (crated & charged)	3820 lbs	1733 kg
	Product - Dry	3061 lbs	1388 kg
Operating Weight Corner Point Loading	Front Left Side	689 lbs	313 kg
	Front Right Side	716 lbs	325 kg
	Rear Right Side	930 lbs	422 kg
	Rear Left Side	726 lbs	329 kg
Installation Clearances (Minimum)	Both Sides	3 ft	91 cm
	Front and Rear	4 ft	122 cm
	Above the Heat Pump	See Section 2.K.2	
Outside Dimensions	Height	93-3/4 in	238 cm
	Width	52-1/4 in	133 cm
	Length	93-1/4 in	237 cm
Water Connections	Water Inlet	1-1/2 in MNPT	
	Hot Water Outlet	1-1/2 in MNPT	
	Condensate Drains (4)	3/4 in MNPT	

Table 1. Weights and Sizing

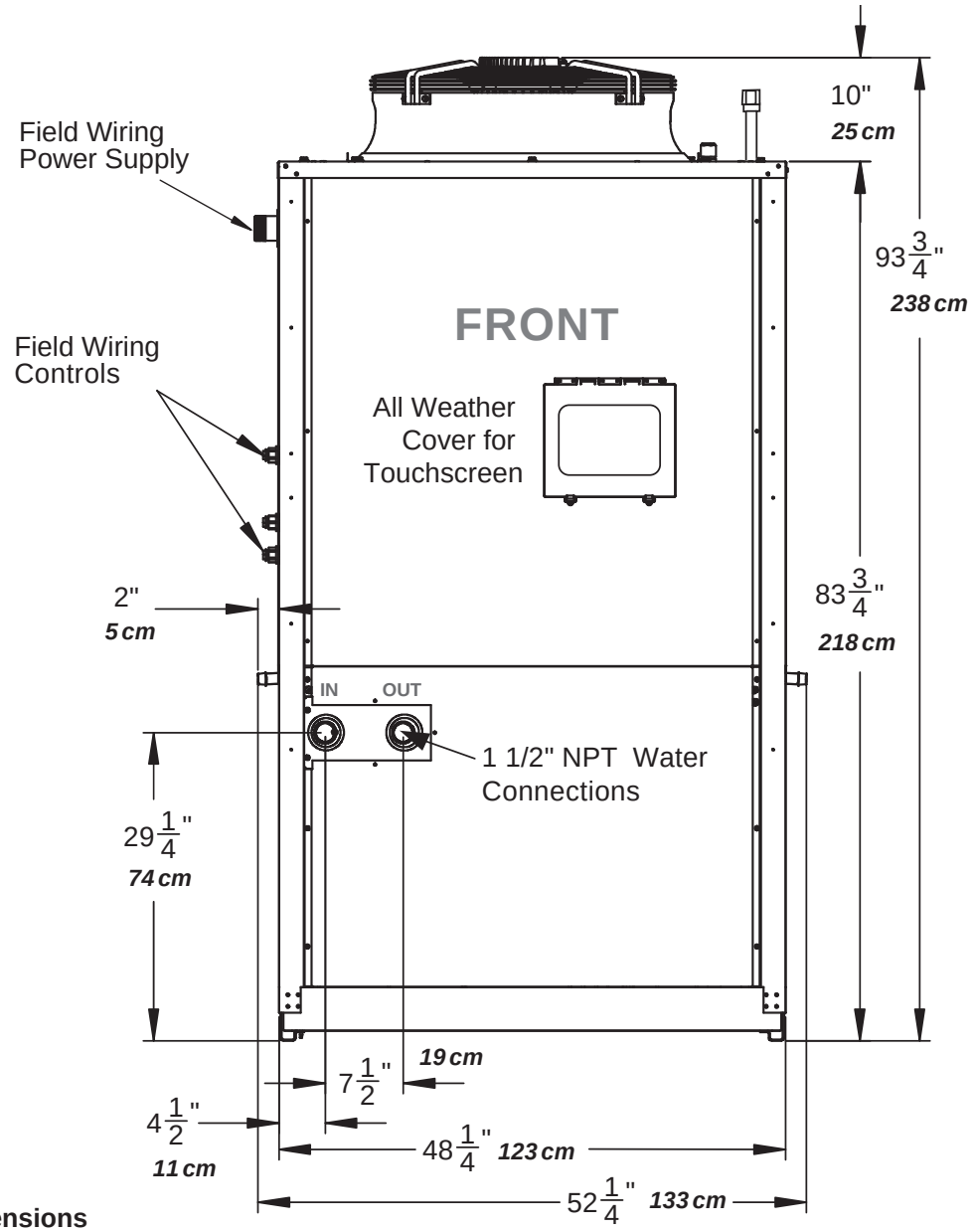
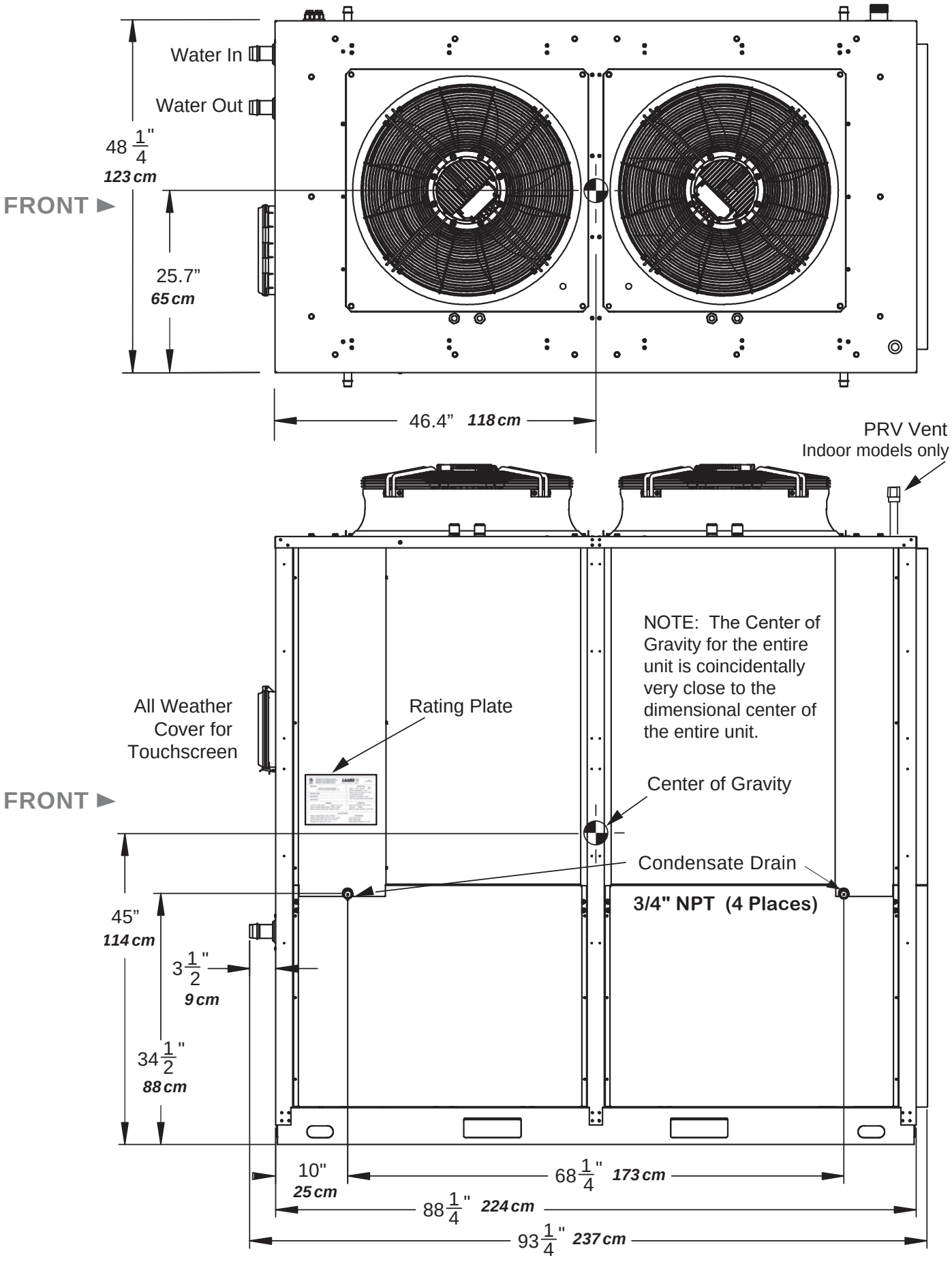


Figure 8. Dimensions


Water In
Water Out
48 1/4"
123 cm
FRONT ►
25.7"
65 cm
46.4" 118 cm
PRV Vent
Indoor models only
NOTE: The Center of Gravity for the entire unit is coincidentally very close to the dimensional center of the entire unit.
All Weather Cover for Touchscreen
Rating Plate
Center of Gravity
FRONT ►
Condensate Drain
3/4" NPT (4 Places)
45"
114 cm
3 1/2"
9 cm
34 1/2"
88 cm
10"
25 cm
68 1/4" 173 cm
88 1/4" 224 cm
93 1/4" 237 cm

2.J Unpacking and Handling

The HPWH is shipped in a single crate. The shipping crate must be picked from the short side using 6 ft or longer forks. Carefully disassemble the crate and inspect the unit for any shipping damage. If there are any signs of damage or mishandling, contact the manufacturer for guidance on how to proceed. Once the heat pump is removed from the base of the shipping crate, the heat pump must be picked from the long side with a fork lift or a crane.

The HPWH shipping weight is 3820 pounds (crated and charged). It is designed to be moved using a fork truck or crane. Equipment and lifting gear with rated capacities exceeding this amount, taking into account the size of the unit, must be used.

Fork truck handling should only be from the side of the unit using the fork cutout in the base frame. These cutouts are 7-1/2" by 2-1/2" and 28-1/2" on center as shown in Figure 10 on page 15 The forks must extend all the way through the unit. If the HPWH needs to be moved through narrow passages suitable equipment dollies should be used. The dolly width should be at least 48" to support the system on the bottom side rails.

Lifting cutouts have been provided at each bottom corner of the unit for using a crane to move and/or lift the HPWH. The cutouts are oval in shape and approximately 3-5/8" by 1-5/8". Suitable lifting straps or spreader bars should be run through these locations, using the base frame structure.

Spreader bars should also be used above the unit to prevent putting pressure on the top structure and panels. The top and side panels are not capable of handling significant force from the sides or ends and are not to be used for lifting.

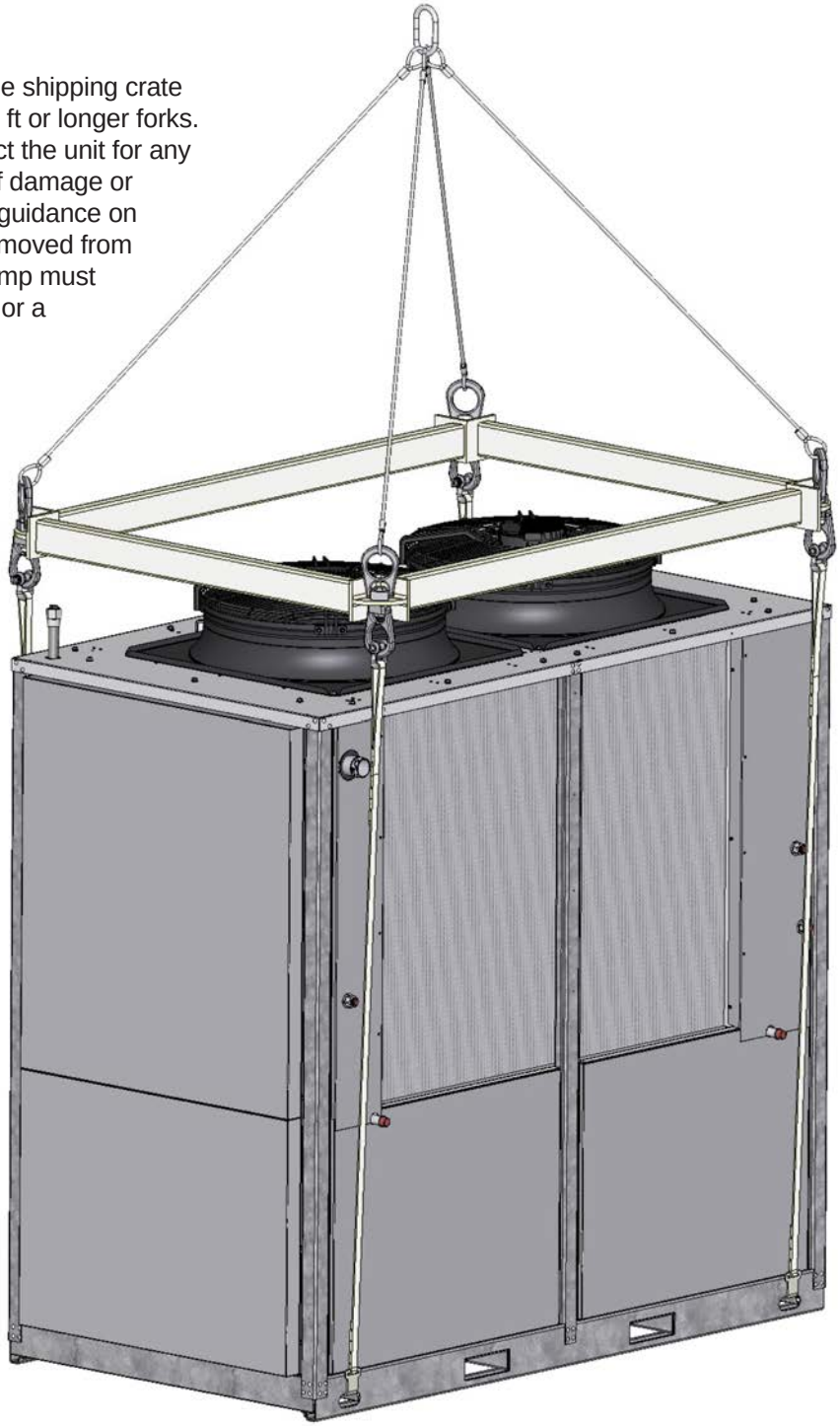


Figure 9. Spreader Bars

The HPWH must not be tilted more than 10 degrees while handling, or damage to the unit will result.

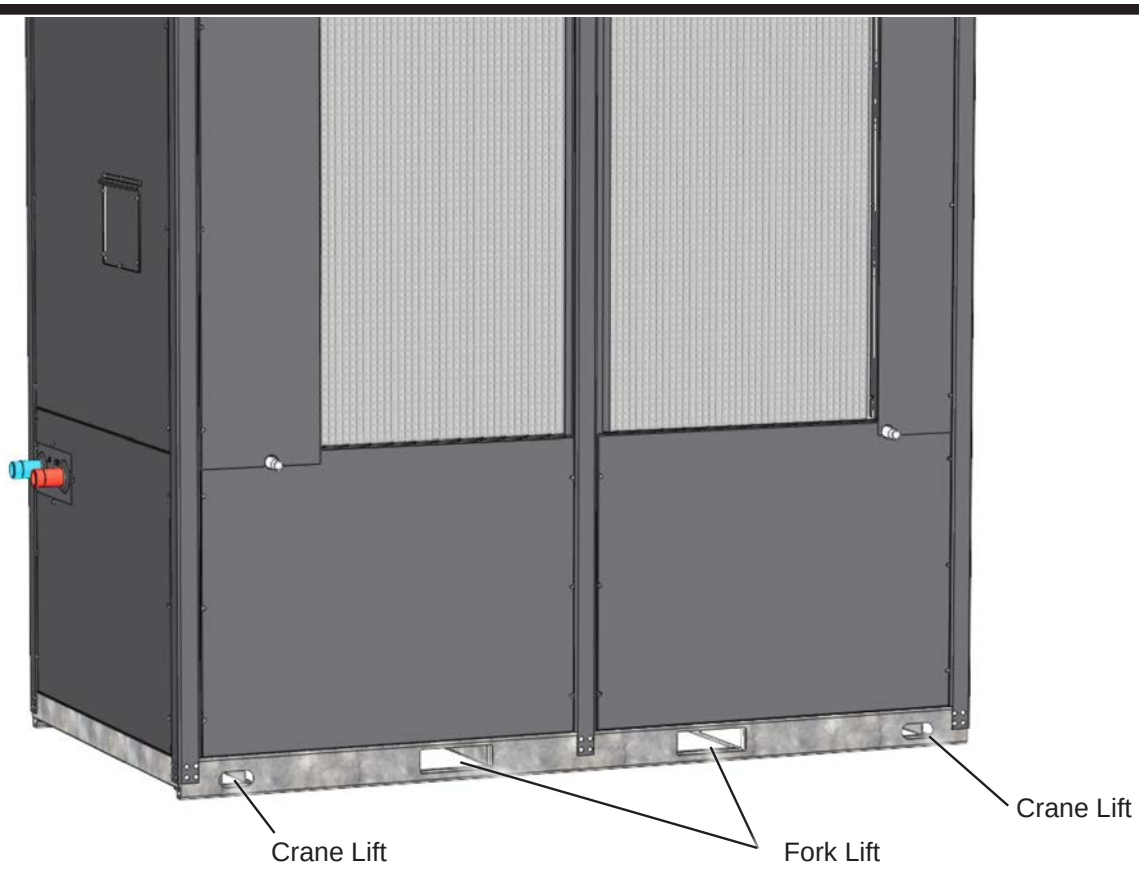


Figure 10. Fork Lift and Crane Lift Points

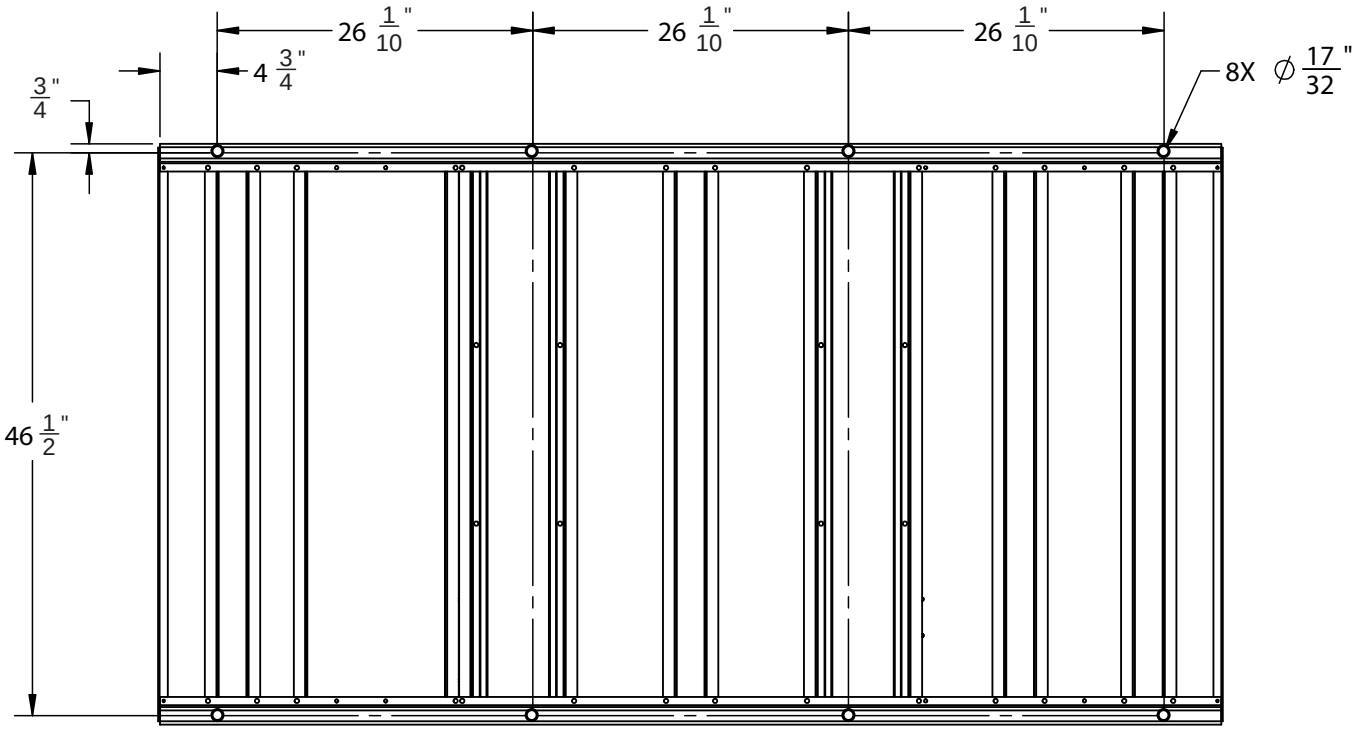


Figure 11. Mounting Hole Dimensions (Bottom View)

2.K Locating the Unit

2.K.1 Altitude

The HPWH is intended for both outdoor and indoor installation at any altitude up to 6,500 ft (2000 meters). The thermal output derate is indicated in Table 2, due to air density decreases.

In order to partially compensate for this altitude derate, an altitude parameter has been set up in the heat pump to mitigate this derate by increasing the fan speed. Simply enter the elevation of the heat pump, the system will adjust fan speed accordingly during the commissioning of the heat pump. (See Chapter 6).

2.K.2 Clearances and Mounting Instructions

Service access to a single heat pump requires 36" clearance along the long sides of the unit, whereas the National Electric Code (NEC) requires 48" clearance at the front and the rear of the heat pump. Consult local codes for additional requirements.

Vibration isolators are recommended to minimize transmission of mechanical vibration to the building structure. See Table 1 on page 12 for corner point loading.

Mounting holes 0.53" in diameter are provided on the outside support rails to bolt the unit onto the concrete platform. (See Fig 11, page 13).

A 10-foot clearance must be maintained above the unit. If the 10-foot clearance is not practical, the discharge from the fans must be ducted away from the unit using 28" diameter ducting to each fan or turned 90 degrees with ducting similar to the evaporator fan discharge Snow Shield/Weather Hood. See Figure 2 on page 8.

⚠ WARNING

Condensate from the evaporator coils may be routed to a nearby drain or piped to a collection system. For units in cold weather conditions, it might be necessary to heat trace the drain piping to a suitable length to prevent freezing of this condensate.

⚠ WARNING

For seismic conditions, it will be required to secure the base of the heat pump to the concrete pad, using a bolt pattern that is shown in Figure 11 on page 15.

2.K.3 Outdoor Installations

The heat pump shall be installed as close to the hot water storage tanks as possible to reduce piping heat loss and pumping head loss.

Units not on a roof should be mounted on a suitable equipment pad (54" by 96") and the base of the HPWH should be elevated to the expected snow level.

Roof mounted units should be mounted on a mounting frame capable of distributing the load to the building structure. A qualified engineer should design the frame and ensure that the additional load can be supported.

Vibration isolators are recommended to minimize transmission of mechanical vibration to the building structure.

Mounting holes 0.53" in diameter are provided on the outside support rails as shown in Figure 11 on page 15.

Condensate from the evaporator coils can be led to a drain or piped to a collection system.

2.K.4 Indoor Installations

An indoor unit shall be placed as close as possible to the hot water storage tanks to reduce heat loss and pumping head loss. Mechanical room units shall be placed on a concrete 6" pad (54" x 96").

Vibration isolators are recommended to minimize transmission of mechanical vibration to the building structure.

Mounting holes 0.53" in diameter are provided on the outside support rails as shown in Figure 11 on page 15.

Condensate from the evaporator coils must be led to a drain or piped to a collection system.

The contractor is responsible for providing a mechanical system that provides ambient air to the evaporator coils and exhaust evaporator fan discharge air to ambient, and to all monitoring and control of these customer-supplied mechanical systems.

When installed with field-provided ducting, it is recommended that additional external booster fans be sized and provided to overcome the pressure loss of the ductwork. External fans and ductwork should be sized for both the inlet and outlet of the heat pump.

Alternatively, the fans in the heat pump have the capacity to be operated at higher speeds. The heat pump fans can be configured to run at full speed, allowing an additional 0.1" w.c. at 26,000 cfm. This additional static pressure can be used to overcome any losses from the inlet and exhaust ductwork. If the static loss exceeds 0.1" w.c., external booster fans are recommended.

Ductwork and booster fans are to be sized by a qualified engineer. The discharge from the fans must be ducted away from the unit. The HPWH can provide a start/stop signal for the operation of the field-supplied booster fans.

Elevation (ft)	Sea Level	2000	4000	6000	8000
Output without adjusted elevation	100%	93%	86 %	80%	74%
Output with adjusted elevation	100%	100%	100%	98%	92%

Table 2. Elevation Derate Correction

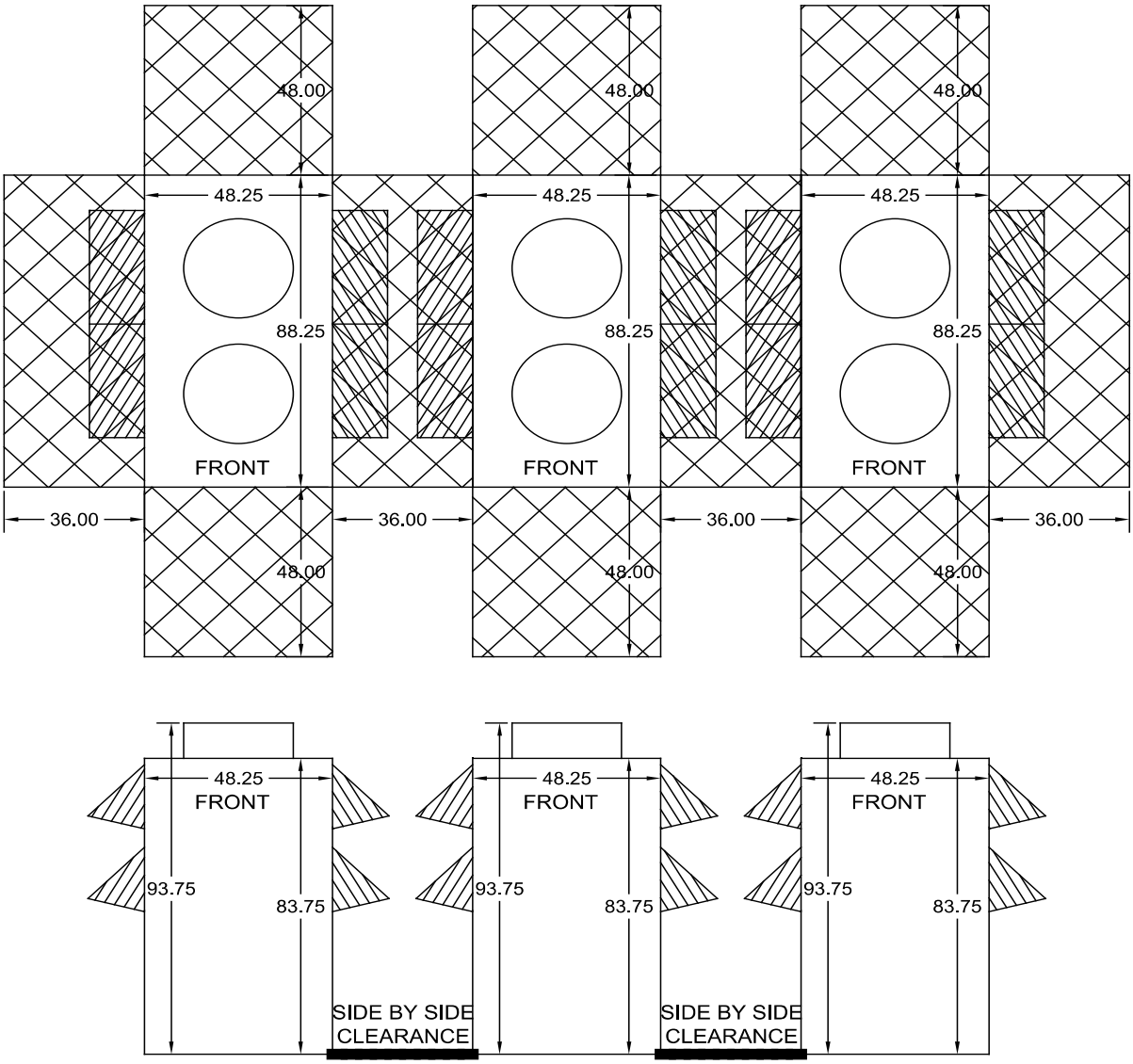


Figure 12. Clearances

2.K.5 Multiple Unit Installations

- Clearances:

Service access and the National Electric Code (NEC), NFPA 70, require a 36” clearance must be maintained along the long sides of the unit and 48” clearance at the front and rear.

For multiple units placed together, see Figure 12 to determine clearances required for optimum performance.

In addition, a 10-foot clearance must be maintained above the unit. If the 10-foot clearance is not practical, the discharge from the fans must be ducted away from the unit using 28” diameter ducting to each fan or turned 90 degrees with ducting similar to the evaporator fan discharge Snow Shield/Weather Hood. See Figure 2 on page 8.

SECTION 3 Water Piping

3.A Water Quality

Water quality standards must be maintained or damage to the heat exchanger will occur. The water quality parameters of this table must be verified and maintained in order to ensure a long life of this unit.

Federal and state legislation supercede this table in cases where stricter limits are required.

Total hardness	4.0 to 11.5 gpg
pH	7.5 to 8.5
Electrical conductivity	10 to 500 QS/cm
Hydrogen carbonate (HCO_3-)	70 to 300 ppm
Sulphates (SO_4^{2-})	< 70 ppm
Hydrogen carbonate / Sulphates (HCO_3-/SO_4^{2-})	> 1
Chlorides (Cl-)	< 80 ppm
Nitrates (NO_3-)	<100 ppm
Ammonium (NH_4)	< 2 ppm
Free Chlorine (Cl_2)	< 1 ppm
Hydrogen Sulfide (H_2S)	< 0.05 ppm
Free Carbon Dioxide (CO_2)	< 5 ppm
Manganese (Mn)	< 0.1 ppm
Iron (Fe)	< 0.2 ppm
Aluminum (Al)	< 0.2 ppm
Oxygen	< 0.1 ppm

Figure 13. Water Quality Requirements

3.B General Water Flow Information

The HPWH is capable of heating potable water directly without the need for an intermediate heat exchanger or fluid. The HPWH uses either a built-in pump or a field-supplied external pump approved for use with potable water. The pump delivers water to the plate heat exchanger gas cooler where it is heated by the hot refrigerant and then sent to the load or the hot side of the stratified tank storage system.

The internal water circuit is equipped with a flow switch to ensure there is water flow prior to the compressor operating.

The HPWH is connected to a stratified storage tank(s) and the tank(s) must be outfitted with a properly rated and sized temperature and pressure (T&P) relief valve.

The external water circuit and storage system must be outfitted with a properly rated and sized expansion tank. Storage tanks must be equipped with dip tubes in critical locations. These are provided when ordering the tank system.

3.C Water Flow & Headloss Data

Heat Pump Setpoint	GPM*
180	6
150	8
130	11

*With 70°F incoming water supply @ 322 MBH Heating capacity

Table 3. Pump Setpoint

Use Table 3 to determine the design flow rate.

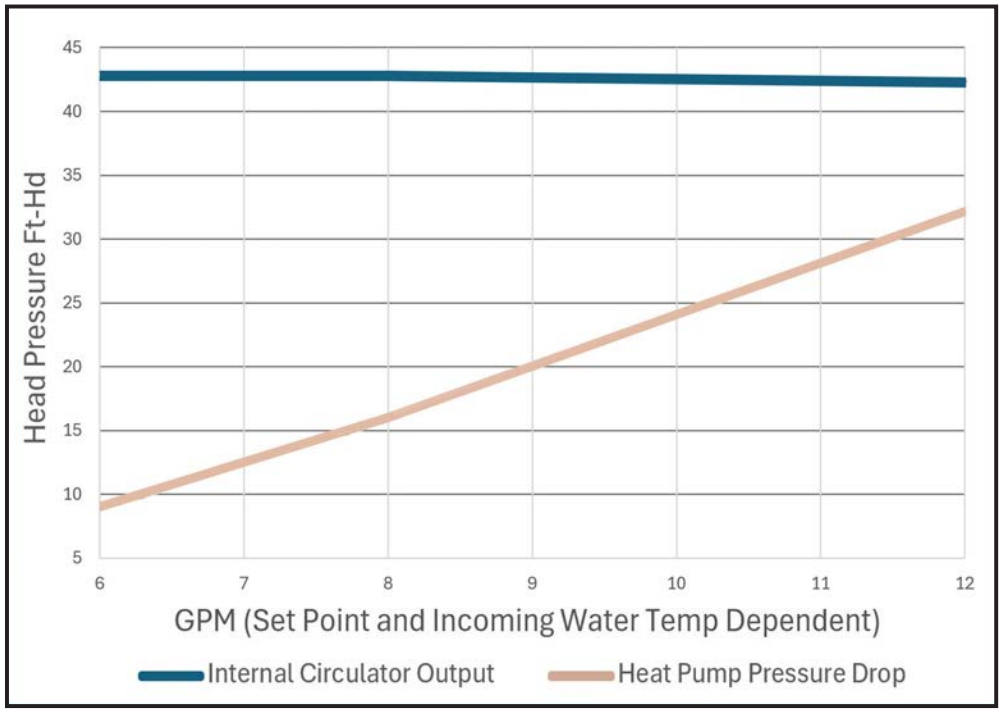
Use Figure 14 to determine if the optional internal circulator is sufficient for your application. Figure 14 shows 2 curves , the “Internal Circulator Output” and “Heat Pump Pressure Drop”. If the sum of all external field provided pressure loss due to pipes , valves, fittings etc. plus the “Heat Pump Pressure Drop” at a given flow is less than the “Internal Circulator Output” curve the optional internal circulator can be used. Pipe sizing should be performed according to applicable codes and standards by a qualified person.

When an external pump is used, it is required to provide one pump and check valve per heat pump. The external pump must be able to provide flow from 2.8 to 12 gpm. Figure 14 can be used to size the external pump(s). Use the “Heat Pump Pressure Drop” curve on Figure 14 to determine the head loss through the heat pump at different flow rates. The external pump(s) should be sized to overcome the “Heat Pump Pressure Drop” plus any head loss due to the external piping , valves, fittings and accessories. The heat pump can provide an enable and variable speed 0-10 VDC control signal for the external pump.

If available, the alarm contacts on the pump can be wired to the heat pumps water pump alarm terminals.

⚠ CAUTION

In addition to the four CO_2 pressure relief valves, a water system pressure relief valve is factory installed on the heat pump. This relief valve is located directly underneath the inlet and outlet water piping. The contractor may install a discharge pipe to the outlet of the pressure relief valve. The diameter of the discharge piping must be equal or greater than the pressure valve discharge opening. This discharge pipe must be directed towards an area where the discharge can not harm people or property.



NOTE: Chart data measured with balance valve in fully open position.

Figure 14. Internal Circulator Curve / Heat Pump Pressure Drop

3.D Water Connections

NOTE : This heat pump is intended to be permanently connected to the water mains and not connected by a hose set.

The water connections on the HPWH are 1-1/2” male NPT. The location is shown in Figure 3 on page 9. The supply and return piping connected to the HPWH should be sized based on expected flow rates (set point dependant) and total head loss. See Table 3 and Figure 14 for sizing assistance

The water piping should be supported by suitable hangers or floor stands. Do not support the piping with unit frame. Rigid hangers may transmit noise through the system resulting from the pipe sliding in the hangers. Use flexible connections to reduce sound attenuation into the piping system. We recommend that padding be used when rigid hangers are installed.

Piping should be well insulated to minimize heat loss. If any of the potable piping is running outdoors and may be subject to freezing conditions, it is required to install heat trace prior to insulating the outdoor potable water piping. The power supply for the external heat trace must be connected to the emergency power supply of the building, to avoid a freeze up during inclement weather.

3.D.1 General Recommendations For Piping Connections

⚠ WARNING

This unit may produce hot water at temperatures as high as 180°F (82°C). All water piping components must be selected for this temperature.

When installing the water piping to and from the heat pump, it is good practice to follow national and local regulations. It is recommended to connect the piping to/from the heat pump using flexible joints to minimize transmission of vibrations and compensate for thermal expansion of the piping.

Refer to Figure 15 and install the following components in the indicated order:

- Install 1-1/2” NPT unions on cold inlet and hot water connections for easy disconnecting of the water piping to/from the heat pump.
- Install drain valves and shut-off valves on both inlet and outlet piping. The drain valves allow for occasional flushing of the gas cooler in case of hard water conditions. Drain valves can also be used for manual air purging. Freeze protection measures can also be done through these valves by blowing air or pumping anti-freeze through the unit while it is isolated.
- An air purge valve should be installed on the highest

-continued on next page

point of the hot water outlet piping to allow air purging.

- Install a metal mesh filter on the inlet pipe with openings not wider than 1/16” (1 mm) in the cold inlet piping to avoid slag and impurities from entering the heat exchanger.
- Install a check valve on the water inlet side of the heat pump. This will prevent reverse flow through the gas cooler in case of a multiple heat pump installation.

3.E Recommended Piping Components

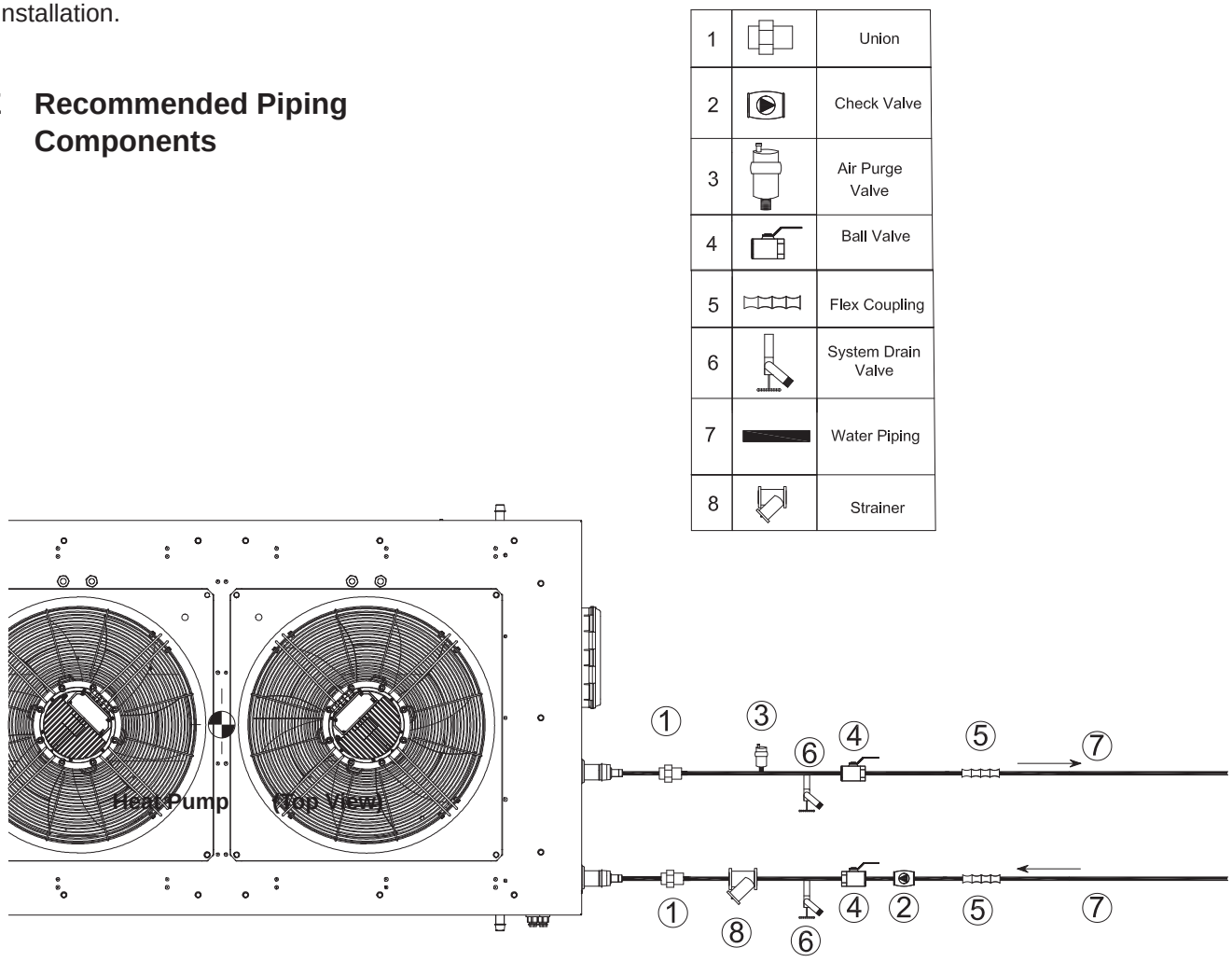


Figure 15. Components

3.F Suggested Piping Systems

The HPWH is designed for single-pass operation to optimize the overall performance of the CO_2 system. Single pass systems are designed to allow the heat pump to operate with high temperature lift (meaning the difference between inlet and outlet water temperatures is large). CO_2 heat pumps operate most efficiently when heating incoming city water (40°F to 80°F) to a hot storage water temperature (140°F to 180°F).

A proven system design strategy for single pass systems is to separate the following:

1. Primary Domestic Hot Water Storage
2. Temperature Maintenance.

3.F.1 Primary Domestic Hot Water Storage

Typical commercial HPWH systems use multiple stratified storage tanks that ensure the hottest water is delivered to the domestic water loop and the coldest water is delivered to the heat pump, helping to ensure highest possible operational efficiency.

HPWH stratified tanks can be piped in 3 distinct ways:

1 Series piping is the recommended way of connecting multiple stratified tanks. This approach eliminates the multiple horizontal diffusers except for one, which must be installed in the CWMU (Cold Water Make-Up) tank. We strongly recommend this piping approach as it eliminates the need for balanced parallel. This method simplifies the piping arrangement of the tanks. Several examples are shown in 3.F.6.

2. Parallel piping: In this method, total water flow from the heat pump(s) is split evenly between multiple tanks. It is important that all stratified tanks are connected in a balanced parallel arrangement to ensure even flow over all tanks. Each CWMU (Cold Water Make-Up) tank requires that an additional horizontal diffuser must be installed in the lower tank connection with the diffuser opening pointing downward. This is the cold water make-up from the water supply and the connection is above the heat pump supply line connection.

3 For a large scale DHW system, it may be advantageous to use a hybrid piping system (multiple banks of tanks in a balanced parallel arrangement with each bank having several tanks in series). The benefits with a hybrid system is that the high water flow from the heat pumps and system draws are split up between the series tank systems.

For HPWH Tank Piping Systems:

- Cold make-up water is piped directly to the stratified storage tank(s), also called CWMU Tank(s).
- Each CWMU tank requires the additional field installed horizontal diffuser.
- Based on temperature sensors placed in the storage tank system, the heat pump turns on and heats the cold water in a single pass.
- A variable DHW pump, either built-in or remotely placed, and controlled by its heat pump, runs the water through the built-in plate and frame heat exchanger, and water is heated to its desired set point in a single pass.
- Once the entire stratified tank system is charged to its setpoint, the heat pump and its variable speed pump shut off.
- Refer to Figure 20 on page 25 thru to Figure 22 on page 27 for typical heat pump based DHW stratified tank systems.
- All stratified storage tanks supplied with this HPWH are supplied with standard 3” connections to allow high water flow with minimal pressure drop.

NOTE: Building recirculation water must NEVER be piped back to the storage tanks. Building recirculation loop MUST be piped to the Temperature Maintenance (or Swing) Tank instead.

NOTE: Contact Laars Applications or your local Laars representatives for guidance in cases of complex, multi-tank arrangements.

Figure 16 depicts the approximate percentage each sensor location represents in a single tank system. This is the percentage of the storage that needs to be charged. In a multi-tank system, the 85% and 15% sensors should remain as the closest sensor to the hot water supply and the closest sensor to the cold-water make-up locations, respectively. The sensors should be equally distributed across all the tanks, representing the total storage percentage as accurately as possible.

The Off-Sensor location is typically at the 15% location, which indicates that less than 15% of the storage tank system is below the target temperature when the unit is shutdown.

The On-sensor location can vary more often; however, it’s typically 40%. This is called the Aquastat Fraction which is defined as the amount of storage consumed when the heat pump is called back on. Decreasing

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the fraction will result in the heat pump running more frequently. Increasing the fraction means less storage is available to provide hot water while the heat pump is recharging.

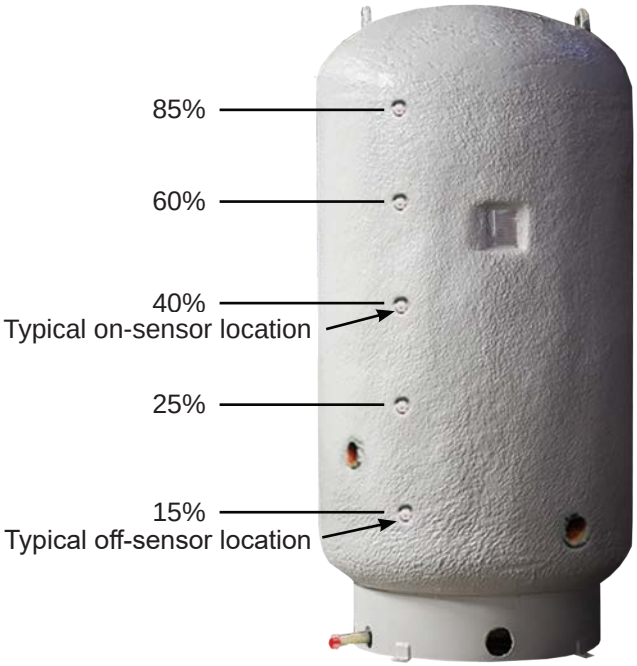
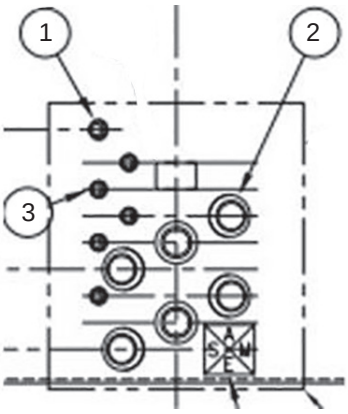


Figure 16. Approx Percentage

3.F.2 Swing Tanks



No.	Qty	Description
1	1	½” NPT (thermal well)
2	6	1-1/2” NPT electric elements (15 or 18 kW)
3	3	3/8” NPT probe

Figure 17. Swing Tank Identifier

Control Scenario 1: Single heat pump with 2 sensors or aquastats installed in the stratified tank(s).

- An electric step controller can be ordered with the swing tank to stage individual elements.
- Unused ports will be factory capped.

Control Scenario 2: Single or multiple heat pumps and Tank System Controller (TSC) with up to ten sensors.

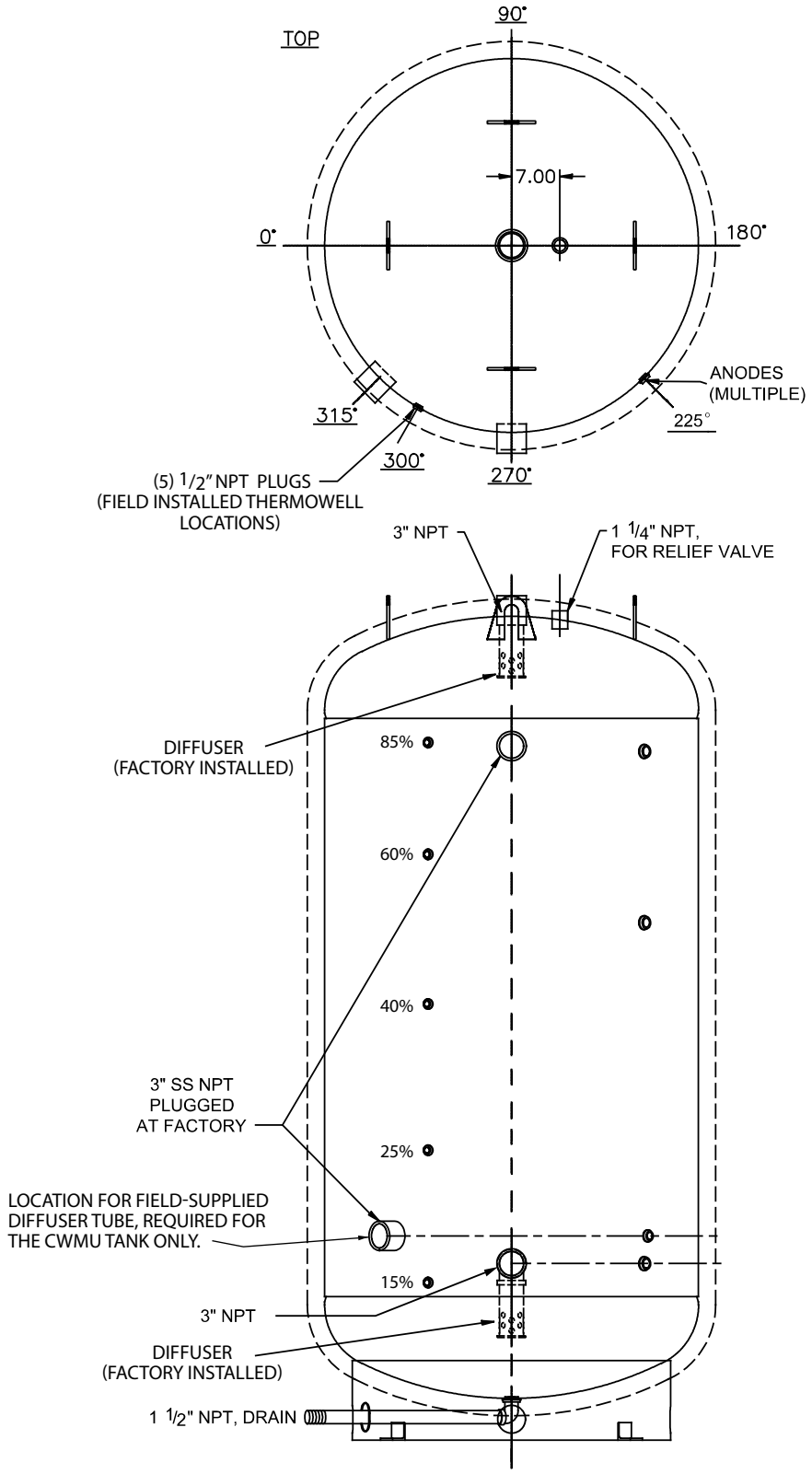
- Use the TSC in order to operate with CTA-2045 grid-enabled protocol.
- A standard TSC can control multiple heat pumps as well as a standard on/off swing tank. A sensor well and sensor, provided with the TSC, will need to be installed into location 1, noted in Figure 17. Further instructions can be found in the TSC I/O manual.
- For CTA-2045 systems, use of the TSC is required. The TSC will need to be ordered with CTA-2045 optional module pre-installed.
- Unused ports will be factory capped.

3.F.3 Temperature Maintenance Heating

Temperature maintenance heating is the process of maintaining the temperature of hot water that is circulating throughout the building, which allows instant access to hot water whenever an occupant needs it. If the hot water is not circulated, the pipes will cool during times of low usage and an occupant will have to wait until all the cold water is flushed out of the pipes before they have access to hot water. In large buildings, this would lead to significant and unacceptable wait times and waste water. The equipment that performs temperature maintenance heating will reheat slightly cooled circulation water back to the desired setpoint.

The temperature swing tank (sometimes called maintenance tank) is an additional tank with an independent heat source. The temperature maintenance tank is plumbed in series with the primary storage system. The tank’s temperature fluctuates between the hot storage water temperature (140°F to 180°F) and the hot water supply set-point (~120°F), as achieved by a down stream located 3-way potable water mixing valve.

3.F.4 Typical Stratified Tank



NOTE: Horizontal 3” diffuser tubes are available for the cold water makeup tank and for parallel tank systems, for their CWMA tanks only.

Figure 18. Stratified Tank

3.F.5 Pipe Sizing Guide

Single Heat Pump Systems:

1. Calculate the total equivalent length of pipe from the heat pump to the storage tanks, through the storage tanks and back to the heat pump. This is shown as the light grey and dotted lines.
2. Determine the highest anticipated flow rate. See Table 3 on page 18
   a. Determine the lowest Delta T (Lowest Anticipated Setpoint – Highest Anticipated Supply Water Temperature).
   b. Use this formula to calculate highest anticipated GPM:
      i. GPM = Heat Pump Max Output / (500 x Delta T)
   c. If using the internal circulator.
      i. Look at the available head chart and determine how much head capacity is available at the calculated GPM. See Figure 14 on page 19
      ii. Ensure that the total piping head loss, at the calculated GPM, is less than the available head.
   d. If using an external circulator.
      i. Use Table 3 to determine the heat pump pressure drop at the calculated GPM.
      ii. Calculate the total friction loss of the piping system.
      iii. Add the values from the previous two steps.
      iv. Use the circulator's curve to determine circulator can produce enough head at the calculated GPM.

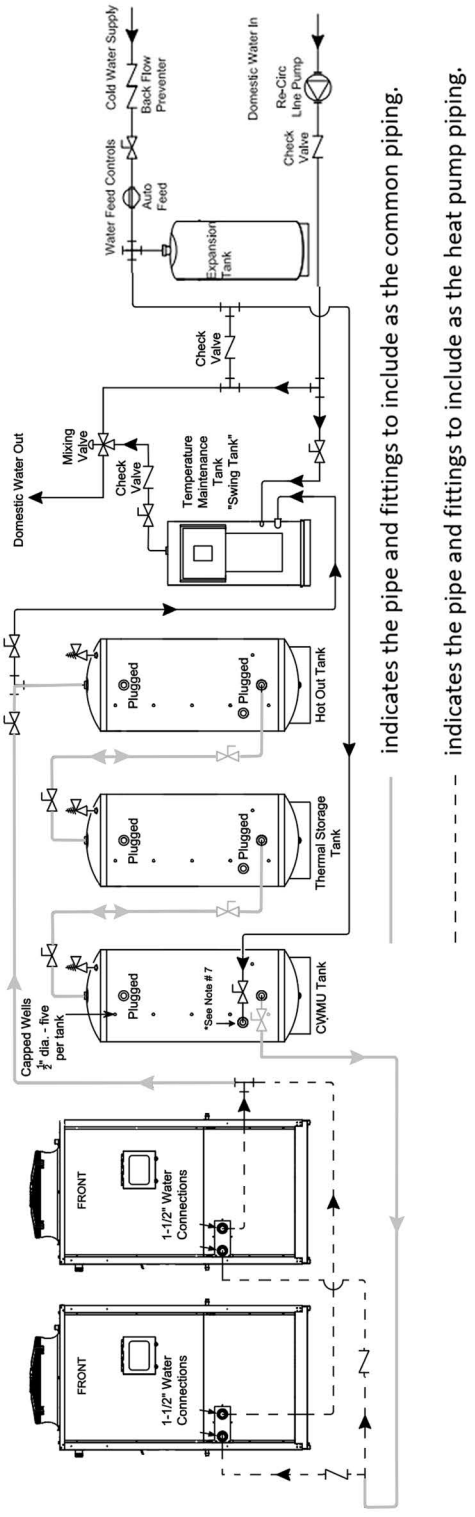


Figure 19. Pipe Sizing Guide

Multiple Heat Pump Systems:

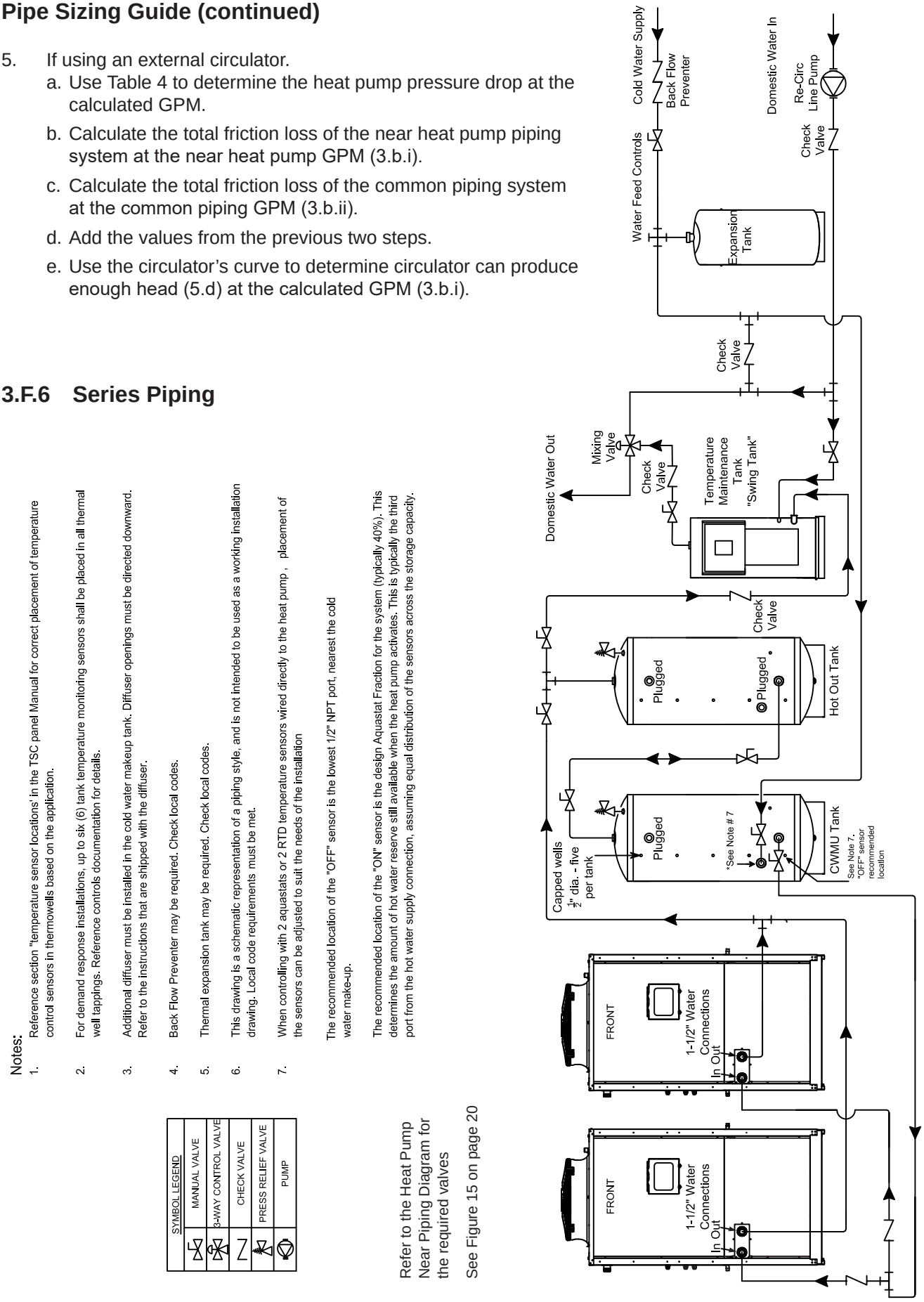
1. Calculate the total equivalent length of pipe to and from the heat pump and the common piping tees (This is shown as the dotted pipes in the above diagram and is referred to as the "near heat pump piping").
2. Calculate the total equivalent length of pipe to and from the common tees and through the storage tanks (This is shown as the light grey pipes in the above diagram and is referred to as the "common piping").
3. Determine the highest anticipated flow rate of the two piping systems.
   a. Determine the lowest Delta T (Lowest Anticipated Setpoint – Highest Anticipated Supply Water Temperature).
   b. Calculate the two anticipated GPM:
      i. Use this formula to calculate the near heat pump GPM :GPM = Heat Pump Max Output / (500 x Delta T). See Table 3 on page 18
      ii. Multiply the calculated GPM by the total number of heat pumps, this is the common piping GPM.
4. If using the internal circulator.
   a. Calculate the total head loss of the near heat pump piping at the near heat pump GPM (3.b.i).
   b. Calculate the total head loss of the common piping at the common piping GPM (3.b.ii).
   c. Look at the Available Head Chart and determine how much head capacity is available at the calculated near heat pump GPM (3.b.i). See Figure 14 on page 19
   d. Ensure the total of the two head losses do not exceed the available head.

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Pipe Sizing Guide (continued)

5. If using an external circulator.
   a. Use Table 4 to determine the heat pump pressure drop at the calculated GPM.
   b. Calculate the total friction loss of the near heat pump piping system at the near heat pump GPM (3.b.i).
   c. Calculate the total friction loss of the common piping system at the common piping GPM (3.b.ii).
   d. Add the values from the previous two steps.
   e. Use the circulator's curve to determine circulator can produce enough head (5.d) at the calculated GPM (3.b.i).

3.F.6 Series Piping



Notes:

1. Reference section "temperature sensor locations' in the TSC panel Manual for correct placement of temperature control sensors in thermowells based on the application.
2. For demand response installations, up to six (6) tank temperature monitoring sensors shall be placed in all thermal well tappings. Reference controls documentation for details.
3. Additional diffuser must be installed in the cold water makeup tank. Diffuser openings must be directed downward. Refer to the instructions that are shipped with the diffuser.
4. Back Flow Preventer may be required. Check local codes.
5. Thermal expansion tank may be required. Check local codes.
6. This drawing is a schematic representation of a piping style, and is not intended to be used as a working installation drawing. Local code requirements must be met.
7. When controlling with 2 aquastats or 2 RTD temperature sensors wired directly to the heat pump , placement of the sensors can be adjusted to suit the needs of the installation

   The recommended location of the "ON" sensor is the design Aquastat Fraction for the system (typically 40%). This determines the amount of hot water reserve still available when the heat pump activates. This is typically the third port from the hot water supply connection, assuming equal distribution of the sensors across the storage capacity.

   The recommended location of the "OFF" sensor is the lowest 1/2" NPT port, nearest the cold water make-up.

Figure 20. Series piping two HPWH and two tanks

Series Piping (continued)

Notes:

1. Reference section "temperature sensor locations' in the TSC panel Manual for correct placement of temperature control sensors in thermowells based on the application.
2. For demand response installations, up to six (6) tank temperature monitoring sensors shall be placed in all thermal well tappings. Reference controls documentation for details.
3. Additional diffuser must be installed in the cold water makeup tank. Diffuser openings must be directed downward. Refer to the instructions that are shipped with the diffuser.
4. Back Flow Preventer may be required. Check local codes.
5. Thermal expansion tank may be required. Check local codes.
6. This drawing is a schematic representation of a piping style, and is not intended to be used as a working installation drawing. Local code requirements must be met.
7. When controlling with 2 aquastats or 2 RTD temperature sensors wired directly to the heat pump , placement of the sensors can be adjusted to suit the needs of the installation

   The recommended location of the "OFF" sensor is the lowest 1/2" NPT port, nearest the cold water make-up.

   The recommended location of the "ON" sensor is the design Aquastat Fraction for the system (typically 40%). This determines the amount of hot water reserve still available when the heat pump activates. This is typically the third port from the hot water supply connection, assuming equal distribution of the sensors across the storage capacity.

SYMBOL LEGEND	
	MANUAL VALVE
	3-WAY CONTROL VALVE
	CHECK VALVE
	PRESS RELIEF VALVE
	PUMP

Refer to the Heat Pump
Near Piping Diagram for
the required valves
See Figure 15 on page 20

Figure 21. Series piping two HPWH and three tanks

Series Piping (continued)

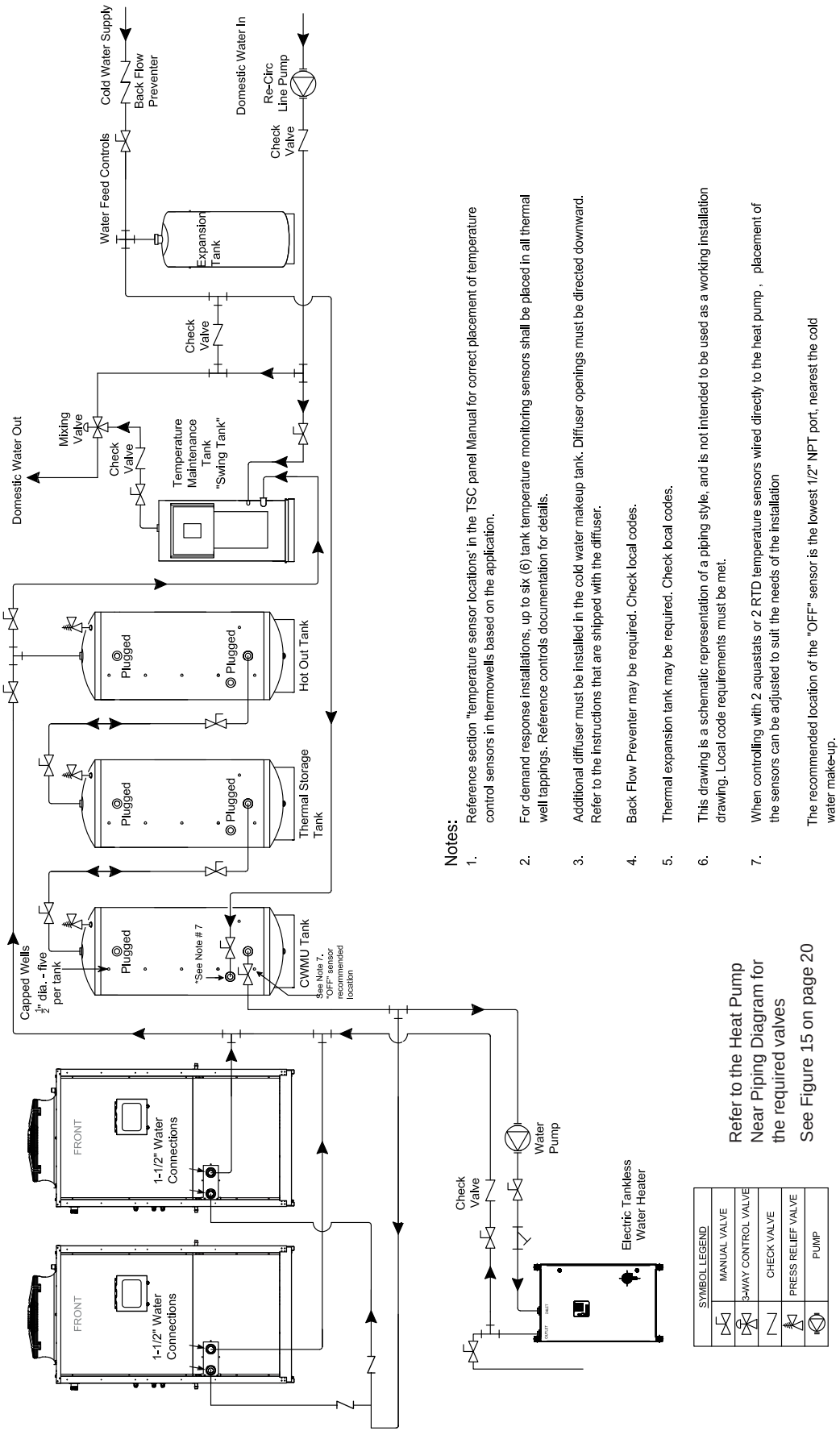


Figure 22. Series piping two HPWH, three tanks, and a tankless electric water heater

3.G Freeze Protection

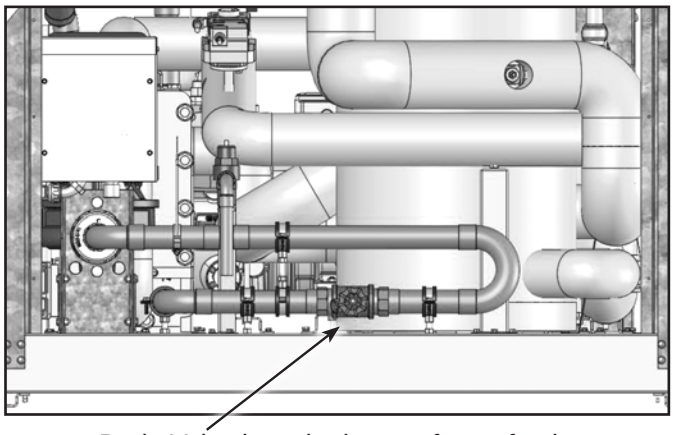


Figure 23. Location of Water Drain Valve

The HPWH may be installed indoors or outdoors. If installing outdoors in a location that may experience freezing temperatures, precautions must be taken to prevent water in the heat exchanger, pump and water lines from freezing. Damage due to freezing water is not covered by the warranty.

If power is not available to the unit during cold weather, water should be drained from the unit and the lines blown out with compressed air.

The #6 valves in Figure 15 on page 20 can be used in conjunction with the #4 valves to isolate the HPWH and flush compressed air or anti-freeze through the unit. If using anti-freeze ensure it is non-toxic and that it is completely flushed from the unit before returning the unit to service.

3.G.1 Factory Installed Freeze Protection

Each HPWH includes heat trace and insulating blanket on the internal heat exchanger, pump, water lines, and condensate drain pan. The heat trace will automatically activate when the temperature within the enclosure falls below 35°F. The heat trace will protect the water lines from freezing down to -15°F.

3.G.2 Field Installed Freeze Protection

Provisions must be made to ensure that none of the external piping can freeze. This is commonly done with insulated electric heat trace which should be connected to an emergency power back-up system that is activated during a power outage.

3.G.3 Heat Trace Emergency Power Connection

Connect power from the building's emergency back-up power system to the designated 120V input terminals **TB2**-26A through 29A. Refer to Figure 24 for connecting the emergency back-up power to the HPWH. See Figure 25 on page 29 to locate TB2.

In case of a power outage in the building, the emergency back-up power supply will now power up the factory installed heat trace within the heat pump to avoid accidental freeze-up during inclement weather. Only the heat trace system is now powered up, thus the heat pump itself will not operate. Total Amp draw of all heat tracing, insulating blanket and the compressor oil heater is less than 5 Amp at 120 V. This information can be used to size up a battery back-up system.

Even with the emergency power input, the contractor is responsible for ensuring that external water and evaporator drain lines are freeze protected.

The field installed heat trace for the external piping must be connected to the building's emergency power system separately in a manner such that the external piping and heat pump will be protected from accidental freeze-up.

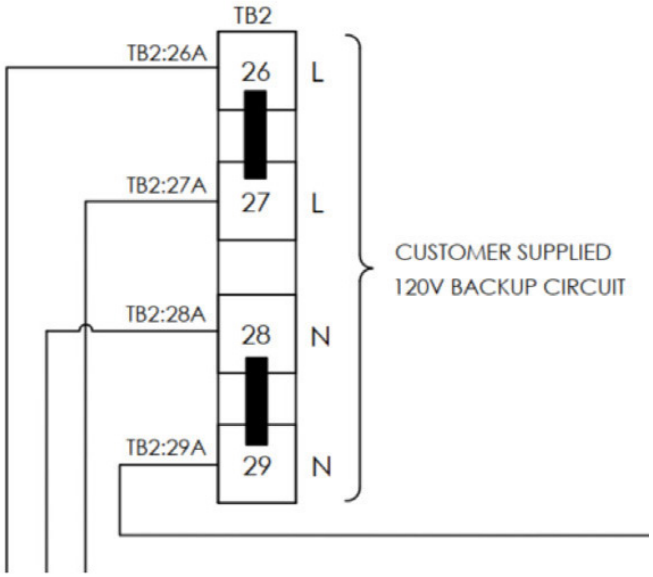


Figure 24. Heat Trace Emergency Power Terminal Block Positions

⚠ CAUTION

If the ambient temperature could go below -20°F for an extended period during a power outage, then the water must be drained from the unit and the lines blown out with compressed air to prevent freezing water. A drain valve with garden hose connection is included on the internal water piping.

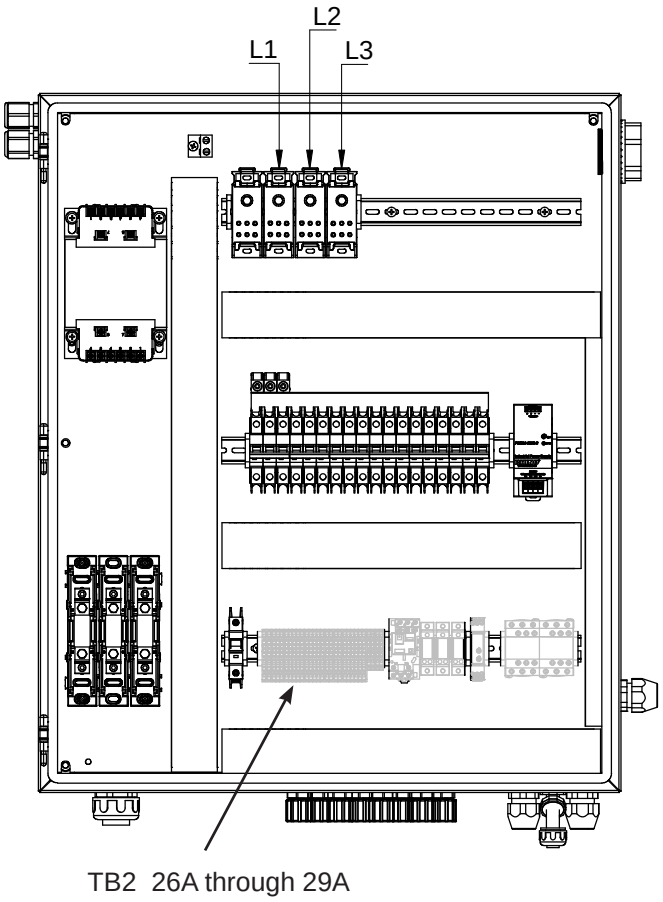


Figure 25. TB2 in the High Voltage Panel

SECTION 4 Evaporator Drip Tray

Each evaporator is equipped with a drip tray to collect water removed from the ambient air. The drip trays will also collect rain water entering through the top mounted fans.

Heat trace lines within the drip trays are installed at the time of manufacture. See Section 3.G on page 28. The heat trace will be automatically activated when the local ambient temperature falls below 35°F.

⚠ CAUTION

In locations that can experience freezing temperatures the drain lines must be suitably insulated and heat traced.

Each drip tray has two 3/4" Male NPT drain fittings as show in the Figure 25 on page 29. The condensate rate may be as high as 60 GPH depending on local conditions. Proper drain sizing should be a function of a local engineer working with job specific requirements. Drain piping must be added, sized and sloped properly to lead the condensate away from the unit, whenever the unit is installed indoors.

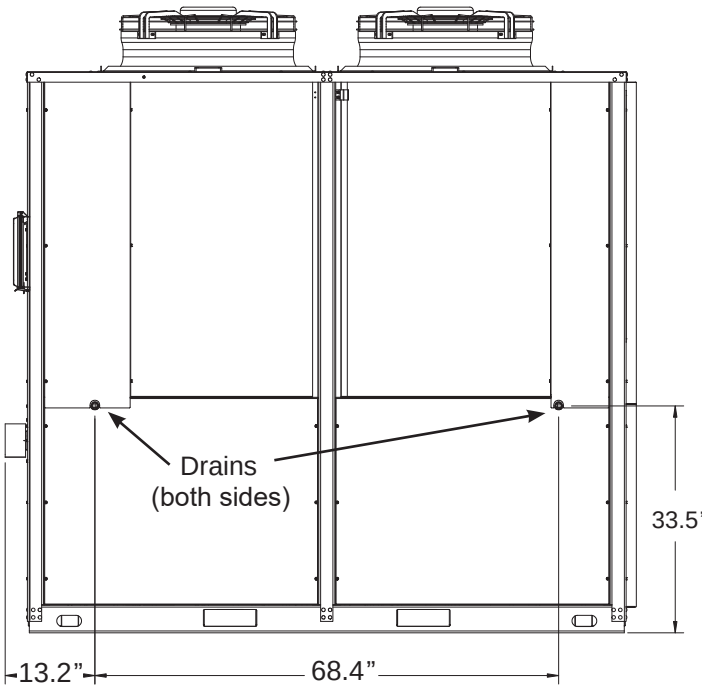


Figure 26. Drains

SECTION 5 Electrical Connections

5.A Electrical Warnings

⚠ WARNING

Electrical Shock Hazard

Electrical shock can cause severe injury, death or property damage. Disconnect the power supply before beginning installation or changing the wiring to prevent electrical shock or damage to the equipment. It may be necessary to turn off more than one power supply to disconnect.

All electrical wiring is to be done in accordance with local codes, or in the absence of local codes, with: 1) The National Electrical Code ANSI/NFPA No. 70 - latest Edition, or 2) CSA STD. C22.1 “Canadian Electrical Code - Part 1.” This appliance must be electrically grounded in accordance with these codes.

⚠ WARNING

A means for main unit disconnection must be incorporated in the fixed supply power wiring in accordance with national and local codes. External main disconnect or main circuit breaker is provided by the installing contractor.

⚠ CAUTION

The supply voltage to this unit must not be disconnected, except for service, or unless otherwise instructed by procedures outlined in this manual.

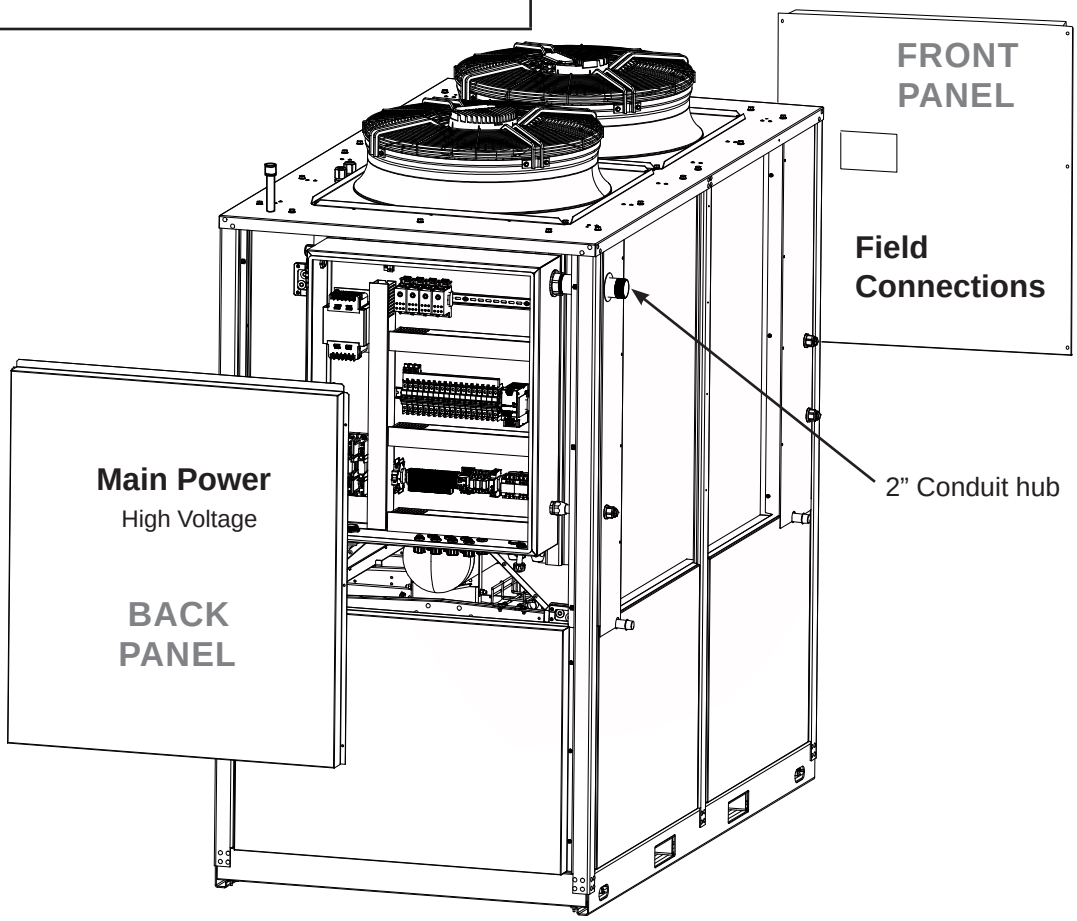


Figure 27. Main Power and Field Connections

5.B Main Power Connections

Main power wiring is terminated in the high voltage enclosure, which is located in the back of the unit. To access the high voltage enclosure, remove back panel (as shown in Figure 27). The panel is secured with six #10 hex screws.

5.B.1 Electrical Requirements

Voltage	Frequency	Phase	FLA	MCA	MOP	SCCR
480VAC	60Hz	3	55	70	110	10kA

Table 4. Main Power Ratings

5.B.2 Grounding Instructions

⚠ WARNING

Failure to ground this water heater properly may cause erratic control system operation, and/or personal injury or death.

This heat pump water heater must be grounded in accordance with the National Electric Code and/or local codes having jurisdiction. The Distribution Block is located in the main power panel. See Figure 28.

5.B.3 High Voltage

Route the main power wiring through the 2" conduit hub. Connect the main power L1, L2, L3, to the distribution blocks located at the top of the enclosure. See grounding instructions in Section 7.A.2 on page 63. Proper phase connection can be verified by referring to Section 7.

5.B.4 Fuses

For 480 volt models if replacement of fuses is necessary use only Class T fast acting 70 amp fuses.

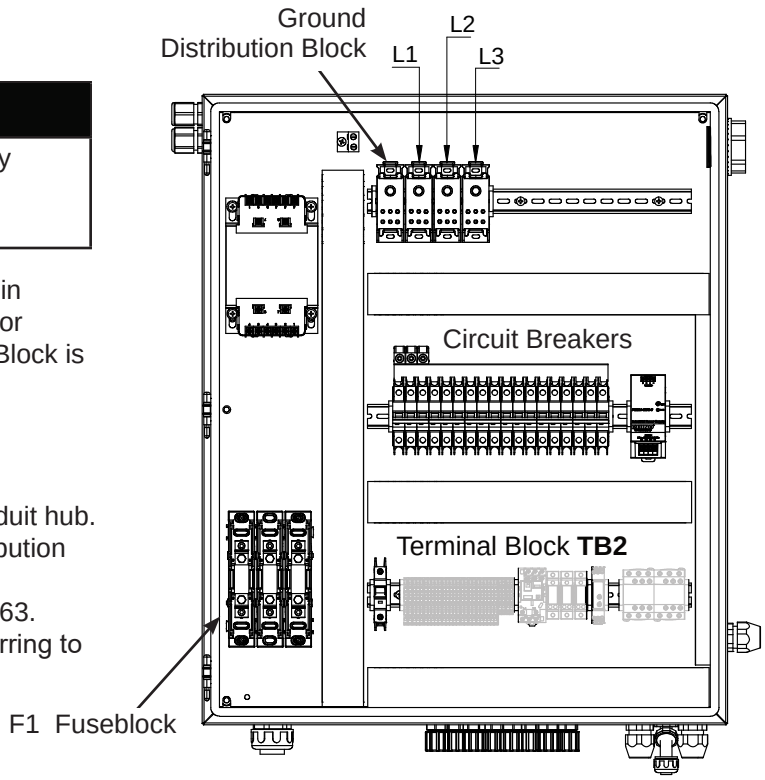


Figure 28. The High Voltage Enclosure

5.C Field Connections

Field Connections are located at the FRONT of the unit. To access the field connections remove front panel (as shown in Figure 28). The panel is secured with six #10 hex screws.

5.C.1 Heat Demand Source

Dry Contacts (aquastat)

The HPWH can receive its ON and OFF heat demand from a set of "break on rise" dry contacts, i.e. aquastats. These are to be wired in the field and they are 24VDC signals. The temperature settings are field adjustable.

Connect the ON aquastat between TB1-8 and any free terminal between TB1 (93 to 100).

Connect the OFF aquastat between TB1-9 and any free terminal between TB1 (93 to 100).

Adjust the aquastat by removing the cover and adjusting the dial to the desired temperatures. See below for recommended settings. See Figure 29 on page 32

RTD

Alternatively, a heat demand may be based on a temperature input. The temperature sensors must be a 3 wire PT1000 type RTD (supplied with the HPWH). All wires will be landed on terminal block TB3. The ON heat demand sensor (RTD1) will have its two common (Red) wires, landed on positions 1 and 2 of TB3, while the third (White) wire will land on position 3 of TB3. The OFF heat demand sensor (RTD2) will have its two common (Red) wires, landed on positions 4 and 5 of TB3, while the third (White) wire will land on position 6 of TB3.
See Figure 29 on page 32

When using either aquastats or RTD's it is recommended to set the ON setting to be at least 5 degrees less than the set point of the heat pump. It is also recommended to set the OFF setting to 125°F in order to prevent high inlet temperature faults at the HPWH. See Section 3.F.1 on page 21 for recommended aquastat/ RTD sensor placement in the tanks.

5.C.2 External Fan connections

Dry Contacts (Inlet and Outlet Fans)

The HPWH is provided with Dry contacts to enable Inlet and/or Exhaust fans. All wires will be landed on terminal Block TB1. The dry contacts are rated up to 30VAC/VDC and 2A maximum. The Inlet fan connections will land across positions labeled 121 and 122 of terminal block TB1, while the Exhaust fan connections will land across positions labeled 123 and 124 of TB1. See Figure 29

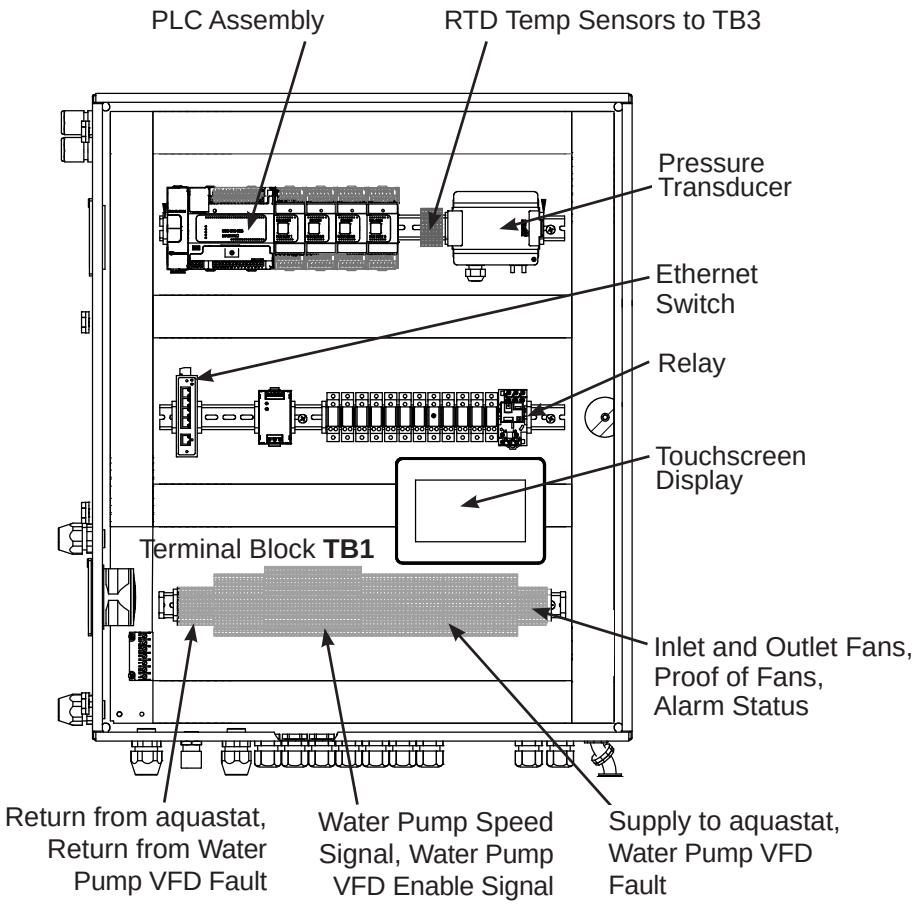


Figure 29. Field Connections Enclosure

Proof of Fans

A proof of fans input is optionally available, suppling 24VDC through a set (or sets) of dry contacts to the terminal block (TB1). If both inlet and exhaust dry contacts are used, remove and discard the factory installed jumper wire across TB1 positions 125 and 128. The dry contacts of the inlet fan will land across positions labeled 125 and 126 of terminal block TB1. The dry contacts of the exhaust fan will land across positions labeled 127 and 128 of TB1. If only one dry contact is used, the jumper needs to remain on the unused contacts. See Figure 29

5.C.3 Alarm Dry Contacts

A set of dry contacts is available for **Alarm Status**. The dry contacts are rated up to 30VAC/VDC and 2A maximum. The contacts will open on any alarm (or when power is not applied to the HPWH), with the terminal block (TB1). Wires will need to be landed across positions labeled 129 and 130 of TB1. See Figure 29

5.C.4 External Water Pump Option

Water Pump Speed Signal (0 to 10VDC)

When an external water pump is used, a 0 to 10VDC speed signal is provided. The speed signal is modulated by the HPWH's internal PLC logic, to control the outlet water temperature to the setpoint. The common (0V) reference wire must be connected to position 58 of terminal block TB1, while the voltage speed input wire (0 to 10V) must be connected to position 59 of TB1. See Figure 29

Water Pump VFD Enable Signal (Dry Contact)

A set of dry contacts is provided for the external pump VFD's enable input. The contacts will land across positions 74 and 75 of terminal block TB1. See Figure 29

Water Pump VFD Fault (Dry Contact)

An input is available to connect the external pump VFD's fault contacts. 24VDC will be fed from the HPWH and through the dry contacts. When the contacts open, the HPWH's PLC will interpret this as a VFD fault condition. 24VDC should be delivered to the contacts from any available terminal block position labeled between 93 and 100 located on TB1. The return from the contacts should be landed on position 7 of TB1. See Figure 29

SECTION 6 Control Operation

The HPWH is equipped with a proprietary control system that allows for automatic operation including evaporator defrost. A touch screen display is included to allow for monitoring of key process variables, adjustment of set-points and trouble shooting. The following sections will describe system operation and the menus available for user interface.

Prior to starting the unit for the first time, please refer to SECTION 7 on page 63 for initial startup procedures. It is recommended that initial startup and commissioning be performed by a factory trained technician to ensure that the system will operate at peak efficiencies for the given configuration. Once these procedures are completed, normal operation and shutdown of the unit will be initiated based on a call for heat. This call for heat can be from the closing of dry contacts of a tank mounted aquastat or a temperature sensor input, or TSC. See SECTION 5 for wiring details.

While a call for heat is present the heat pump will vary compressor discharge pressure and water flow rate to achieve the desired temperature. The heat pump default water temperature setting is 130°F but can be adjusted on the home screen while logged in as user or installer.

The Home Menu

The Home Menu shows the state of the HPWH including the compressor pressures, gas cooler water inlet and outlet temperatures.

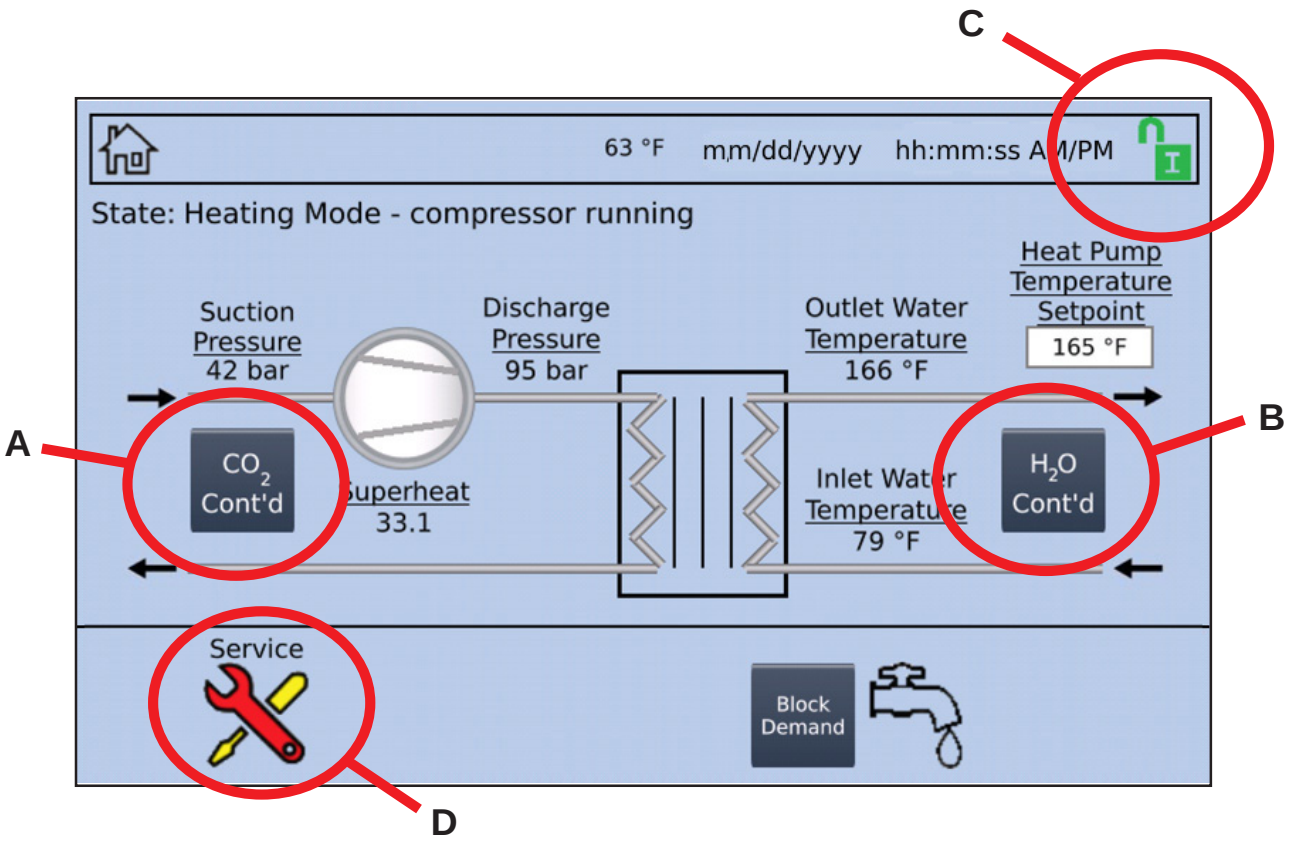
From the Home Menu, you can navigate to the following four (4) primary menus:

A. CO_2 - P & ID menu

B. H20 - P & ID menu

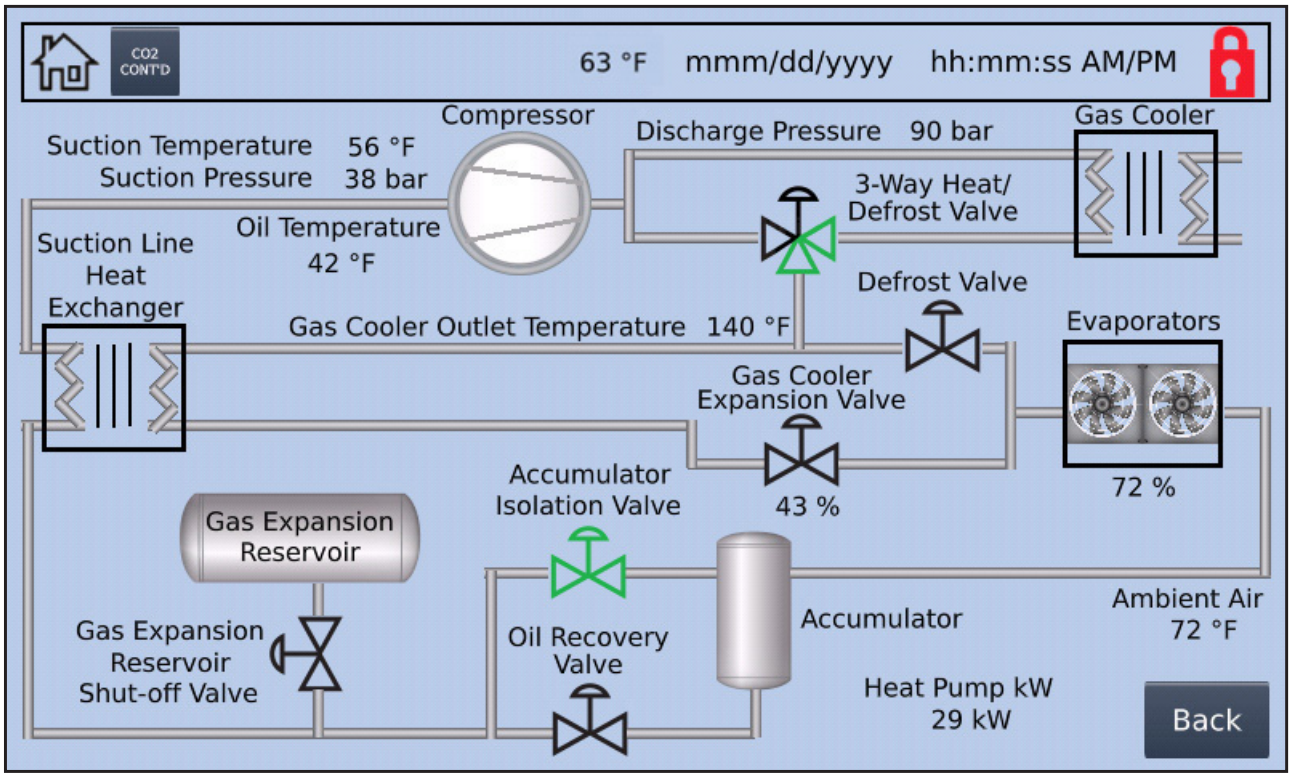
C. Security

D. Service menu



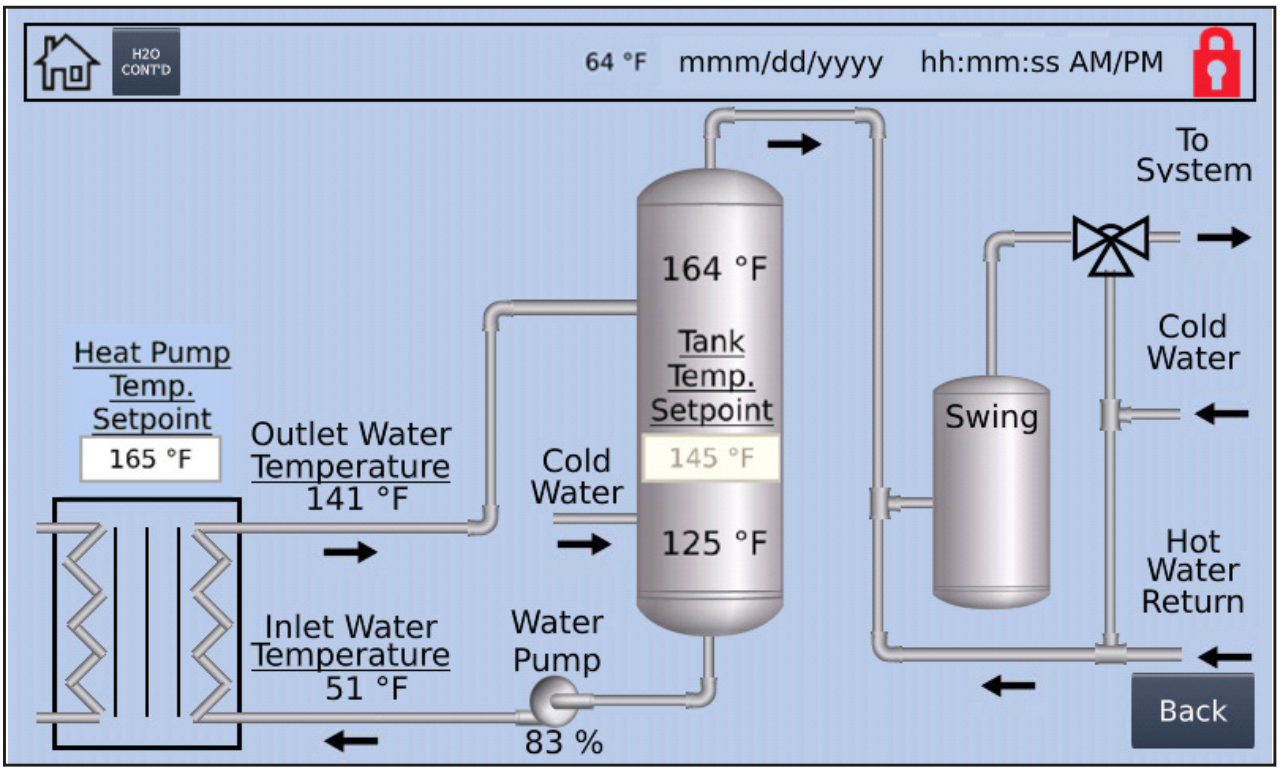
CO2 P & ID CONT'D

6.A CO2 Process and Instrumentation Diagram (P & ID) Menu



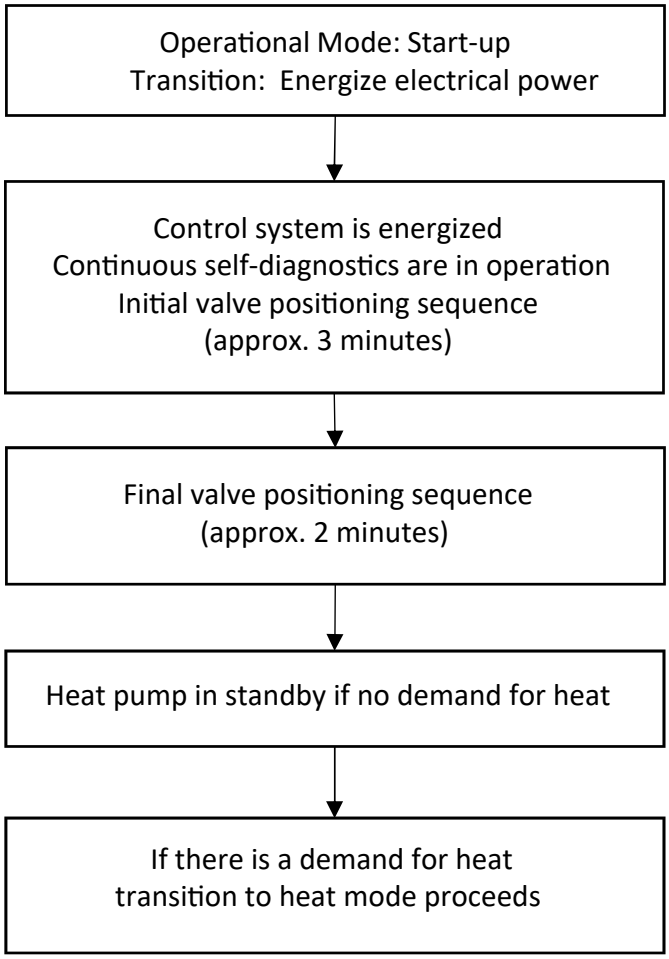
WATER P & ID CONT'D

6.B Water Process and Instrumentation Diagram (P & ID) Menu



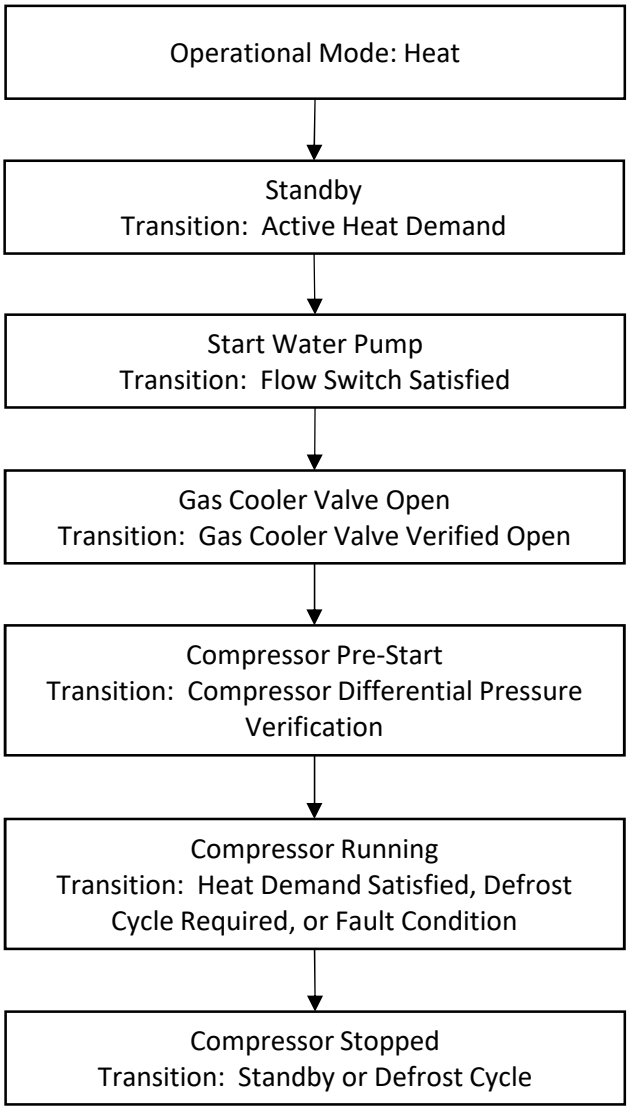
6.B.1 Auto Mode: Start Up

The Startup Mode states are identified in the figure below.



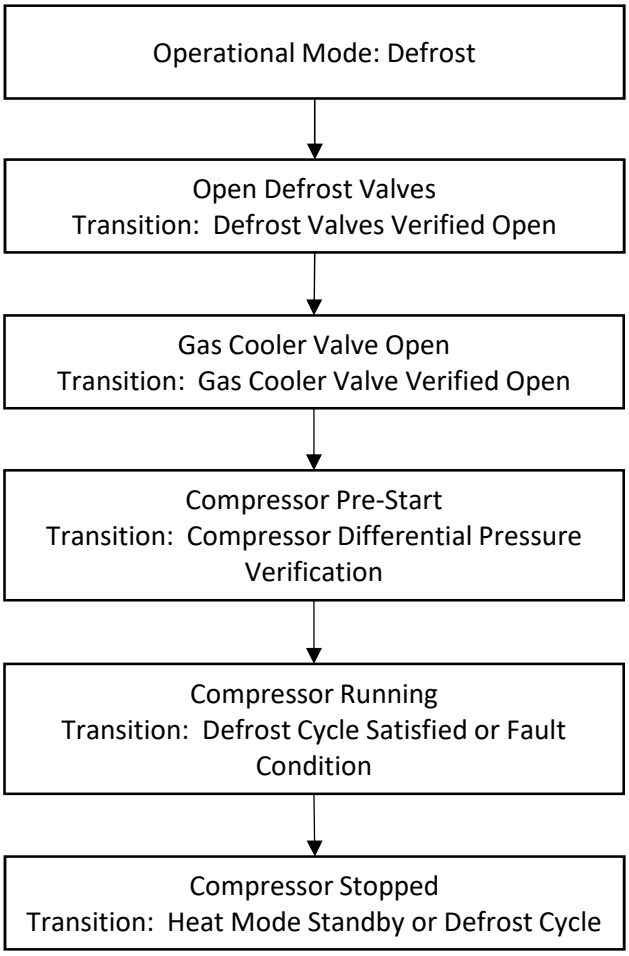
6.B.2 Auto Mode: Heating

The heating cycle states are identified in the figure below.



6.B.3 Auto Mode: Defrost

Under certain atmospheric and the HPWH's run conditions, ice may form on the evaporator coils which if uncontrolled will lead to sub-par performance or system shutdown. The control system is designed to enter a defrost cycle when these conditions exist. The defrost cycle allows hot refrigerant to enter the evaporators thereby melting ice formed on the coils. The defrost cycle states are identified in the figure below:

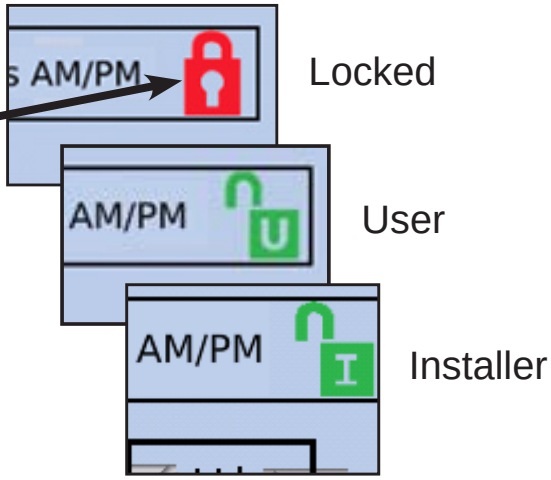


6.B.4 Default Values

	User	Installer	Minimum	Maximum	Setpoints prior to factory reset
Time & Date					
Hour	w	w	NA	NA	NA
Minute	w	w	NA	NA	NA
Month	w	w	NA	NA	NA
Day	w	w	NA	NA	NA
Year	w	w	NA	NA	NA
IP Address					
CPU IP Address	r	w	0.0.0.0	255.255.255.255	192.168.100.101
CPU Subnet Mask	r	w	0.0.0.0	255.255.255.255	255.255.255.0
CPU Default Gateway	r	w	0.0.0.0	255.255.255.255	0.0.0.0
Panel IP Address	r	w	0.0.0.0	255.255.255.255	192.168.100.201
Panel Subnet Mask	r	w	0.0.0.0	255.255.255.255	255.255.255.0
Panel Default Gateway	r	w	0.0.0.0	255.255.255.255	0.0.0.0
Compressor					
Low Compressor Speed (%)	x	r	NA	NA	70 @ 300 F
Normal compressor speed (%)	x	r	NA	NA	85 @ 280 F
High Compressor speed (%)	x	r	NA	NA	100
Injection time (sec)	x	r	NA	NA	0:46
Pause Time (sec)	x	r	NA	NA	0:10
Defrost					
Saturation Temp Defrost SP (°F)	x	w	-5	15	5
Start Defrost Delay Time (minutes)	x	r	NA	NA	5
Defrost Differential Pressure SP ("WC)	x	w	0	2	0.3
Saturation Temperature Defrost Complete SP (°F)	x	w	30	50	32
Minimum Defrost Time (minutes)	x	r	NA	NA	5
Gas Cooler Defrost SP (barg)	x	r	NA	NA	60
Evaporator Fans					
Fan Minimum Pressure (barg)	x	r	NA	NA	35
Fan Maximum Pressure (barg)	x	r	NA	NA	60
Manual Fan Speed (%)	x	r	NA	NA	60
Evap Diff Press					
Evap DP Clogged Pressure Threshold ("WC)	x	w	0	2	0.4
Evap DP Clogged Ambient Temp Threshold (°F)	x	w	40	100	60
Low ambient temperature recent defrost timeout	x	w	00:00	59:59	05:00
Gas Cooler Valve					
Low Ambient temp (°F)	x	r	NA	NA	40
Discharge Pressure (barg)	x	r	NA	NA	94
Kp (.1%)	x	r	NA	NA	6000
Ki (1s)	x	r	NA	NA	50
Kd (1s)	x	r	NA	NA	0
Gas cooler Valve output High Limit (%)	x	r	NA	NA	98
Manual Low Limit Value (%)	x	r	NA	NA	15
Heat Demand Source					
Not Commissioned/ Commissioned	x	w	Not Commissioned	Commissioned	Not Commisioned
Tank Wired Directly To The Heat Pump	x	w	-	-	checked
ON/OFF Aquastats (Tank wired directly to Heat Pump must be selected)	x	w	-	-	checked
ON/OFF sensors (Tank wired directly to Heat Pump must be selected)	x	w	-	-	unchecked
Tank System Controller	x	w	-	-	unchecked
Manual	x	w	-	-	unchecked
Heat Demand Duration (Manual must be selected)	x	w	00:00	59:59	05:00
Heat Pump Temperature Setpoint	x	w	130	180	NA
Tank Temperature Setpoint (Tank wired directly to Heat Pump must and ON/OFF sensors must be selected)	x	w	120	175	125
Water Pump					
Water Temperature Set Point (°F)*	w	w	130	180	130
Kp (.1%)	x	r	NA	NA	500
Ki (1s)	x	r	NA	NA	50
Kd (1s)	x	r	NA	NA	0
Start (%)	x	w	0.00%	100.00%	50.00%
Stop (%)	x	w	0.00%	100.00%	5.00%
Step (%)	x	w	0.00%	100.00%	1.00%
Margin (%)	x	w	0.00%	100.00%	7.00%
More> Other Settings					
Heat Pump Elevation (feet)	x	w	0	9999	0
Startup Low Suction Pressure Threshold (barg)	x	r	NA	NA	15

w= read/write access, r= read only, x= not available

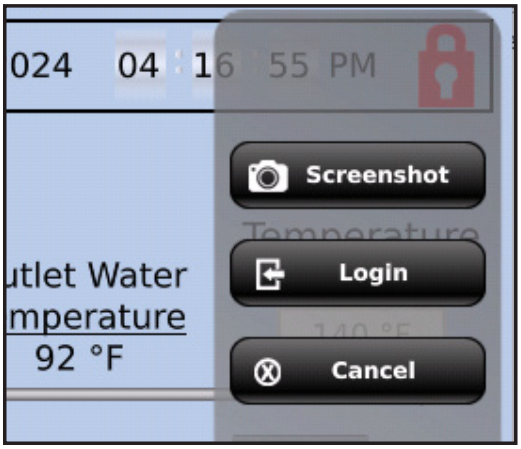
6.C Security



The Security Icon is on all screens. It displays the current security level of the control system.

- A closed red padlock indicates a logged-out state and full protection.
- An open green padlock (noted with a U) indicates a user level of protection, granting minimal modifications.
- An open green padlock (noted with an I) indicates that the Installer Level password has been entered.

To change the security level, press and hold the padlock symbol for approximately 3 seconds. Then press the Login button, when it appears.



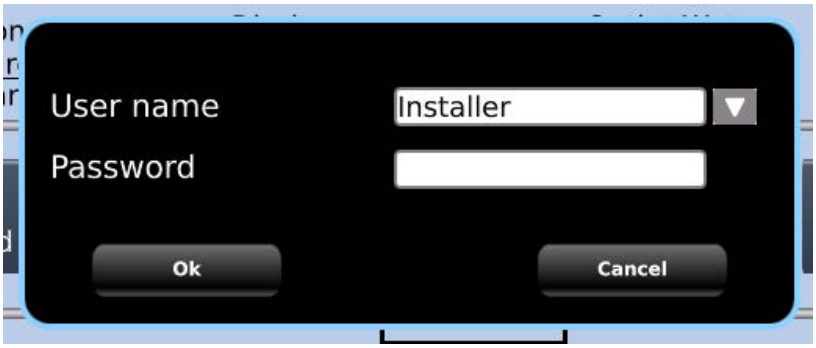
NOTE: Installer Level access is for factory authorized and trained personnel, and allows for configuration and parameter changes to be made at initial setup and commissioning.

Press the drop-down symbol to show the User name (security level) options.



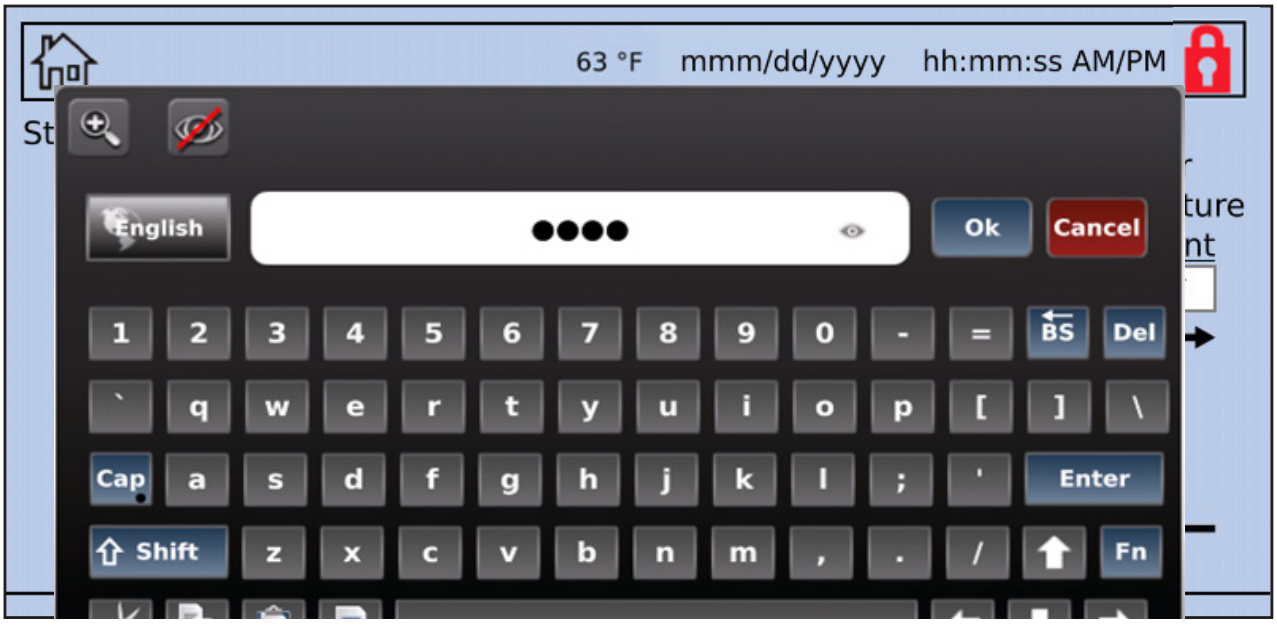
Several options are given, but only access to the User and Installer levels are detailed in the following.





For authorized personnel only, the Installer level can be selected.

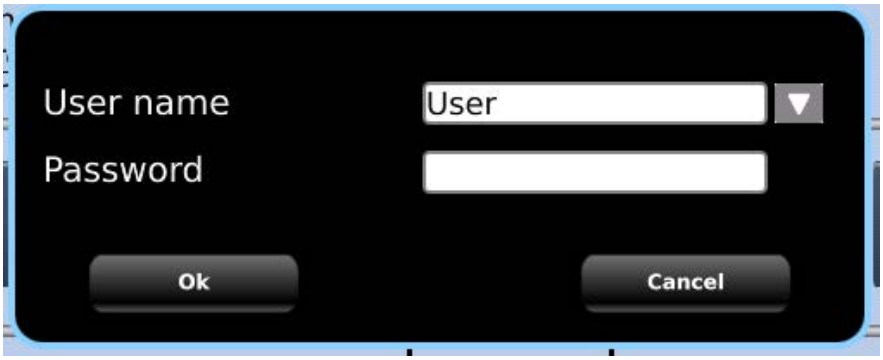
Enter the password “inst” and select Ok.



The green unlocked icon should now show with the letter I in the upper right portion of the screen.

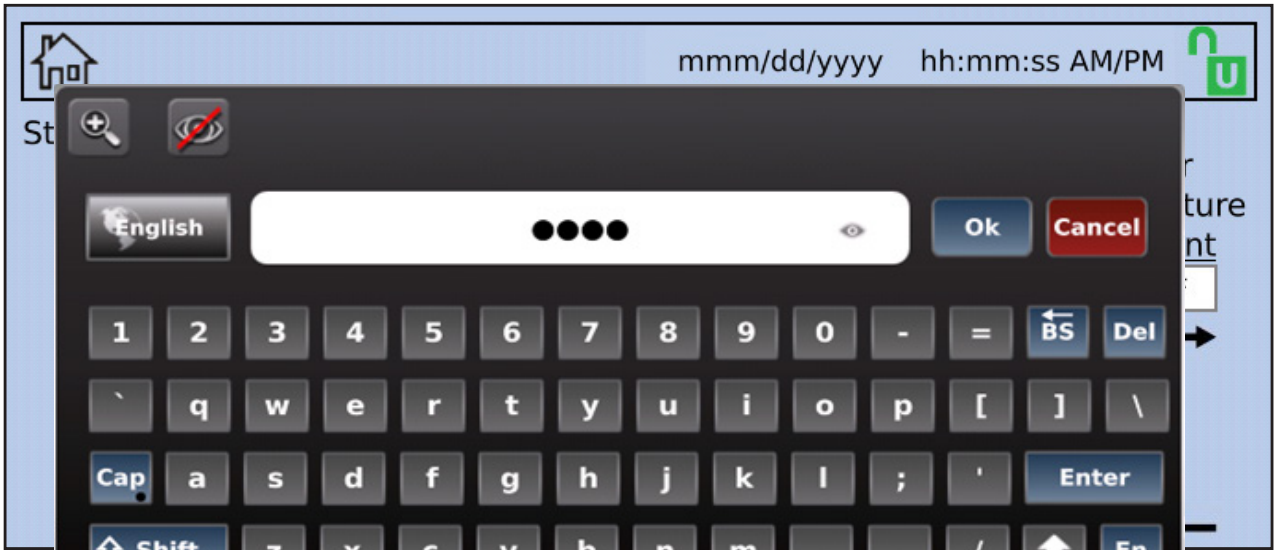


The User security level can be accessed in the same way, by selecting User in the drop-down.

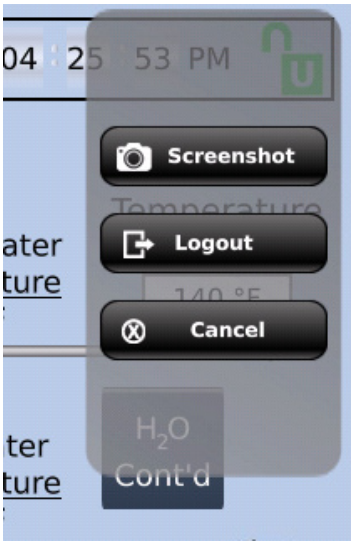


Enter the password “user” and select Ok.

The green unlocked icon should now show with the letter U in the upper right portion of the screen.

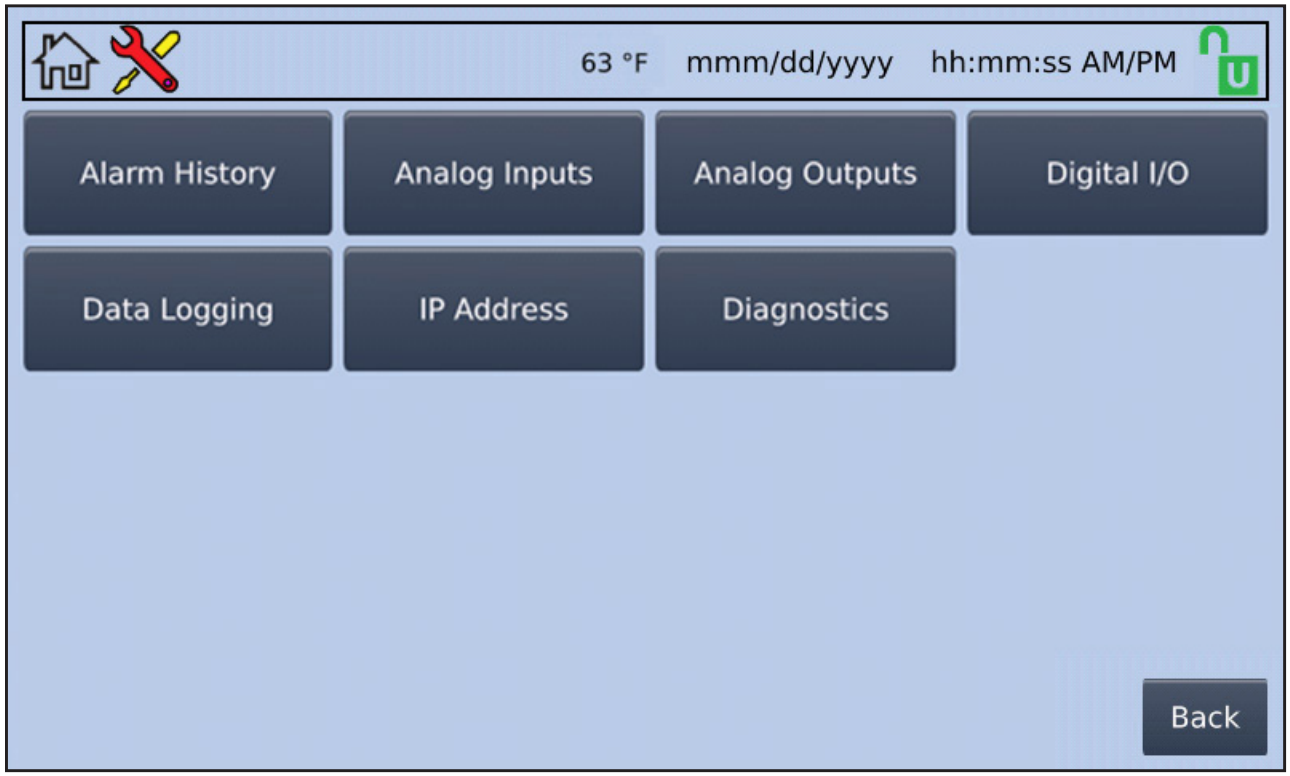


To ‘Logout’, press and hold the padlock for approximately three seconds and then select ‘Logout’ from the menu. Note that the display will lock itself automatically after one hour.



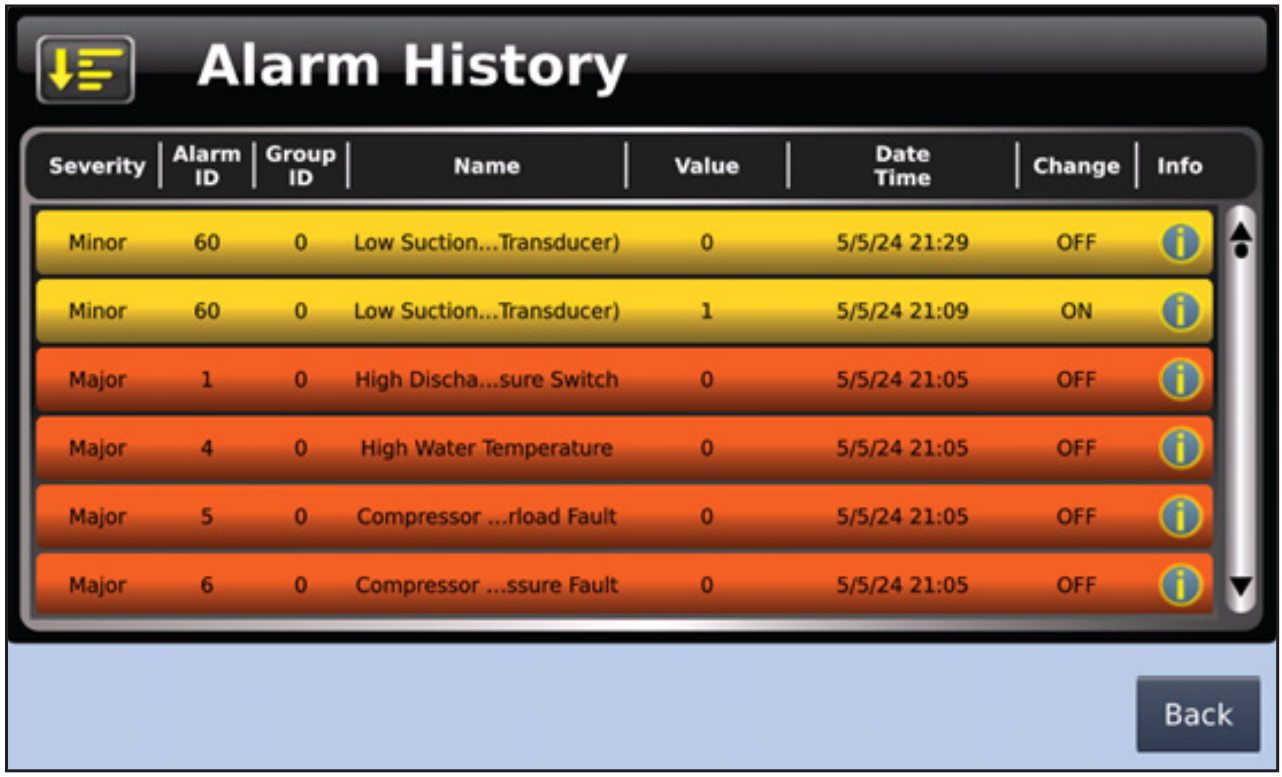
6.D Service Menu (User Security Level)

The Service Menu, while in the user security level, shows these service functionalities.



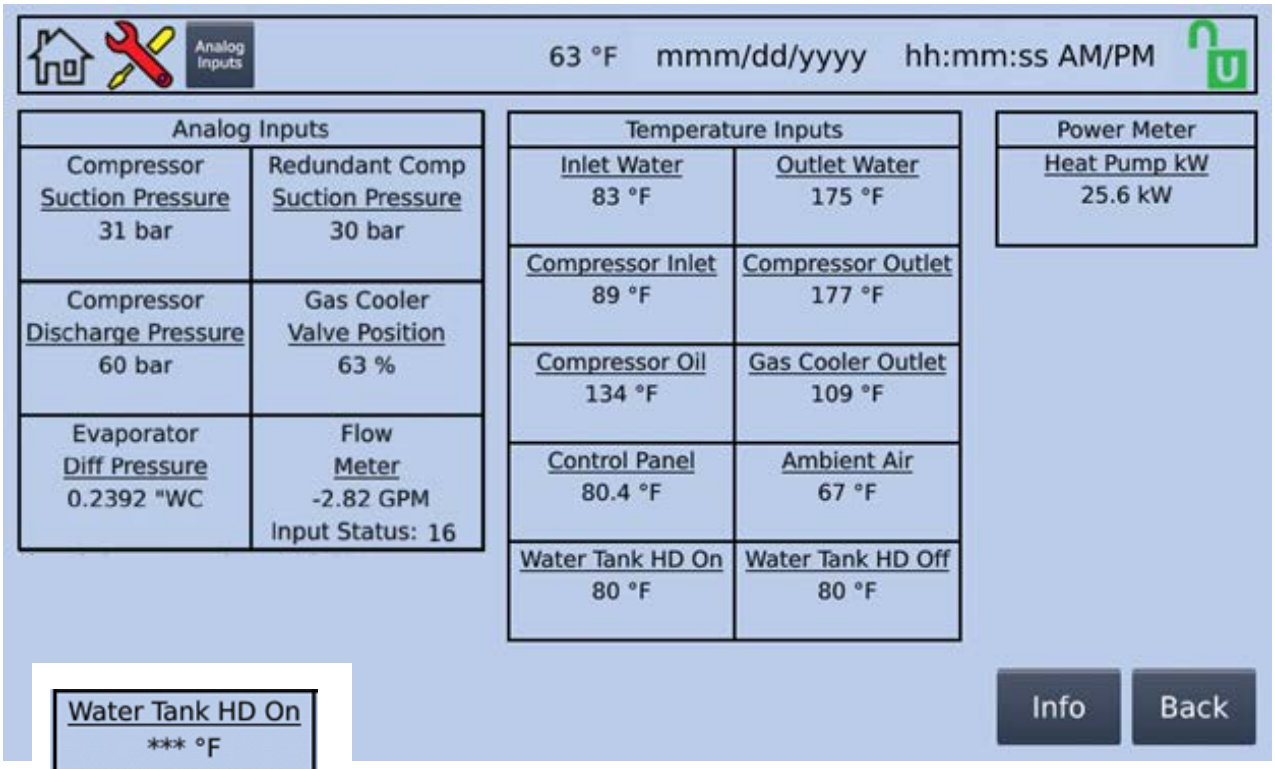
6.D.1 Alarm History

The Alarm Screen displays the Alarm History. Pressing the info (i) button will give a more detailed description of the alarm or fault condition. See Section SECTION 9 on page 67 for full list of alarms.

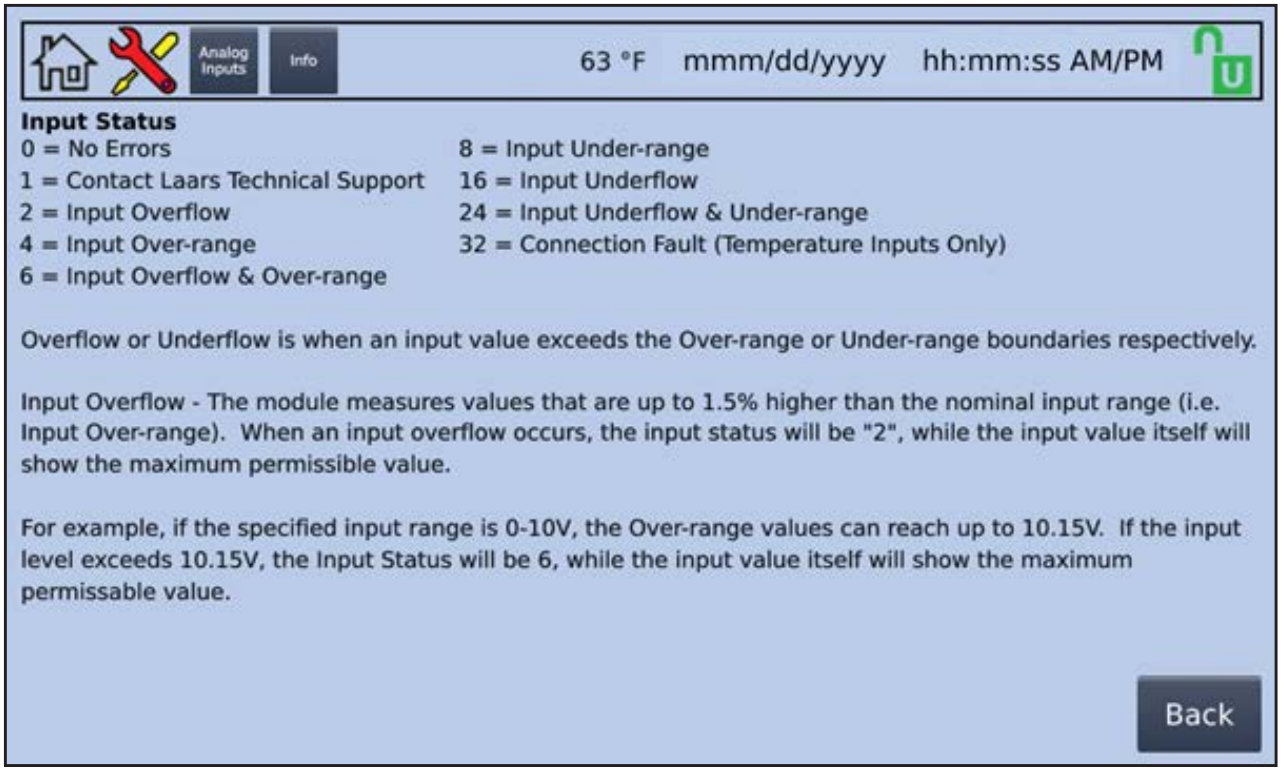


6.D.2 Analog Inputs

The Analog Input Menu shows the status of the various analog inputs to the heat pump, the temperature inputs, and the heat pump instantaneous power draw (when installed with the power meter option).

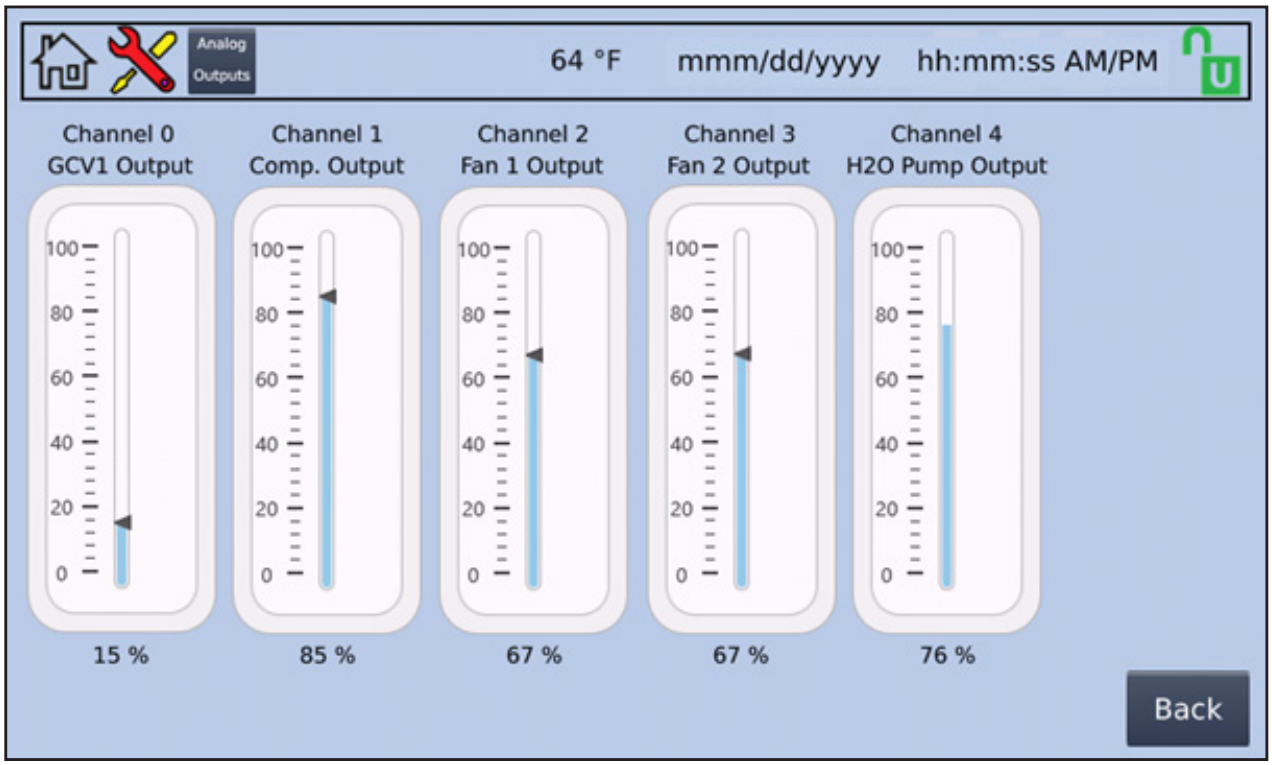


If an Input Status shows on any parameter on the Analog Input screen, press the Info button to display error descriptions.



6.D.3 Analog Outputs

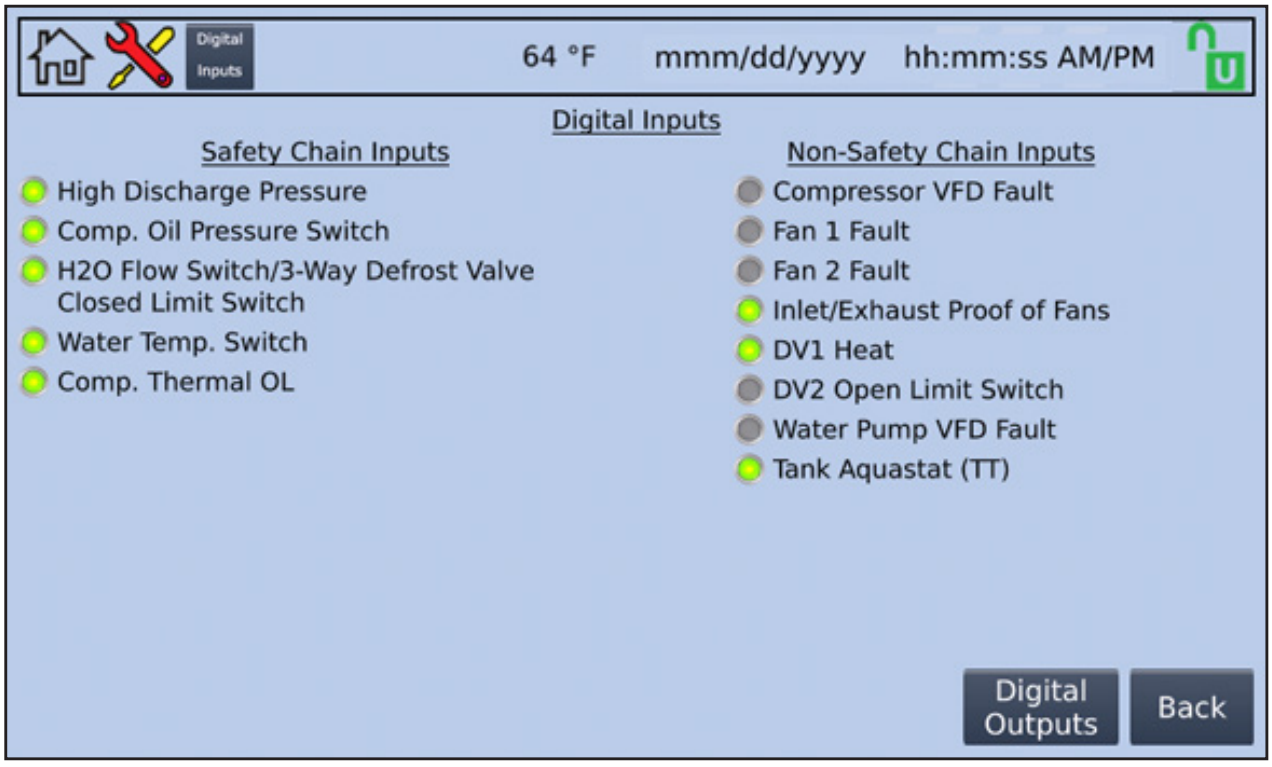
The values for GCV1 correspond to the percentage that the Gas Cooler Valve is open. All other outputs relate to the relative speed of the compressor, fans, and water pump.



6.D.4 Digital I/O's

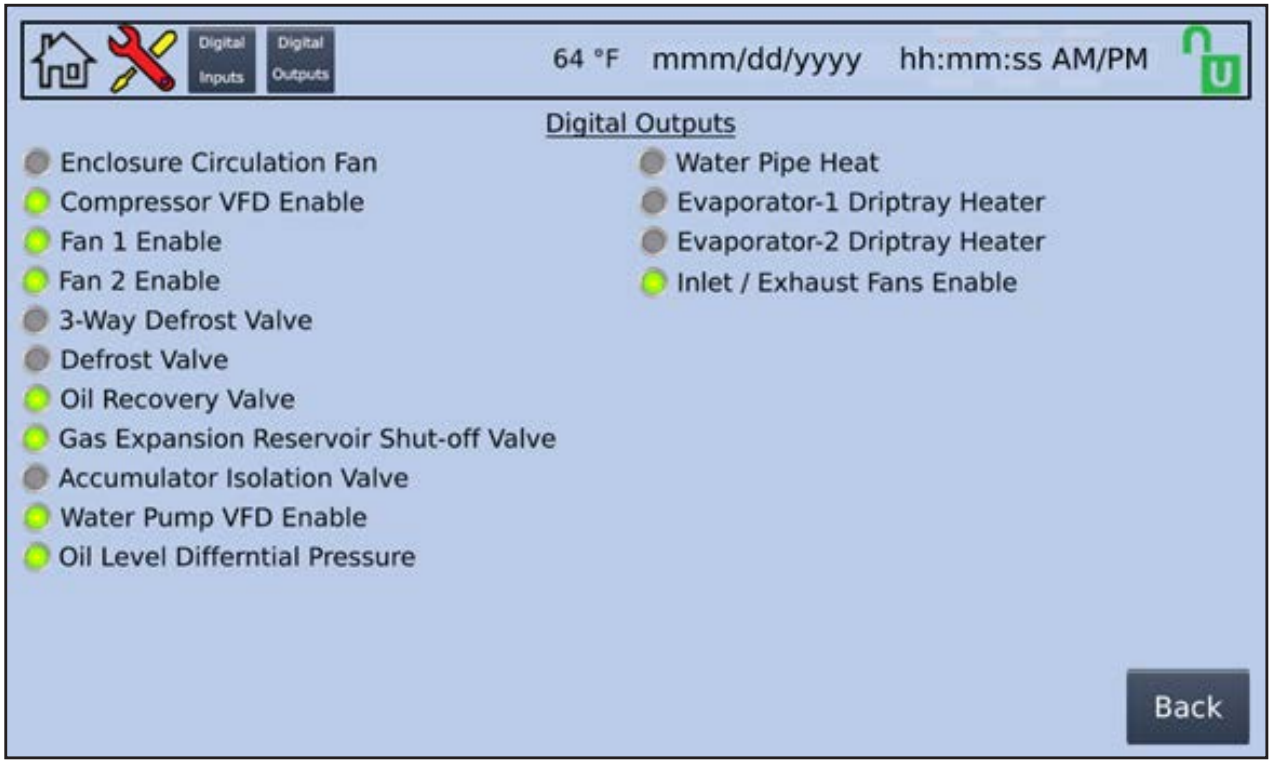
6.D.4.a Inputs

Displays the state of the digital inputs (grey indicates no connection or input present)



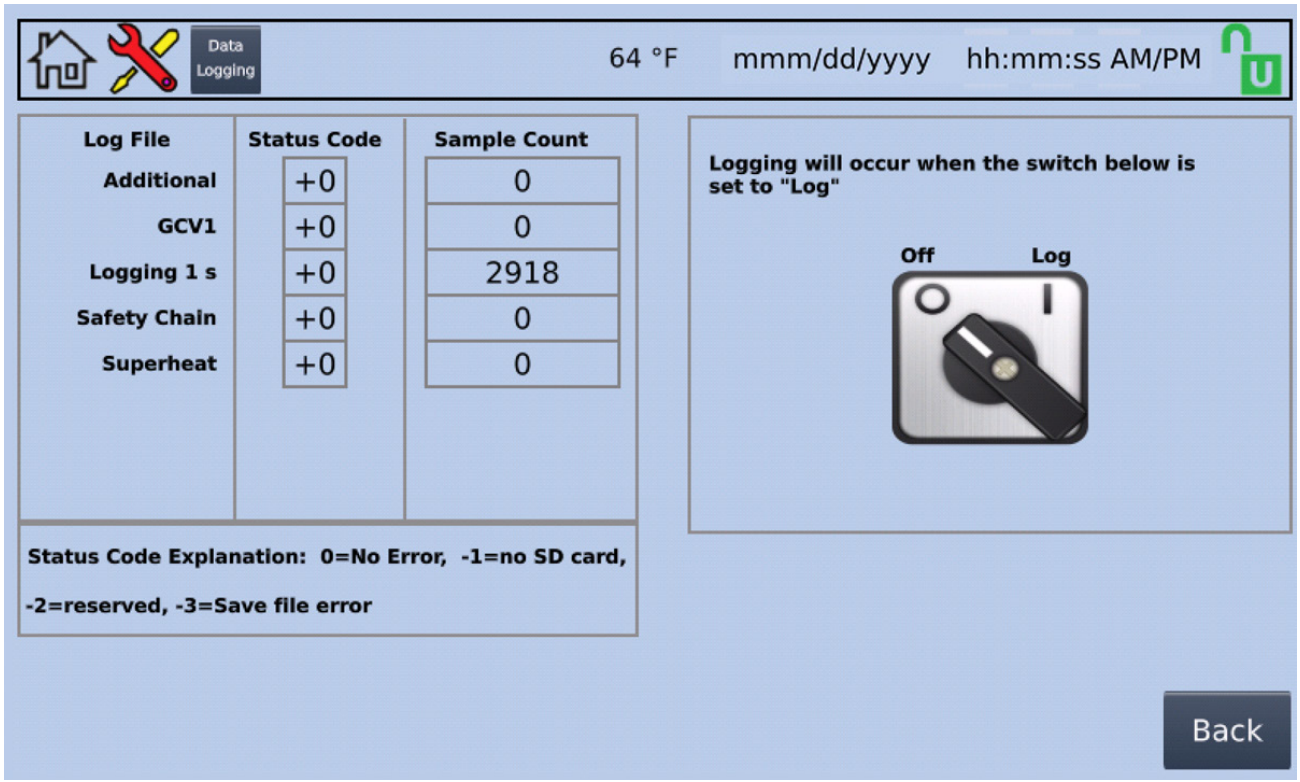
6.D.4.b Outputs

Indicates the status of each digital output (grey indicates an inactive output)



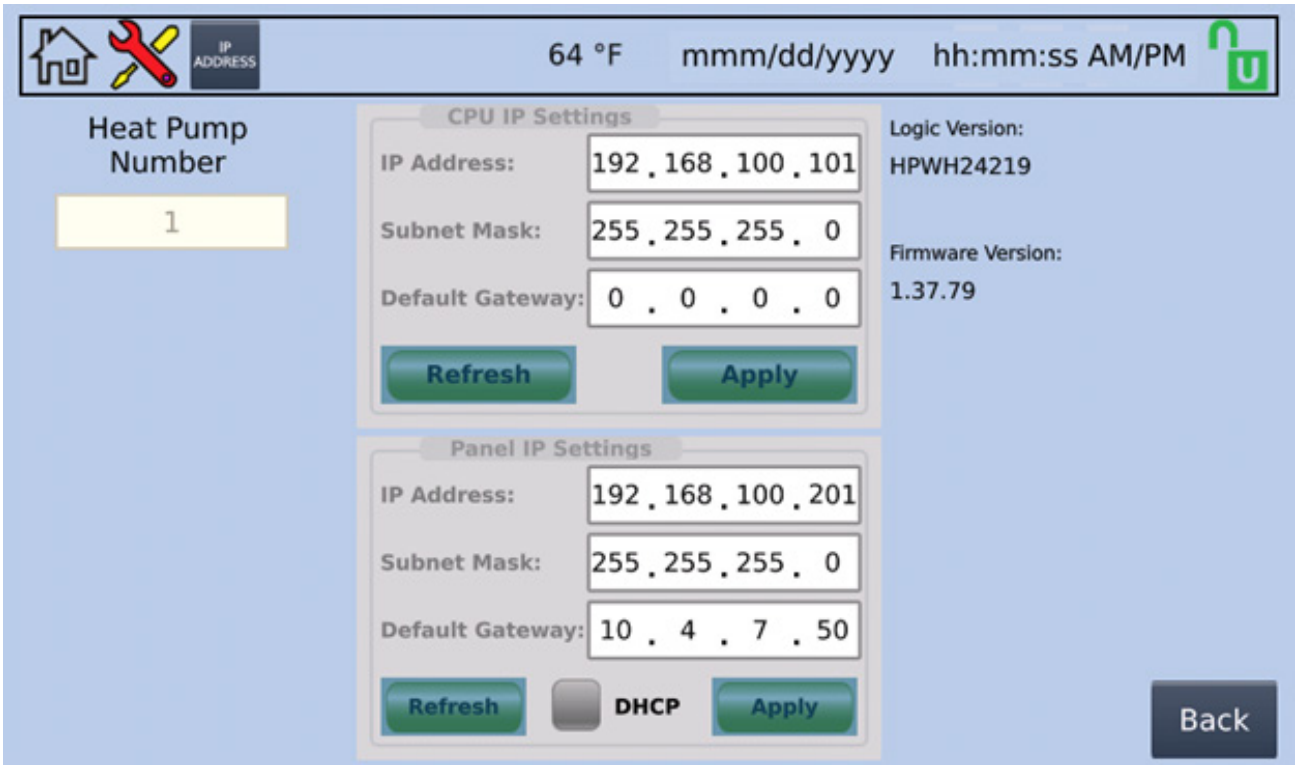
6.D.5 Data Logging

Data log files can be created, per the screen instructions.



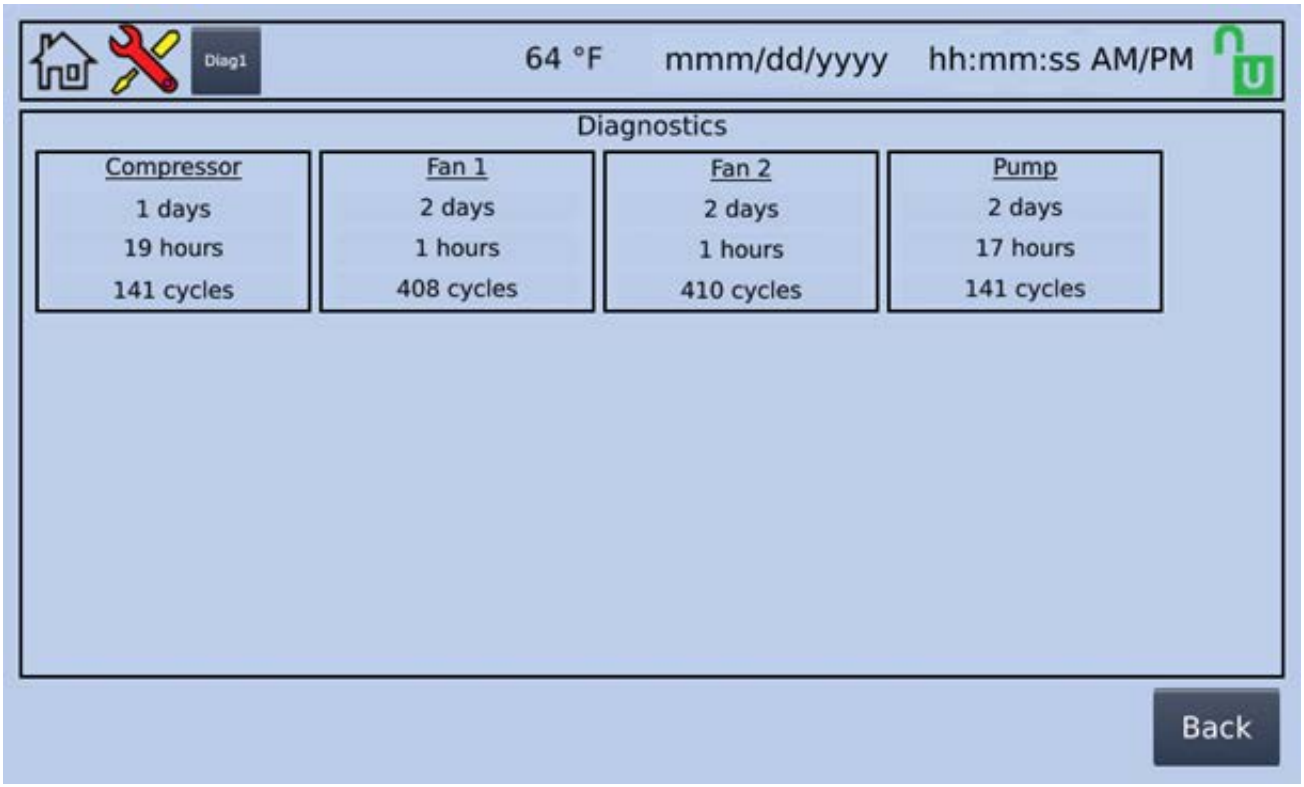
6.D.6 IP Address

The IP addresses are read only, with the User security level. Additionally, the PLC logic and firmware versions are provided.



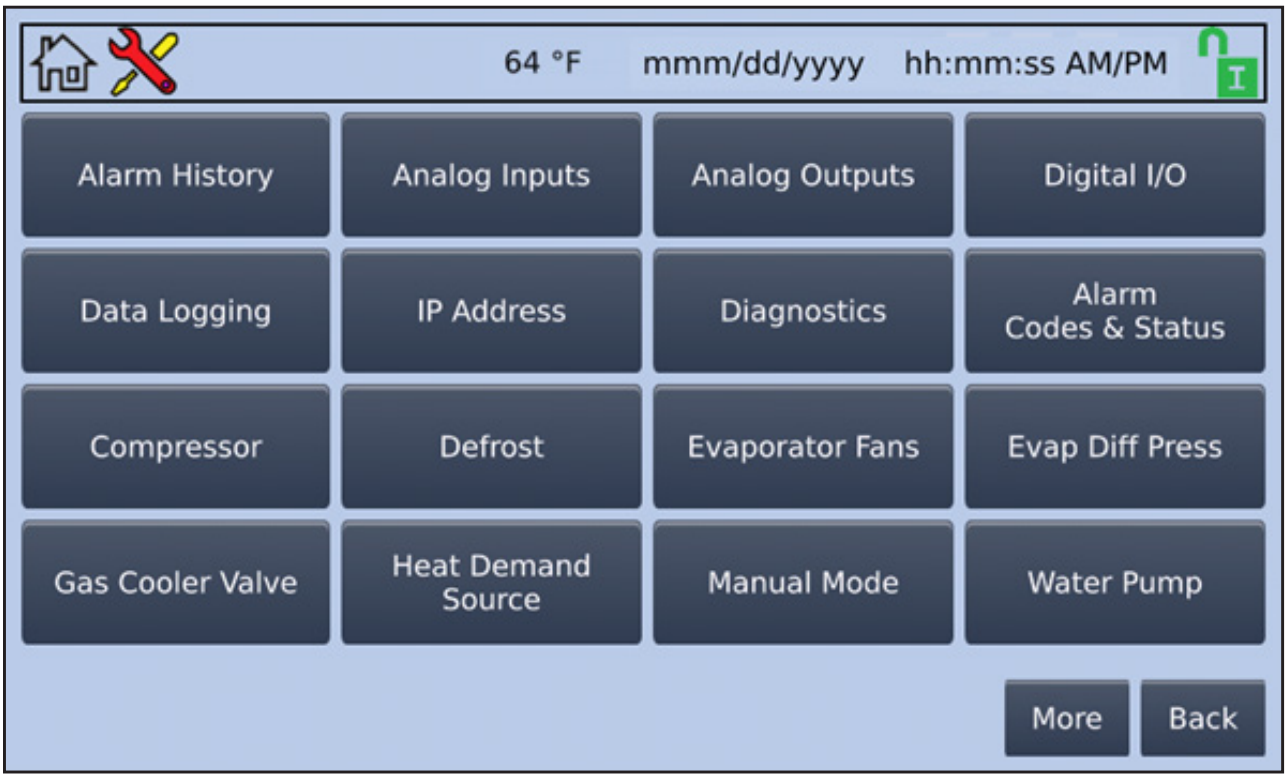
6.D.7 Diagnostics

This menu displays the total runtime hours on the major components, as well as the total on/off cycles



6.E Service Menu (Installer Security Level)

The Service Menu, with Installer security level, shows additional functionalities.



More



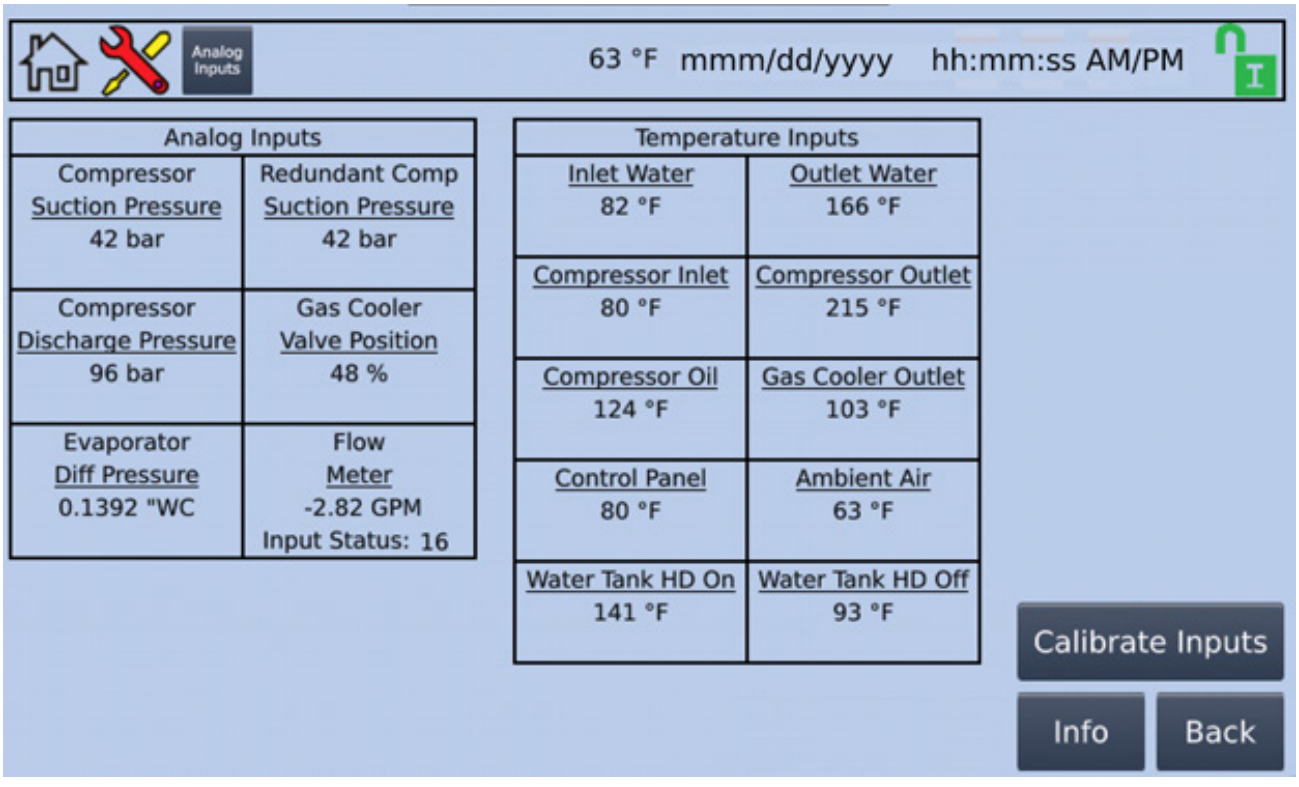
6.E.1 Alarm History

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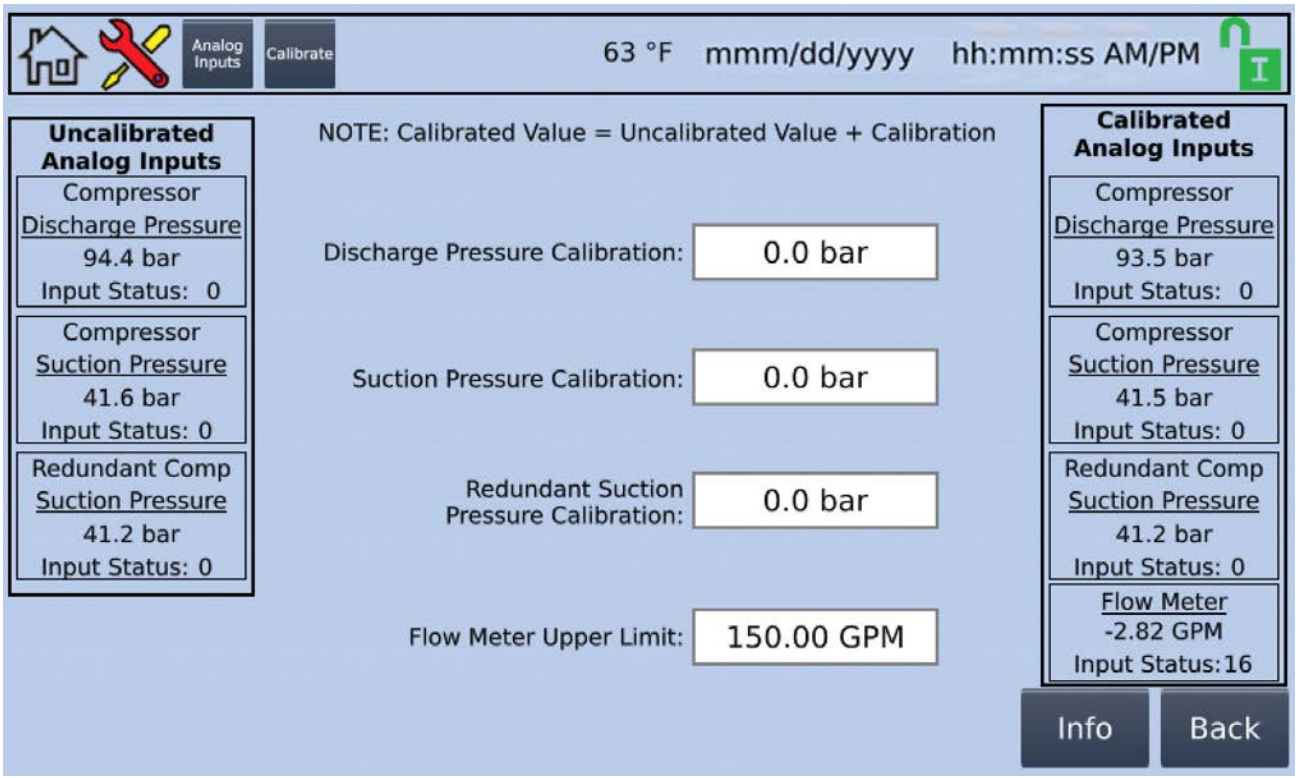
6.E.2 Analog Inputs

The Analog Input Menu shows the status of the various analog inputs to the heat pump, the temperature inputs, and the heat pump instantaneous power draw (when installed with the power meter option).

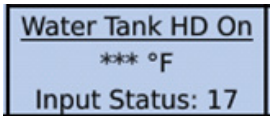


6.E.2.a Analog Inputs, Calibrate

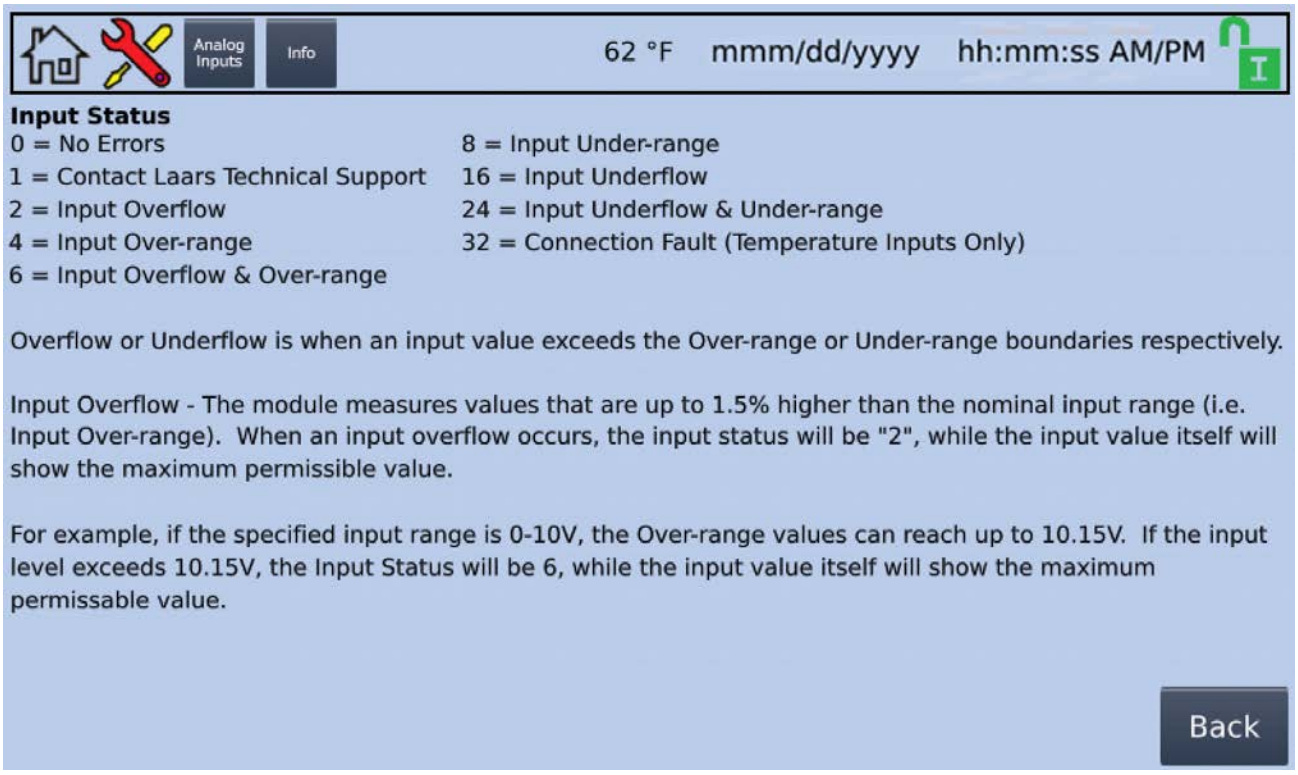
Each pressure transducer can be calibrated by adding a positive or negative offset value. The upper limit of the installed flow meter can be entered, as well.



6.E.2.b Analog Inputs, Info

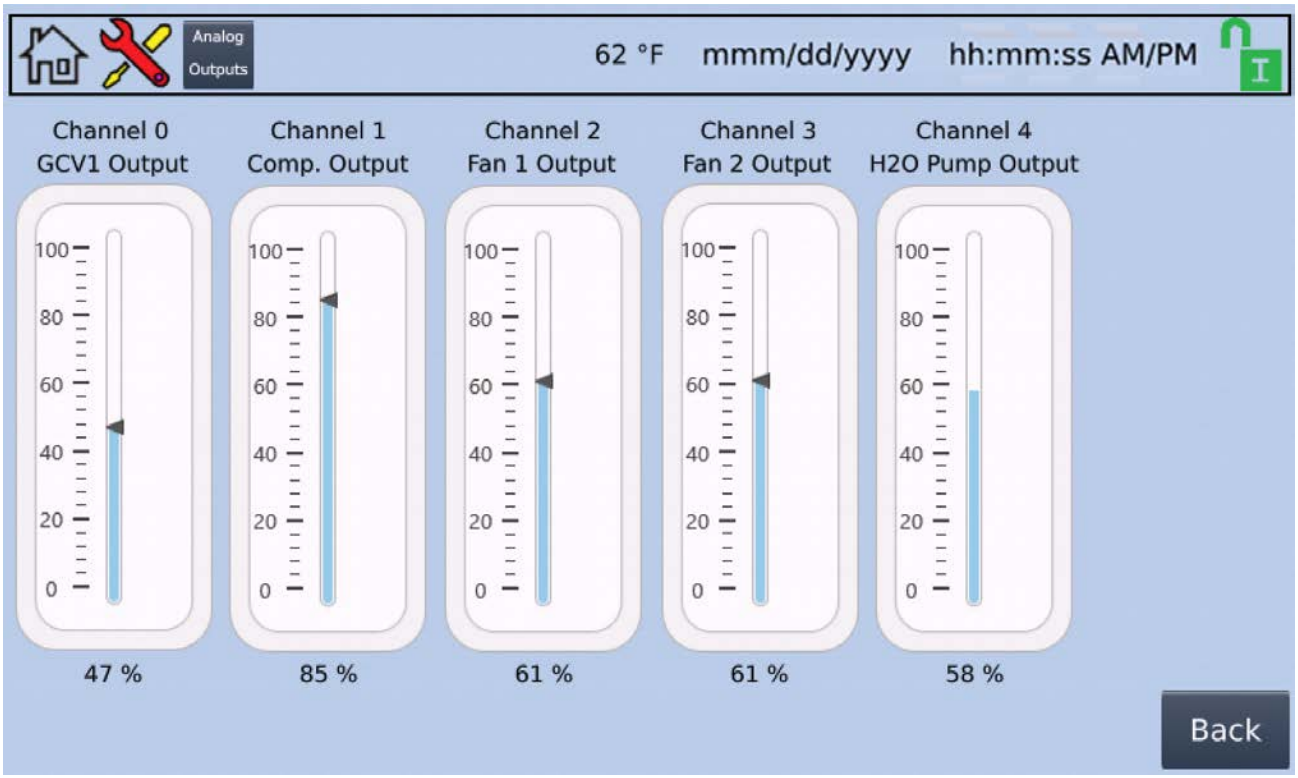


If an Input Status shows on any parameter on the Analog Input screen, press the Info button to display error descriptions.



6.E.3 Analog Outputs

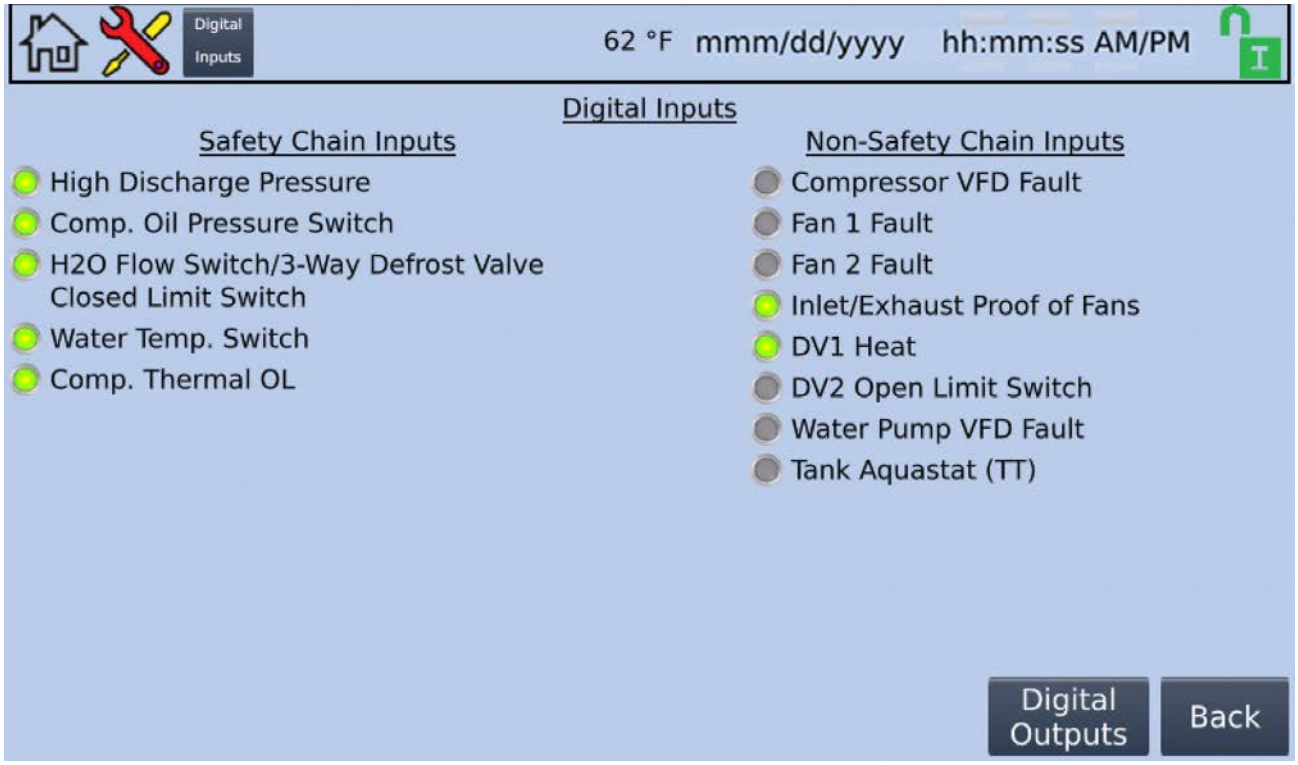
The values for GCV1 correspond to the percentage that the Gas Cooler Valve is open. All other outputs relate to the relative speed of the compressor, fans, and water pump.



6.E.4 Digital I/O's

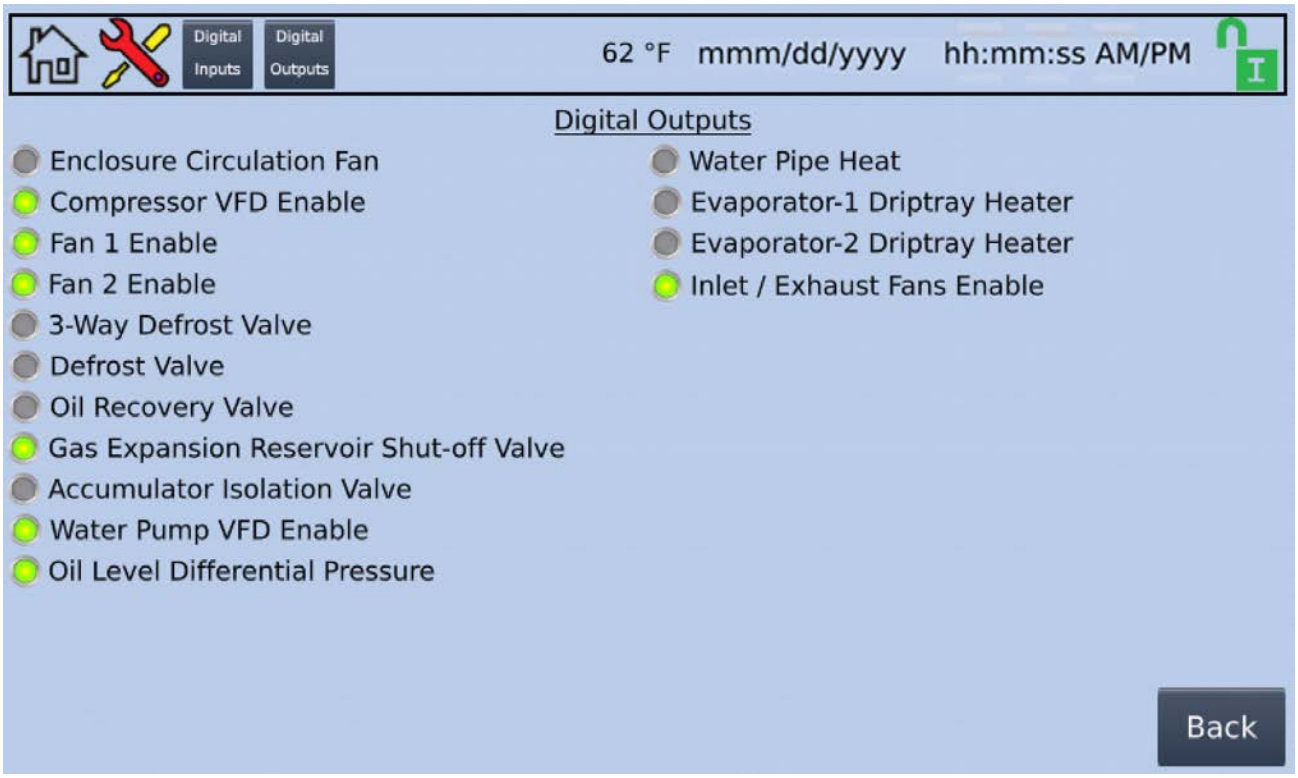
6.E.4.a Inputs

Displays the state of the digital inputs (grey indicates no connection or input present)



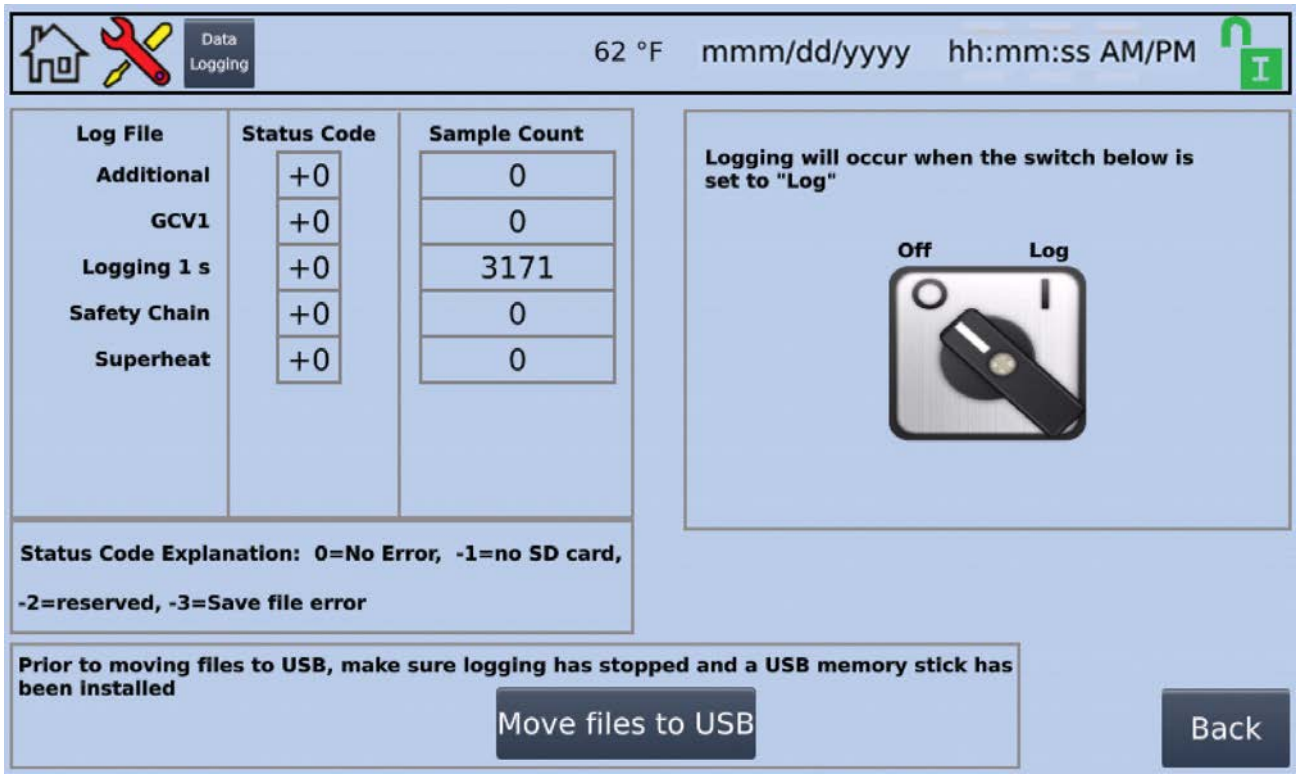
6.E.4.b Outputs

Indicates the status of each digital output (grey indicates an inactive output)



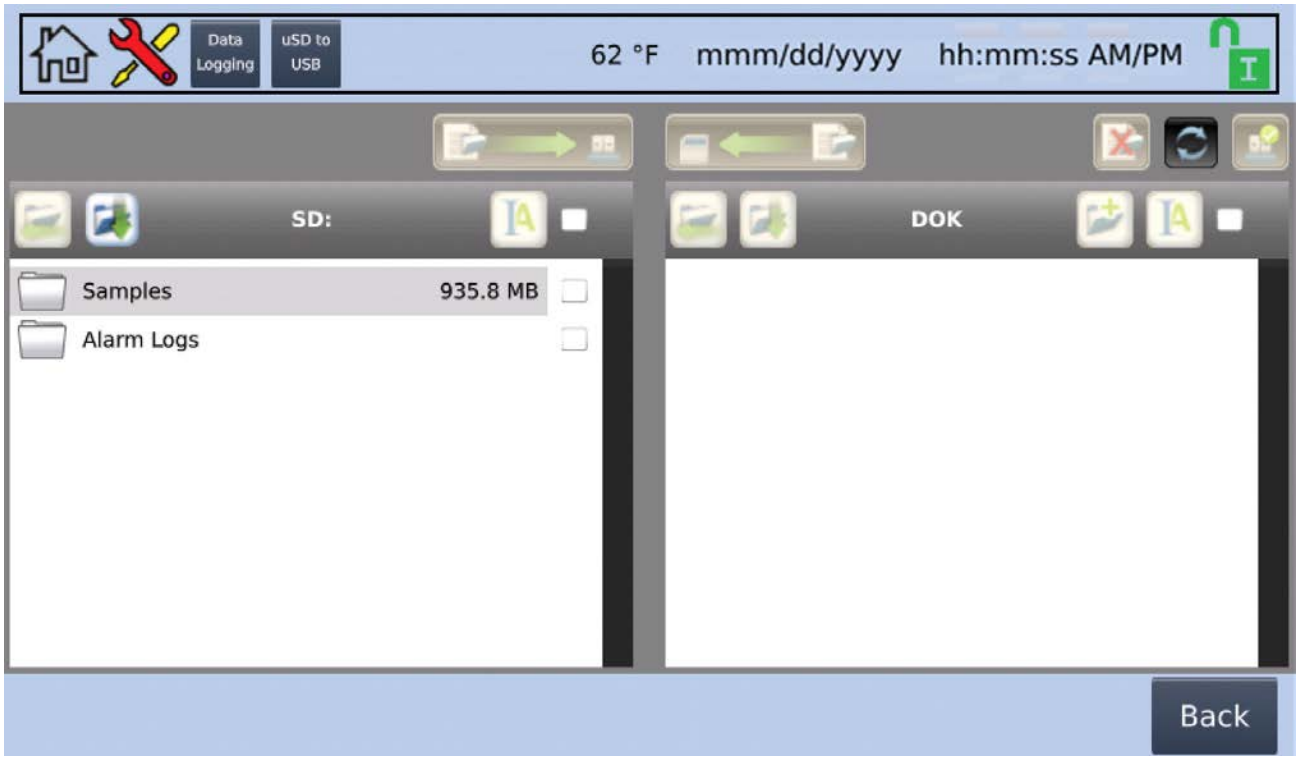
6.E.5 Data Logging

Data log files can be created, per the screen instructions.



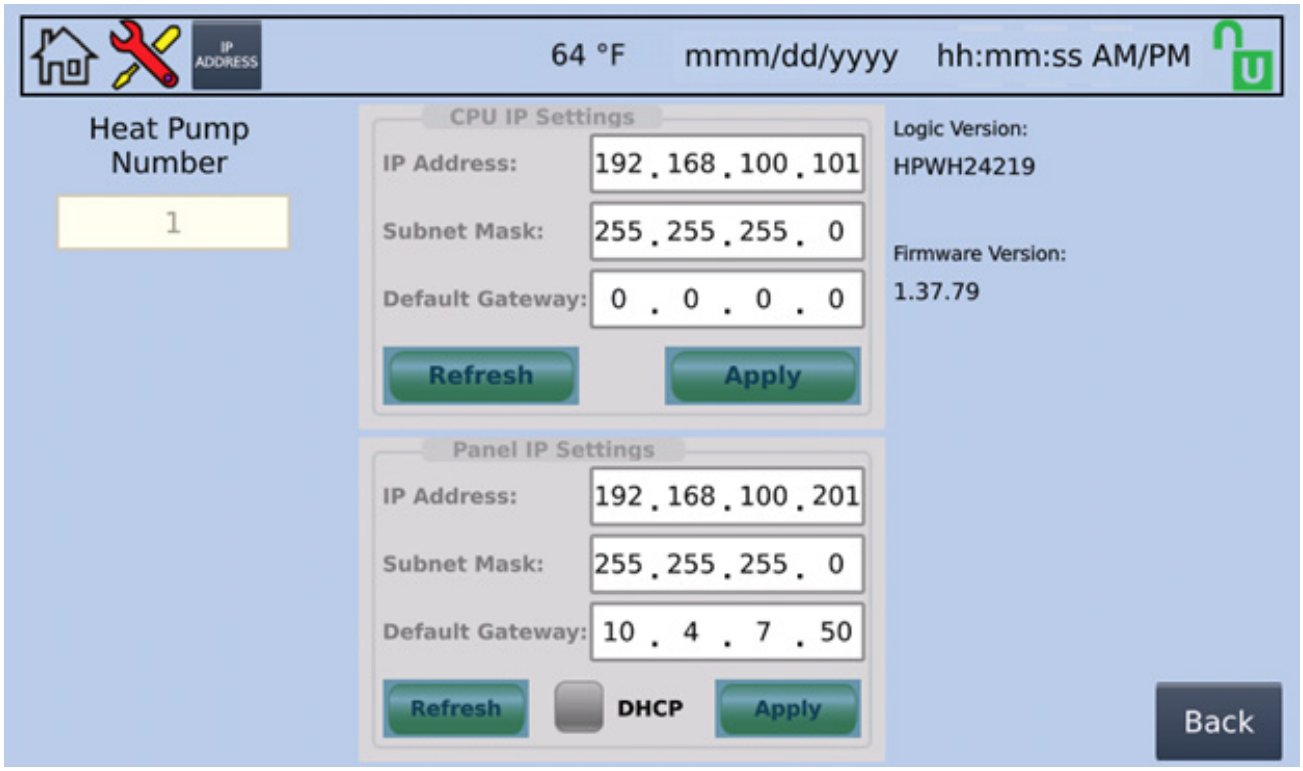
6.E.5.a Outputs

Data log files can be found and moved to a USB memory stick



6.E.6 IP Address

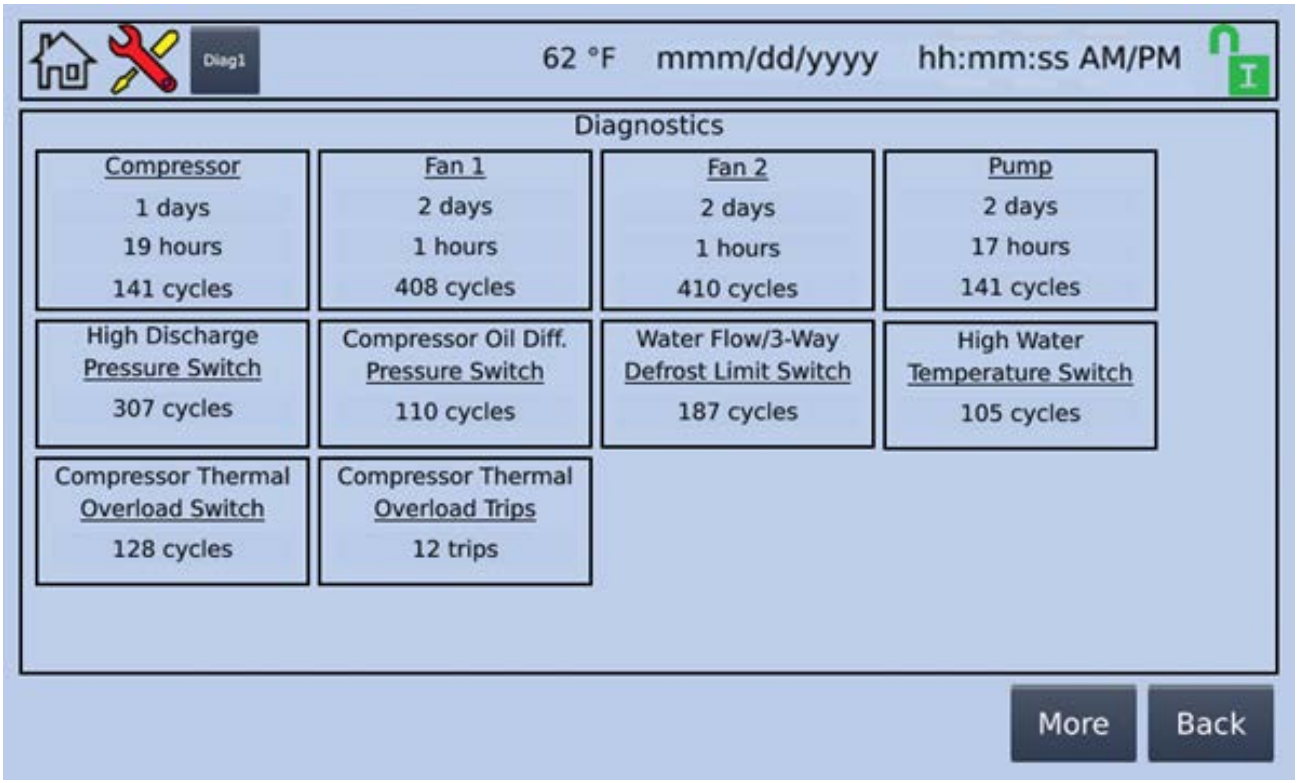
When multiple (cascaded) heat pumps are installed, this screen is used to assign sequential numbers for each individual heat pump. The CPU IP settings can be changed, but the assigned Heat Pump Number (between 1 and 16) will automatically configure a unique IP address. The Panel IP settings are for remote communication to each heat pump, if desired. Additionally, the PLC logic and firmware versions are provided.



6.E.7 Diagnostics

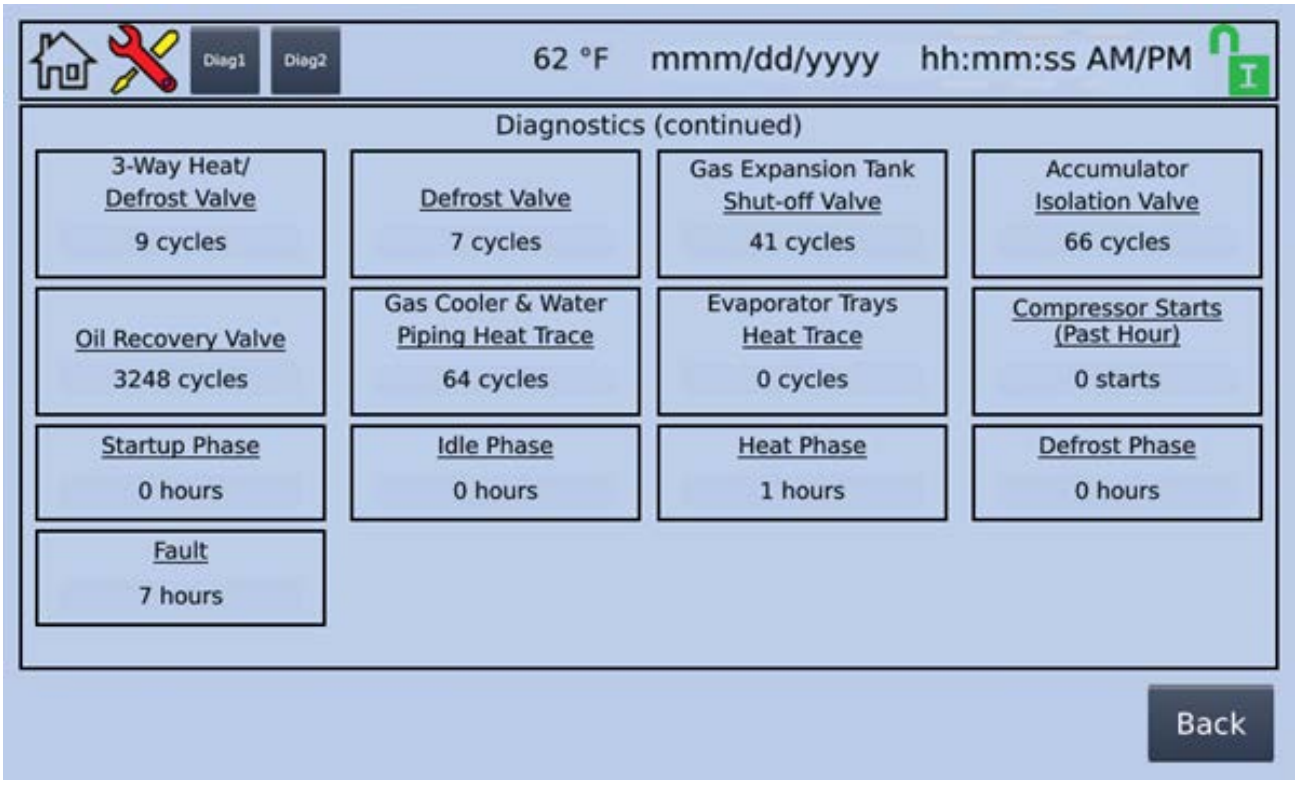
6.E.7.a Diagnostics Menu A

This menu displays the total runtime hours on the major components, as well as the total on/off cycles of components and safety switches.



6.E.7.b Diagnostics (More Menu A)

Displays the total cycles of several control components, as well as hours of various machine states.



6.E.8 Alarm Status Viewer

Displays the state of all possible alarms. The arrow button on the upper left corner of the screen will allow the list to be sorted.



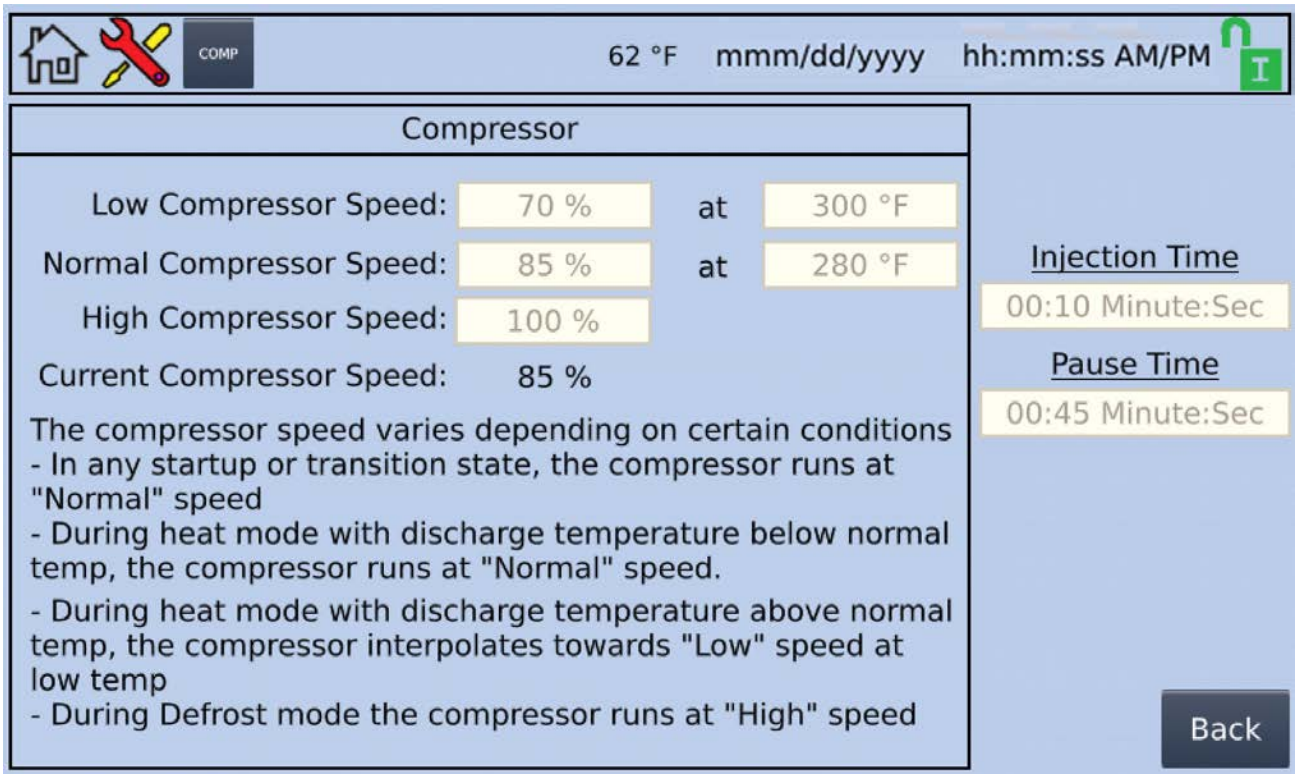
Selecting the gear symbol under the action column allows to disable the fault from showing on the home screen's "banner" or to Shelve (delay) the message from appearing for an adjustable amount of minutes.

6.E.8.a Alarm Status Action

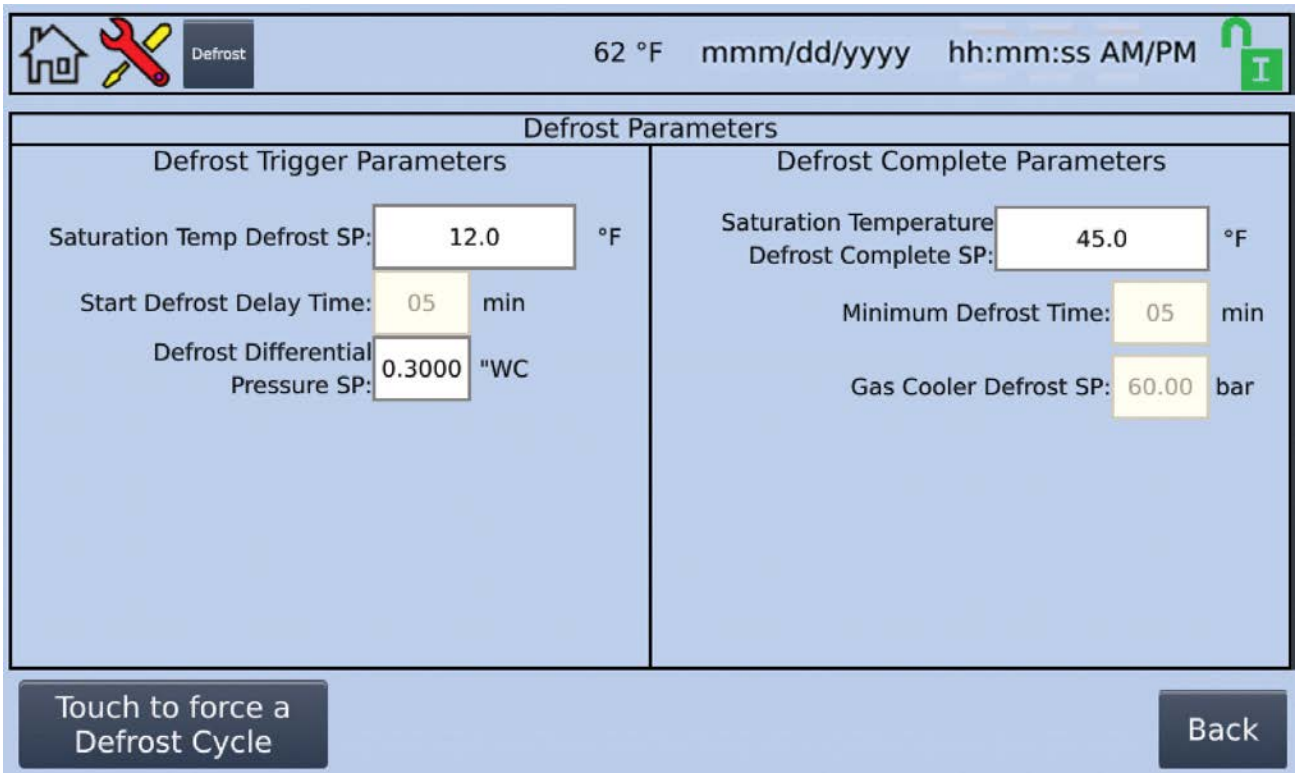


6.E.9 Compressor

Displays the compressor speed and logic

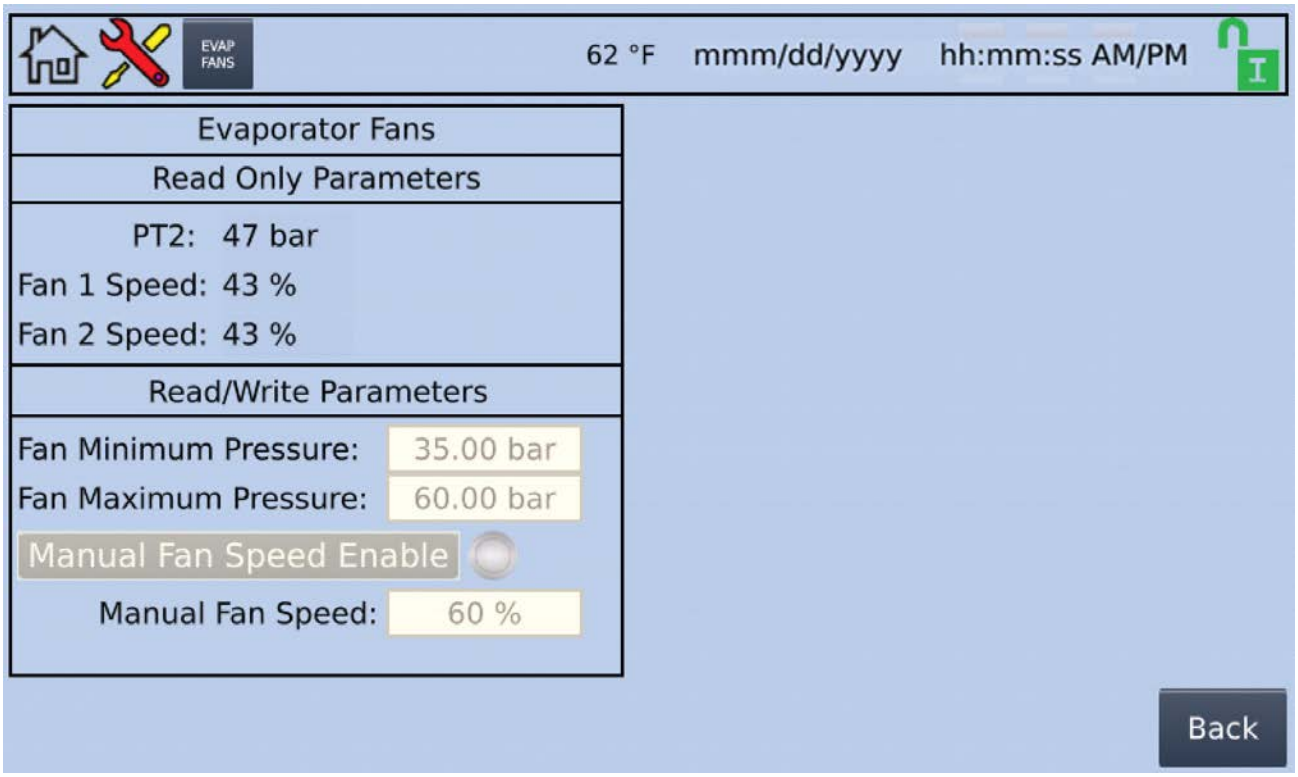


6.E.10 Defrost



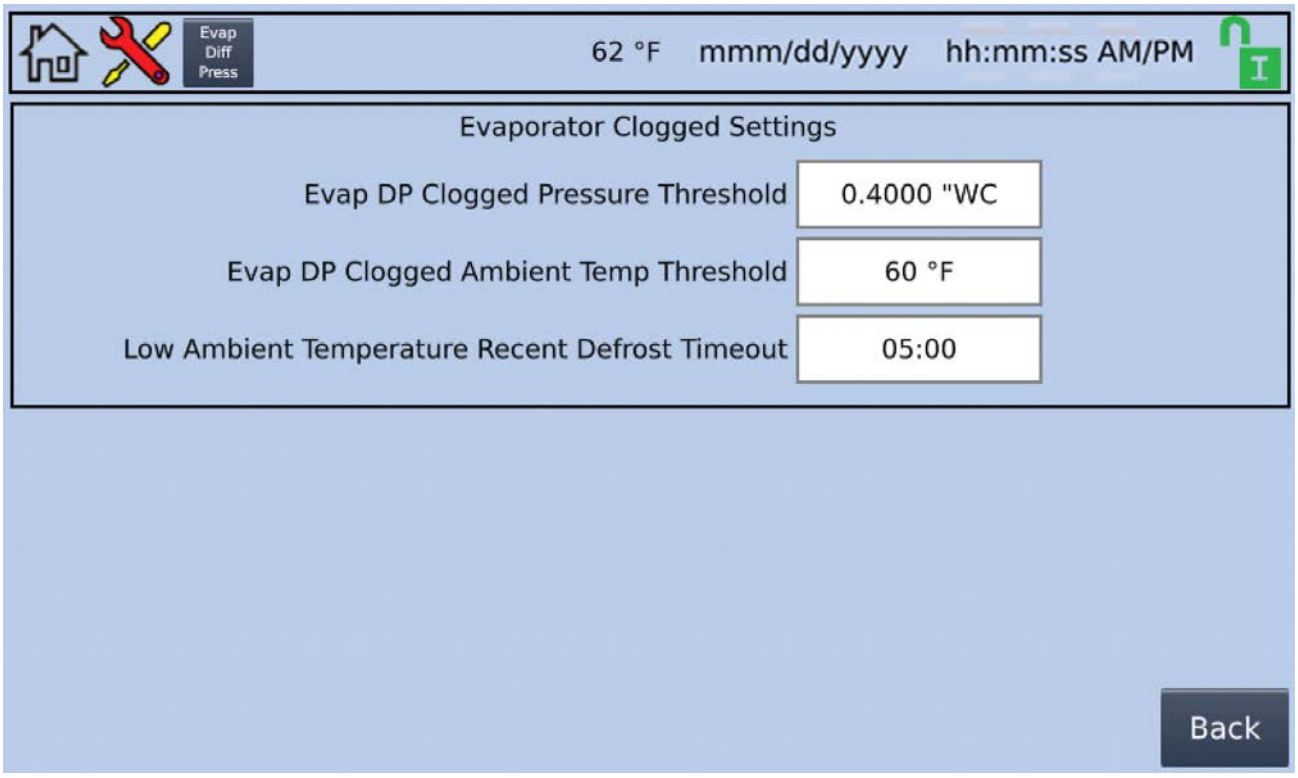
6.E.11 Evaporator Fans

This is a read only screen showing the evaporator fan(s) speed parameters.



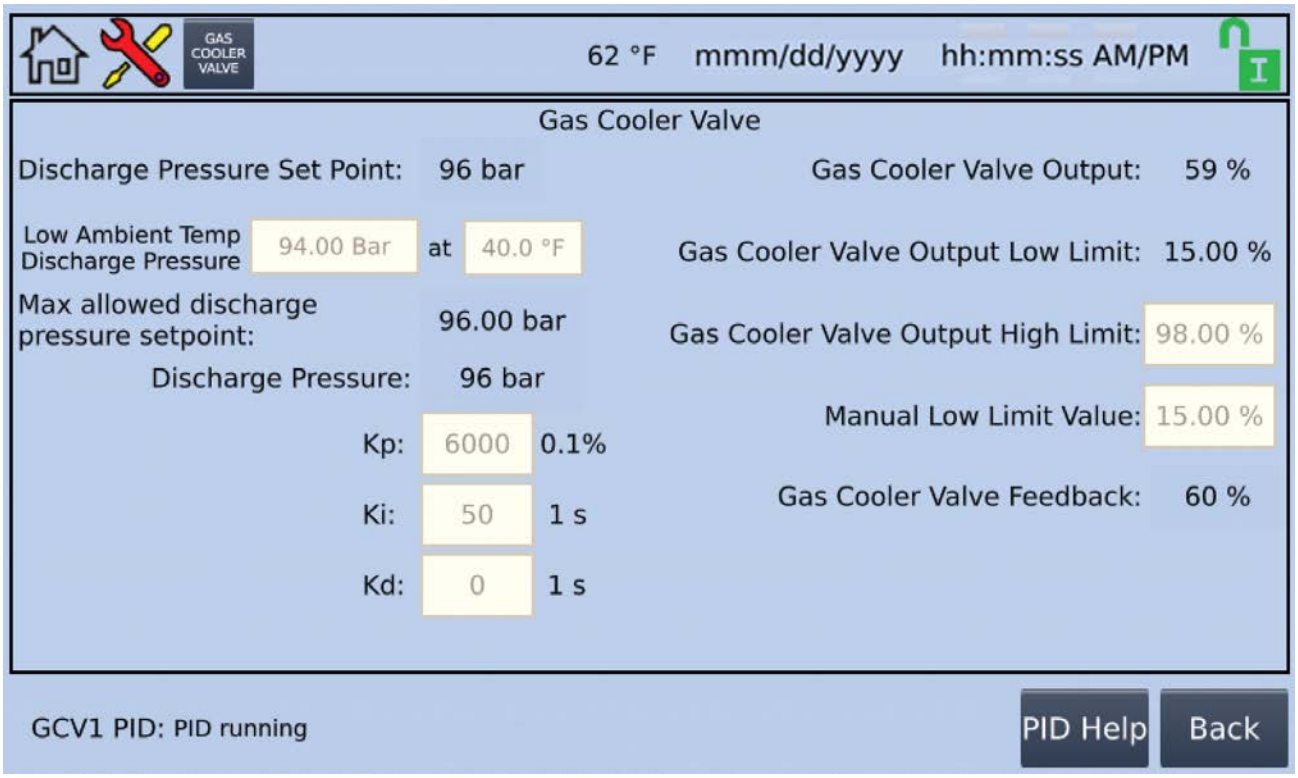
6.E.12 Evap Diff Press

This screen provides the ability to change the evaporator clogging detection settings. Below the ambient temperature threshold, the defrost logic takes over control, and a clogged evaporator may initiate unnecessary defrost cycles.



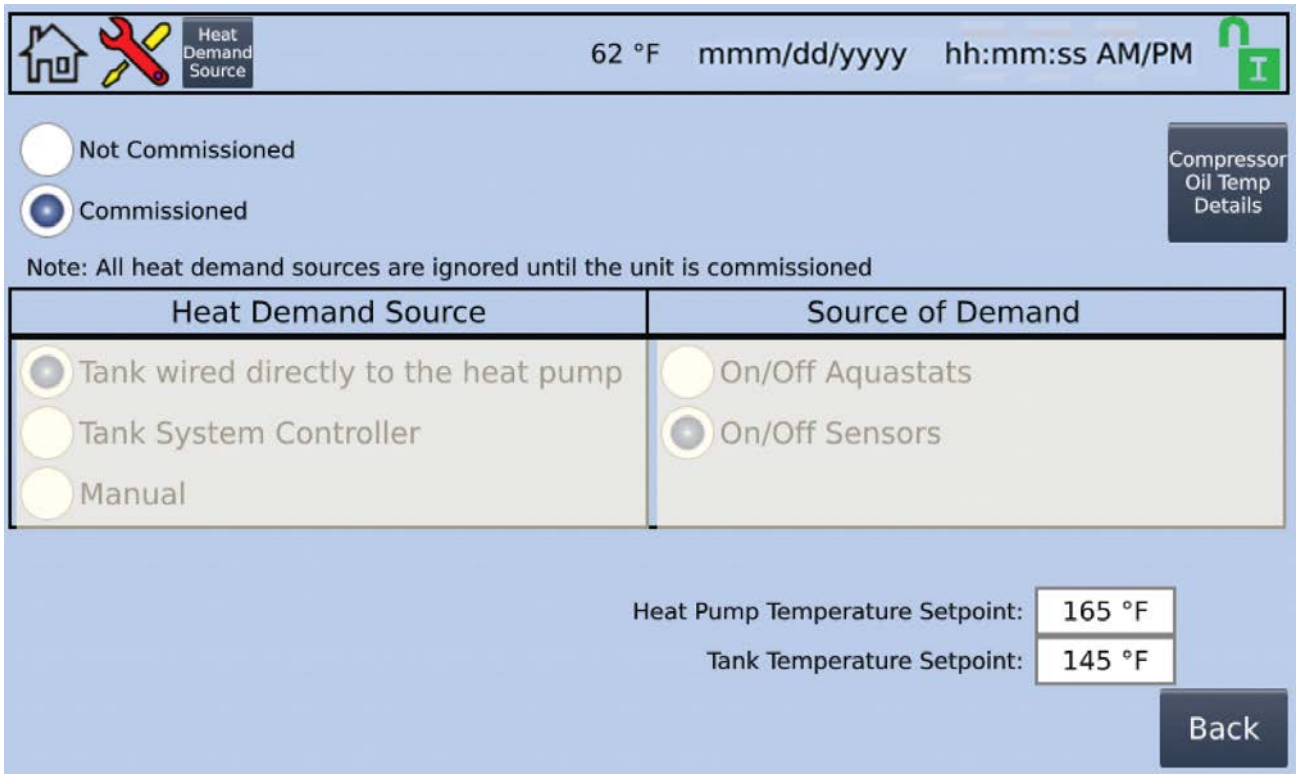
6.E.13 Gas Cooler Valve

This is a read only screen showing the gas cooler operation and settings.



6.E.14 Heat Demand Source

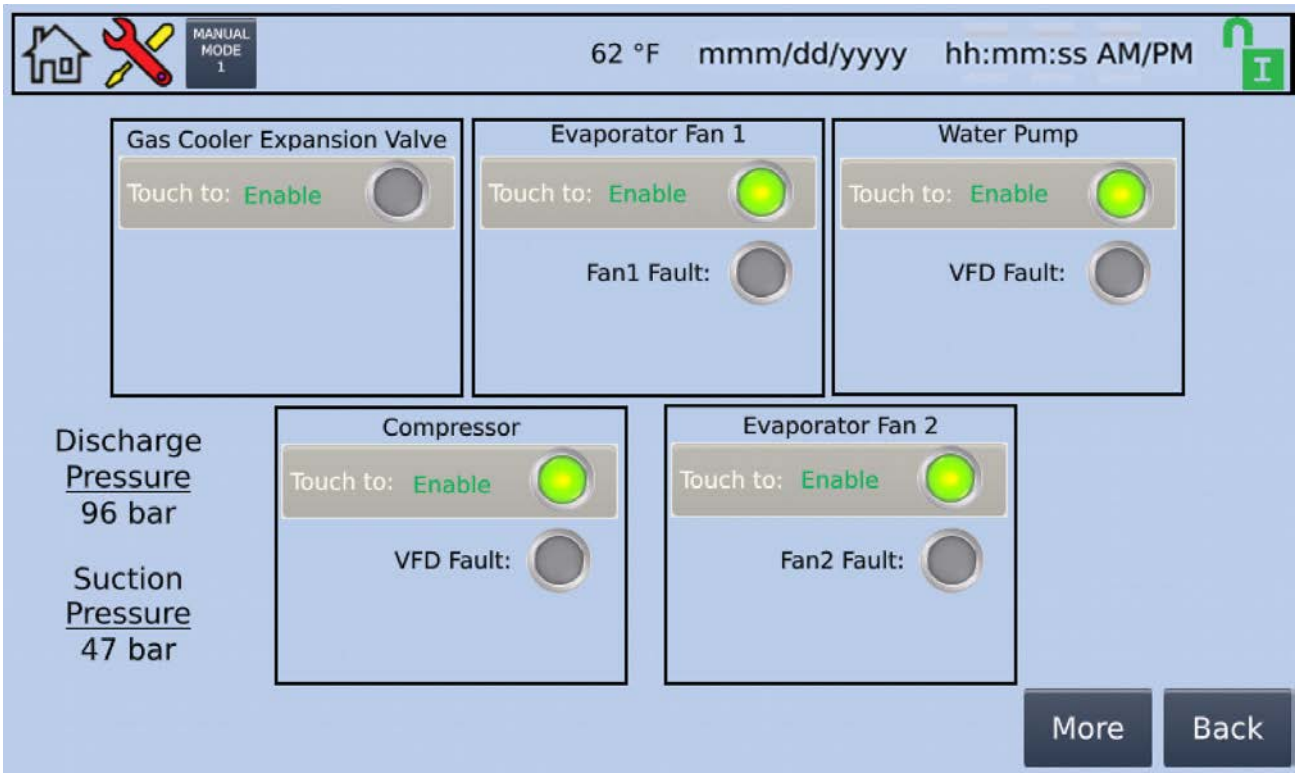
This screen is for selection of the heat demand source. The heat demand source will be ignored when the Not Commissioned (default) state is selected. Only select Commissioned when the heat pump is ready to operate. Additionally, the Heat Pump Temperature and Tank Temperature Setpoints can be adjusted, when the On/Off Sensors source of demand is selected.



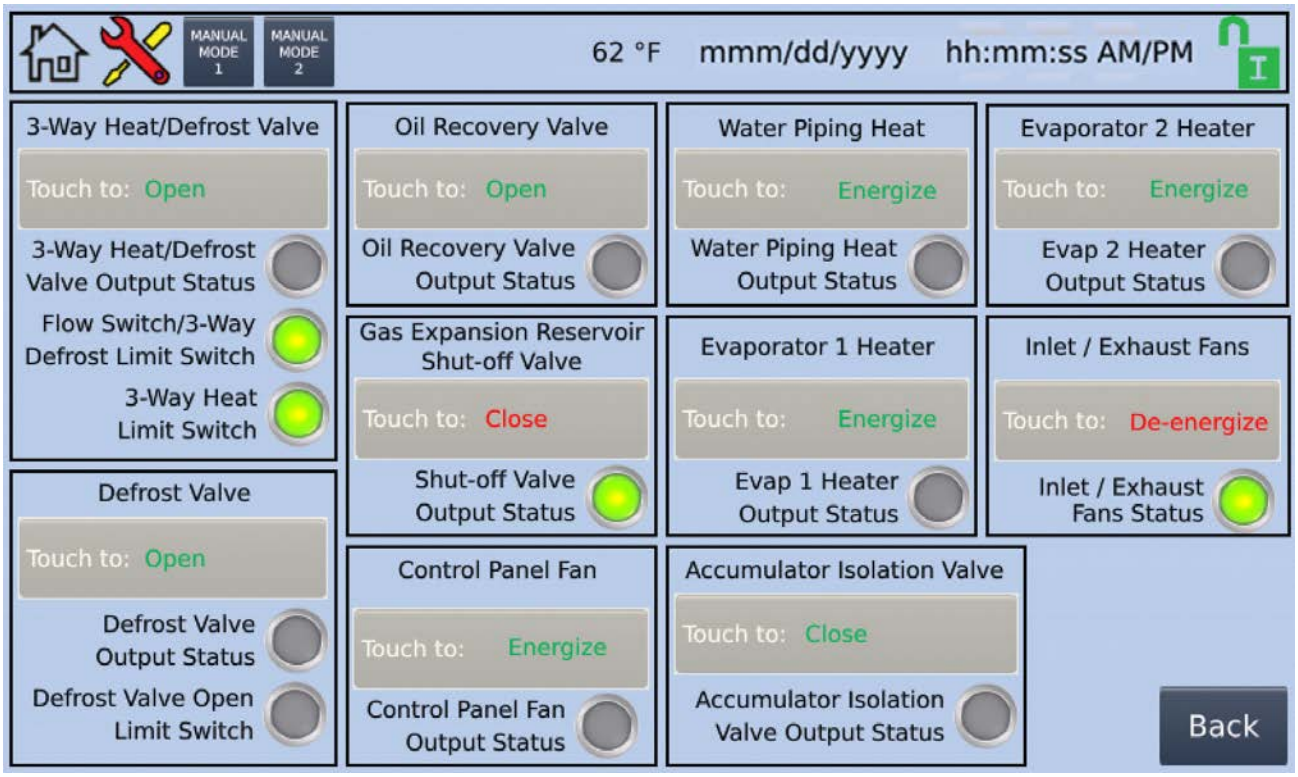
6.E.15 Manual Mode

Limited manual operation is permitted, when the Heat Demand Source is in the Not Commissioned state. Otherwise, these are read only screens.

6.E.15.a Manual Mode, Menu 1

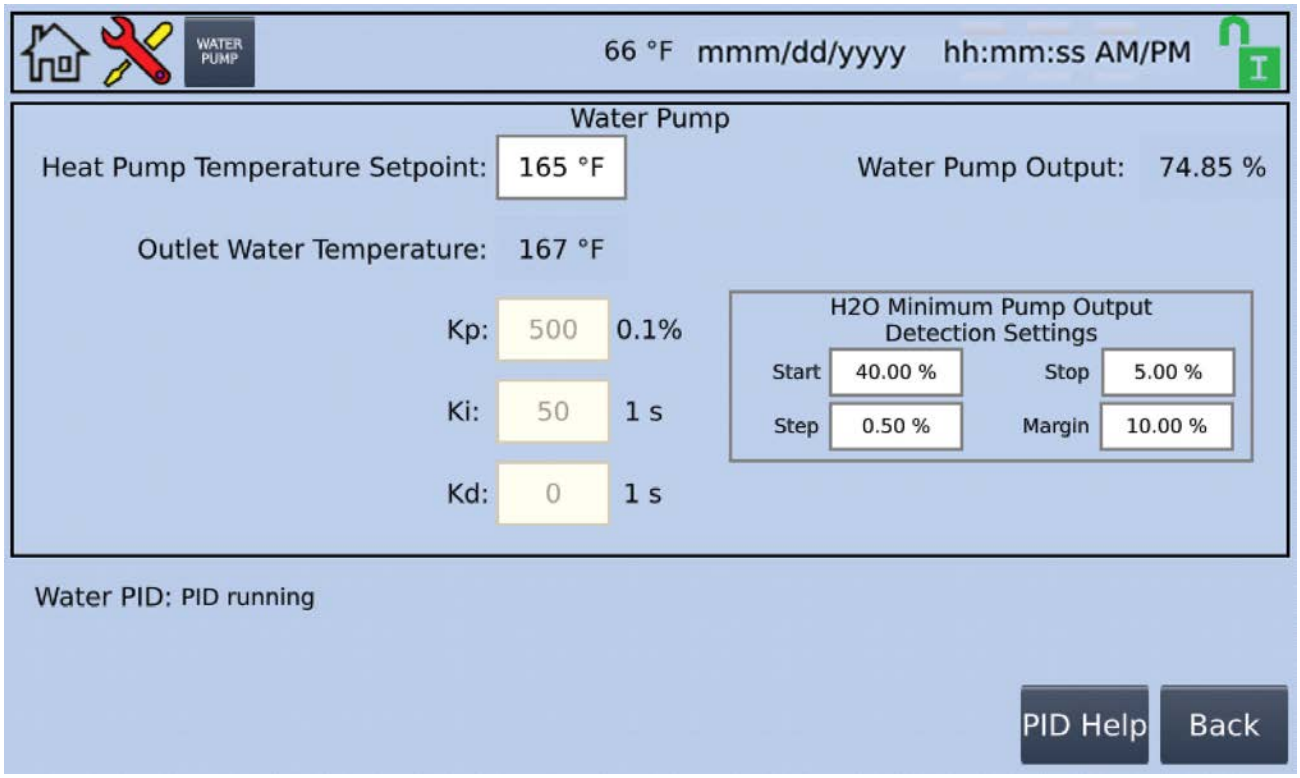


6.E.15.b Manual Mode, Menu 2

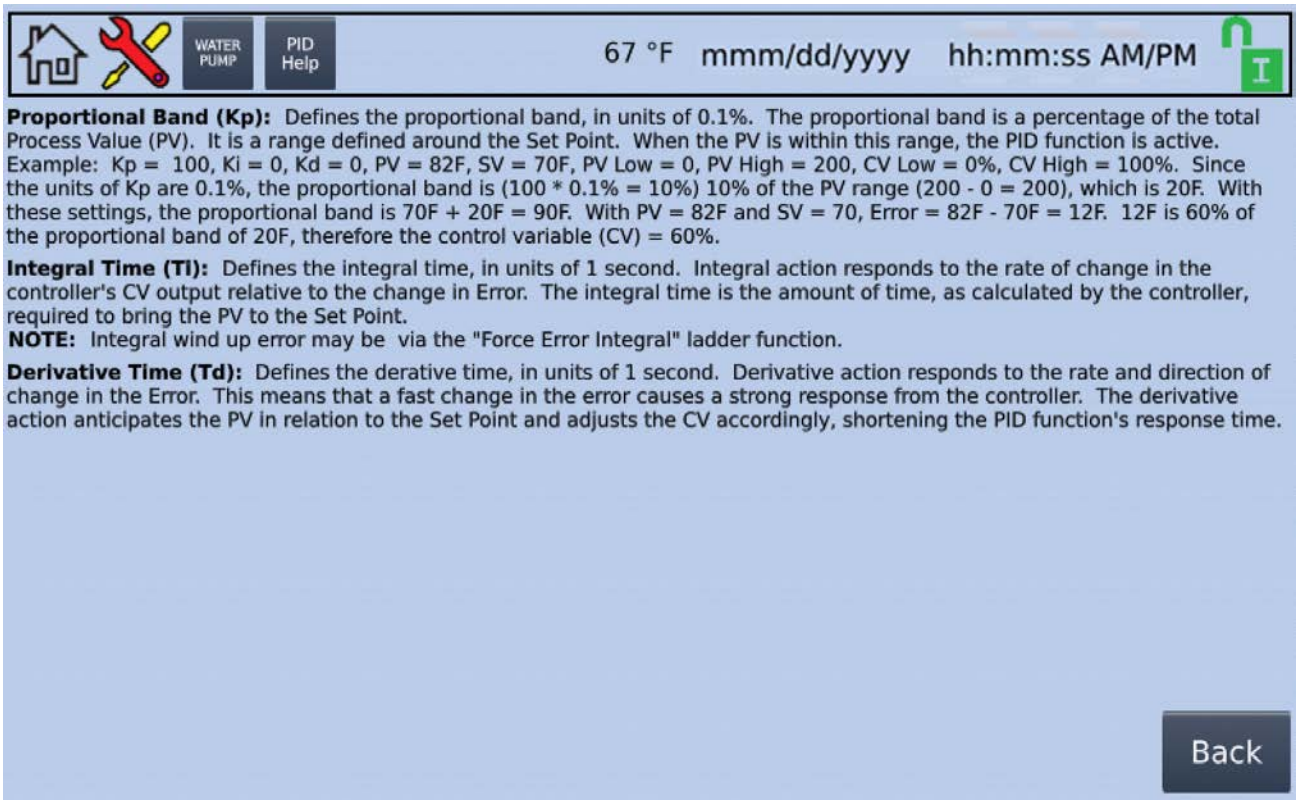


6.E.16 Water Pump

This screen allows the water temperature set point and the pump PID values to be changed. The screen also shows the output speed signal sent from the PLC to the water pump. Additionally, the heat pump uses minimum pump speed detection logic on every transition to a heat demand.

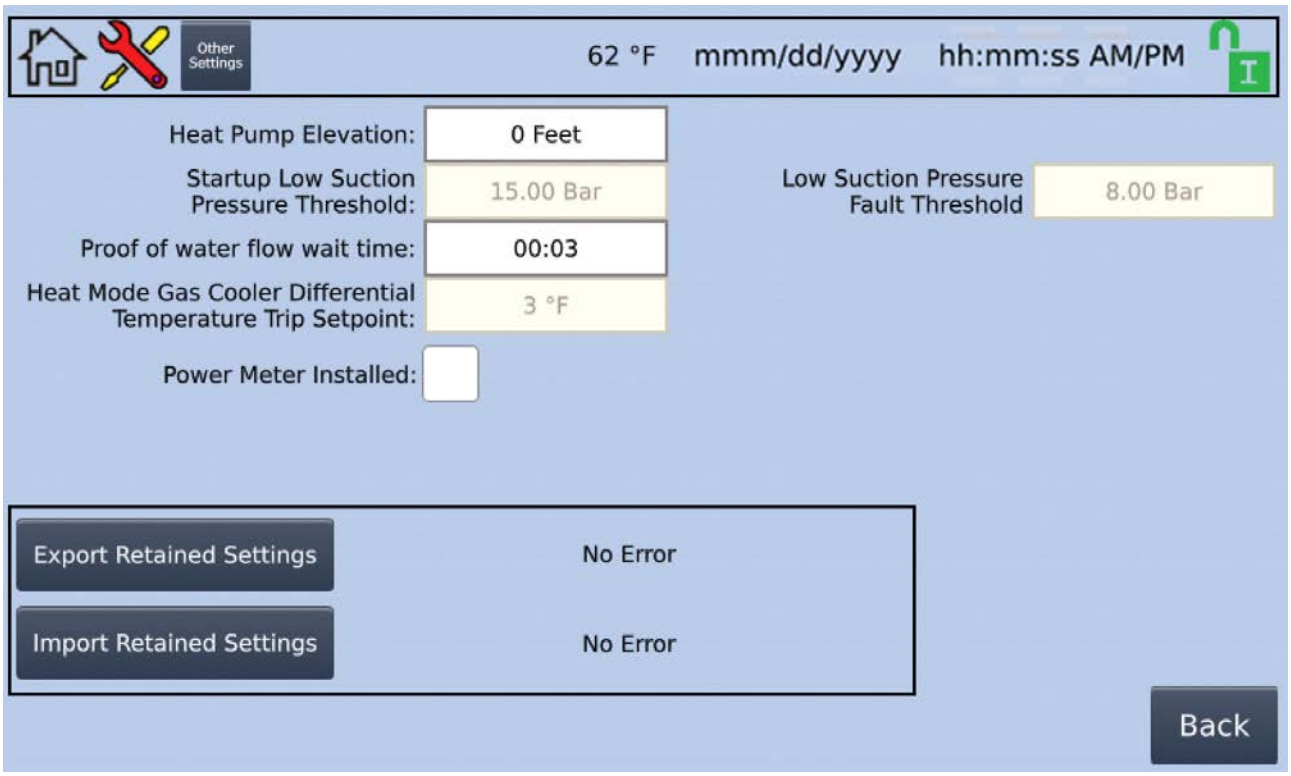


6.E.16.a PID Help



6.E.17 Other Settings

This screen allows for the installed elevation to be entered, which automatically increases the maximum fan speed at higher elevations. The Proof of water flow wait time (default 3 seconds) gives the ability to increase the time before the water pump flow switch indicates a fault. Increased wait times may be necessary, when longer pipes/plumbing is installed to the tank system.



Retained tags are tags that retain their value at power-up. This means that when the controller powers up, the tags will not revert to zero but will instead retain their last known value. This feature is particularly useful for tags that need to hold data across power cycles, such as those used in critical systems where data loss is not acceptable. The retention of values is enabled by checking the “retain” option in the Tag Editor window, and an initial value can be set for these tags upon first download, ensuring they start with a known value.

6.E.18 Power Meter Option for Commercial Heat Pump Water Heater.

When the CTA-2045 option is selected, a factory installed and commissioned power meter will be added to the High Voltage panel. The meter monitors the voltage at each of the 3 phases of the 480V supply power. A current transformer donut which measures the Heat Pumps kW is wired to the power meter and set on the upper din rail for shipping.

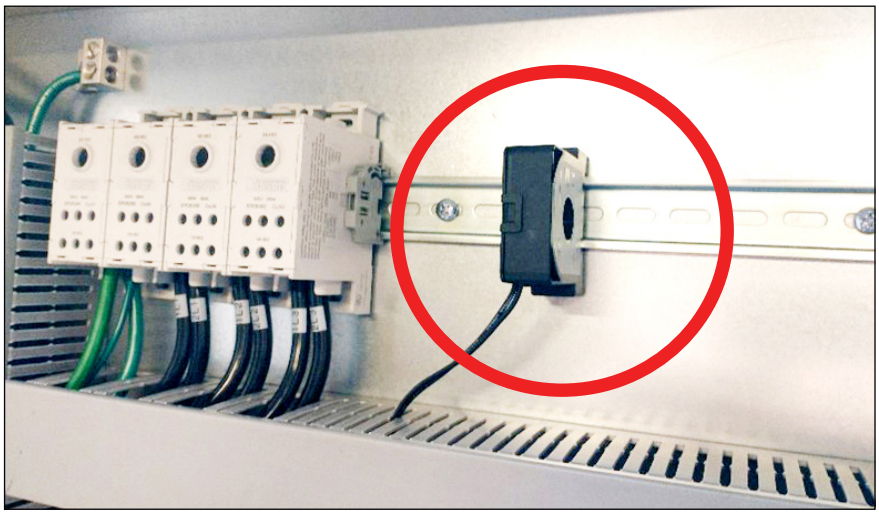


Figure 30. Power Meter

The electrical contractor that is installing the Main service feed to the Heat Pump will need to route the 480V **L1 leg** through the current transformer before landing the wire on DB1. The current transformer can be removed from the DIN rail for easier installation around the service wires.

Refer to Figure 28 on page 31 to locate the L1 leg.

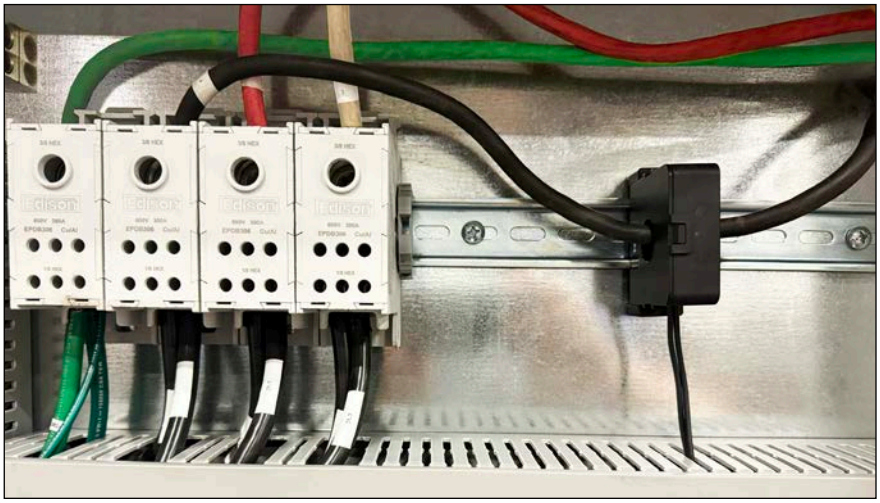
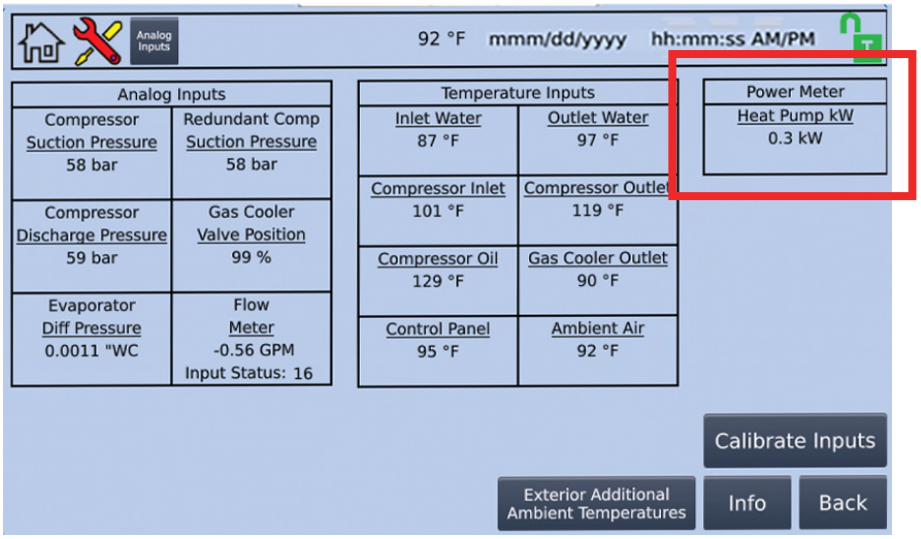


Figure 31. 480V wire routed through the power meter

Communication between the Power meter and Heat Pump PLC is achieved via Modbus communication and the kW value is displayed on the Heat Pump Analog Inputs screen. The following passwords and user levels will allow access to the Analog Inputs screen within the Service menu to see this input.

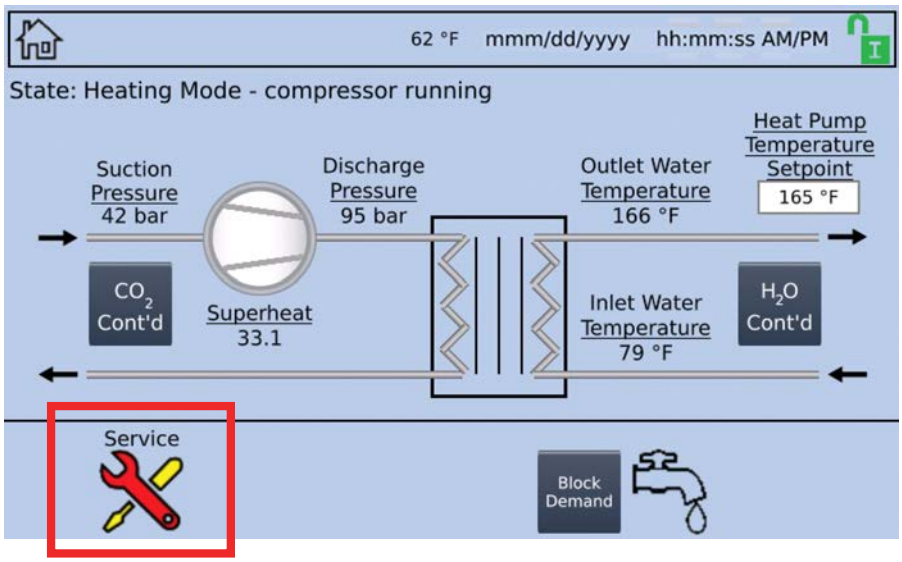
User Level = user

Installer level = inst

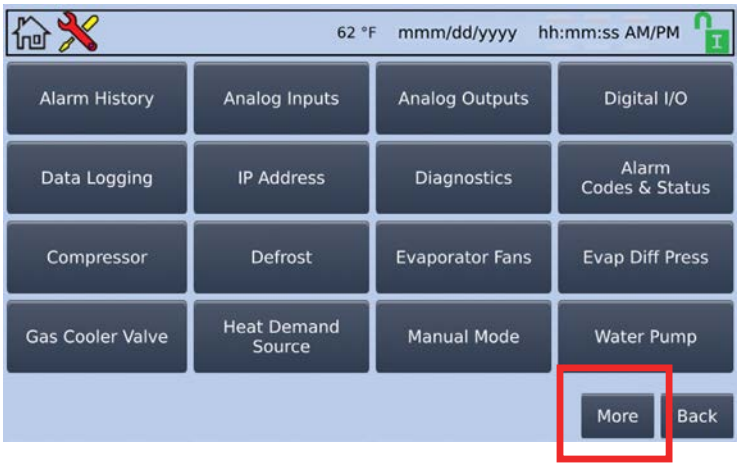


If the Power meter box in the upper right-hand corner of the screen is not present, follow the steps outlined below to ensure proper configuration.

1) From the home screen under the Installer level password, select the Service Icon.



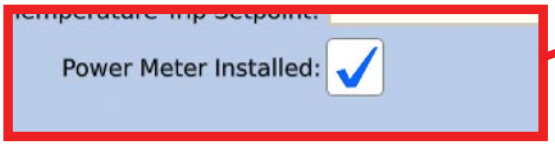
2) Next select the “More” button in the lower right-hand corner of the screen.

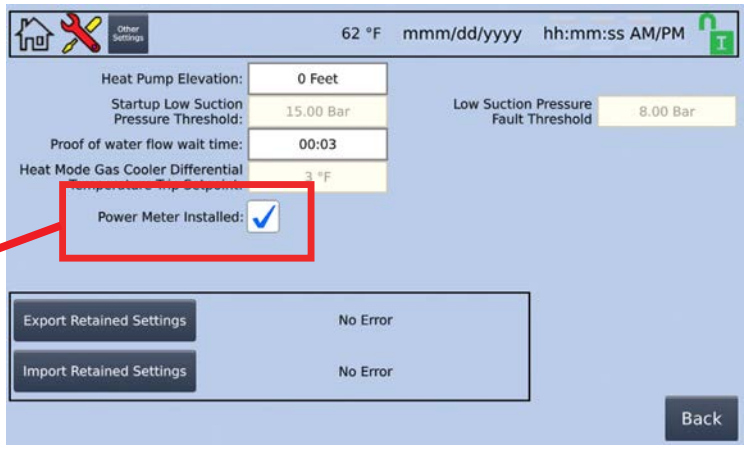


3) The following screen will appear. Select “OTHER SETTINGS” to jump to the next page.



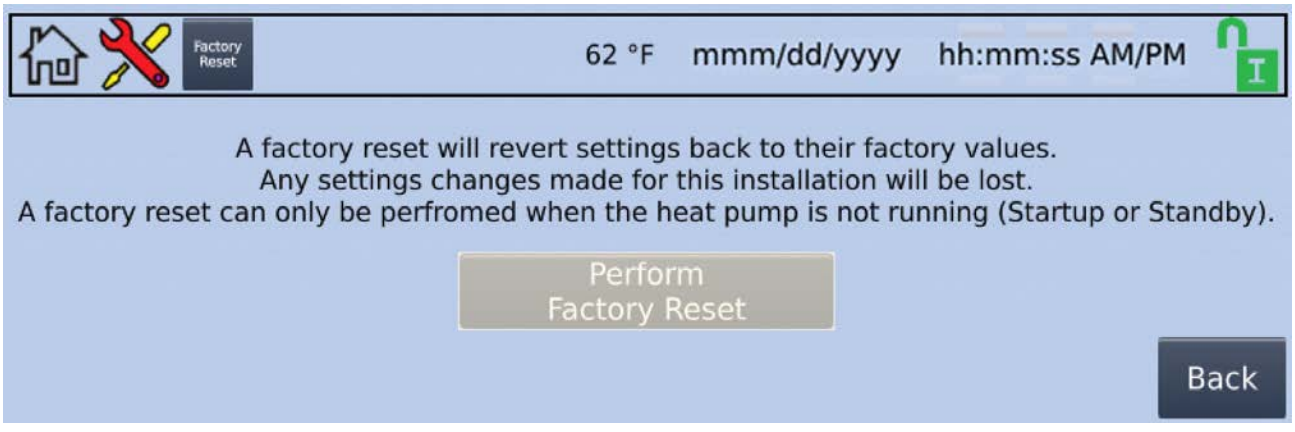
4) Check to make sure the box labeled “Power Meter Installed” is ‘Checked’.





6.E.19 Factory Reset

Factory Reset will return all settings (other than IP addresses) to factory defaults.



SECTION 7 Startup and Shutdown

7.A Initial Startup

⚠ WARNING

Initial commissioning of the HPWH should only be completed by authorized and qualified personnel.

7.A.1 Refrigerant Charge

The HPWH is shipped charged with refrigerant. The refrigerant pressure should be checked prior to operating the unit. There are two pressure gauges located on the left side of the unit directly behind the lower left rear panel. If these gauges read less than 500 psi, contact the manufacturer before proceeding with startup.

If the system is de-energized, venting of the refrigerant through the pressure regulating relief valves on the equipment can occur. In such cases, the system might need to be recharged with refrigerant, but in any case, the pressure-regulating relief valves shall not be defeated or capped. The relief setting shall not be altered.

7.A.2 Power Phase Rotation

Proper phase rotation and connections within the HPWH are verified by the factory during final testing. This ensures the rotation is correct within the unit. If phase rotation is suspect, a phase rotation tool is the best way to confirm proper wiring is supplied to the unit.

Since the compressor and water pump each have 3-Phase motors, it is very important to check that the phase sequence results in the correct motor rotation. This is specifically important when replacing these components or their VFDs. Figure 33 shows how the main power enters the unit. Figure 34 and Figure 35 show how the two VFDs receive and distribute the phased power.



Figure 32. Fan Rotation

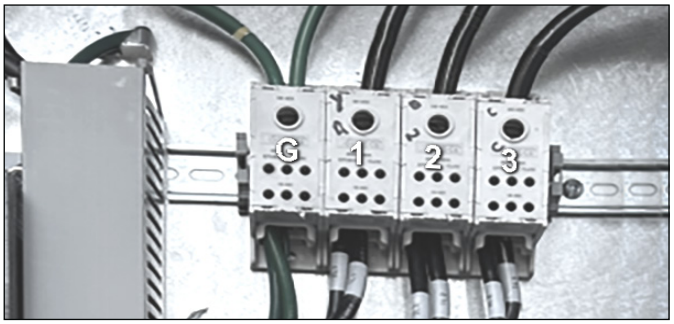


Figure 33. Distribution Blocks

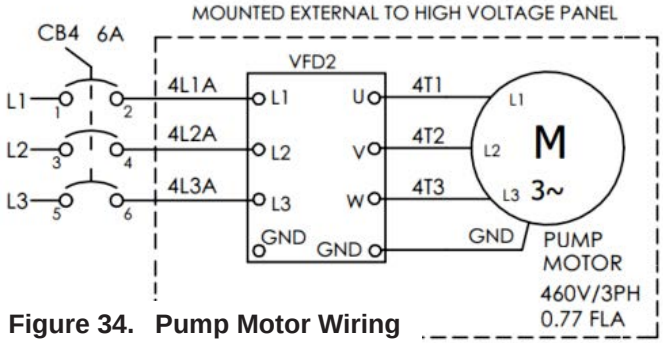


Figure 34. Pump Motor Wiring

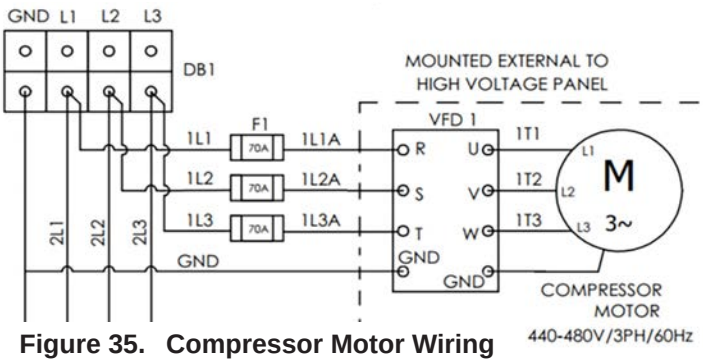


Figure 35. Compressor Motor Wiring

7.A.3 Water Side Fill

NOTE: When the system has been fully piped the installer must ensure that strainers are in place and clear so that heat pump components are supplied with clean potable water. Damage caused by debris entrained in the water is not covered by the warranty.

For the initial water charge, air must be removed via an external vent valve or service valves as shown in Figure 15 on page 20. After filling the system with water, the pump can be placed in manual mode to assist in purging any trapped air.

1 Log into the user as Installer. See Section 6 for instructions on how to log in and navigate the service screens.

2 From the service screen place the heat pump into “Not Commissioned” mode under the “Heat Demand source” page.

3 From the service screen select “Manual Mode”. For the water pump press “Touch to enable” Set the pump percent speed to any value between 50-100%.

4 Check that the water circuit flow switch has been satisfied. Navigate to “Digital I/O” and confirm the “H2O Flow Switch/ 3-Way Defrost Valve Closed Limit Switch” radio button is illuminated green and stays illuminated until all air is removed.

5 Confirm proper pump rotation refer to Figure 32.

6 Once all air is removed from the system, return the water pump back to automatic mode by pressing water pump “touch to disable”.

7.A.4 Preliminary Electrical and Control Verification

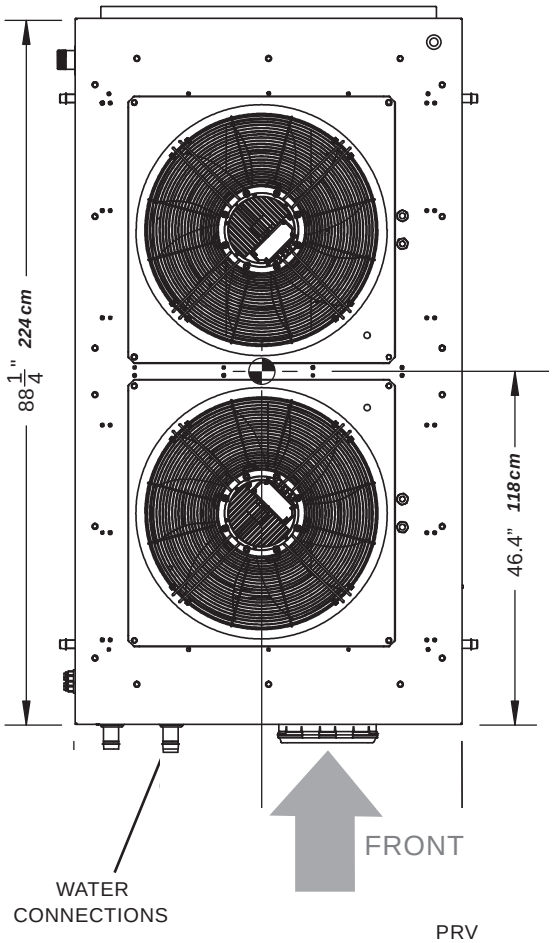
NOTE: Before initializing startup sequence and/or sending a call for heat to the heat pump, all steps in this section must be completed.

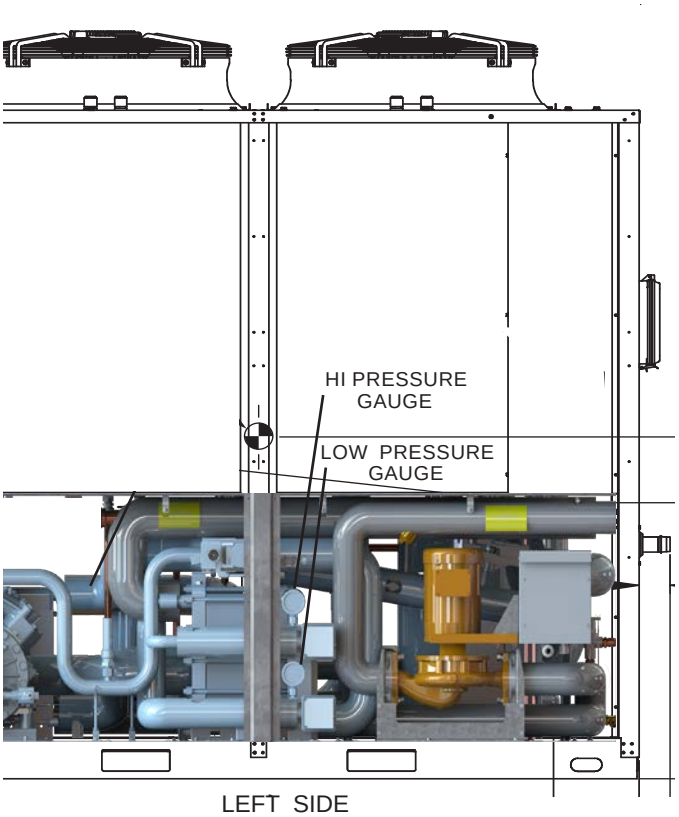
a. Verify that the unit has not been without power for more than 2 years. If it has call the factory.

b. Verify electrical connections are secured in the proper terminal blocks.

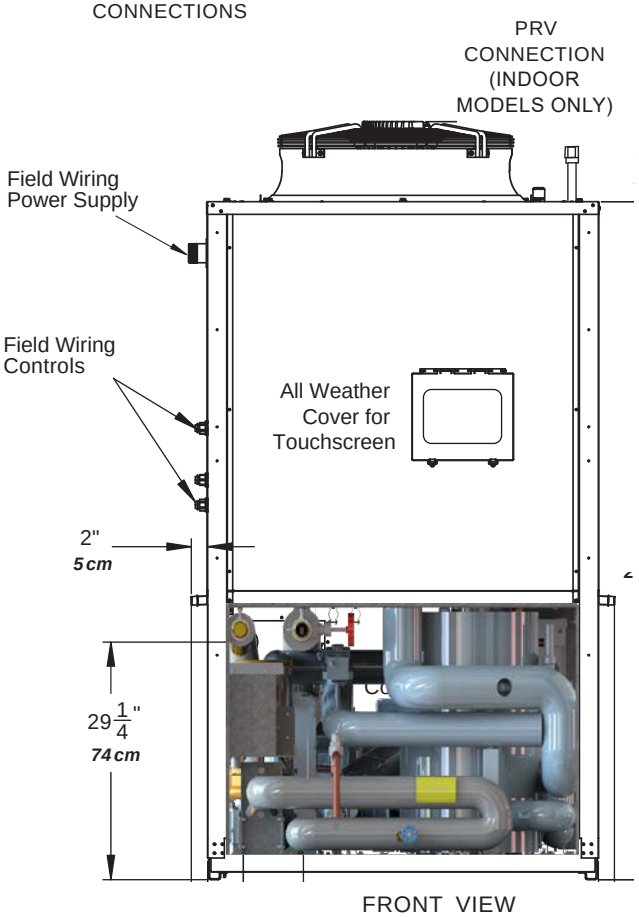
c. Electrically energize the unit with the three phase main electrical power supply. Allow a minimum of 2 hours to pass before attempting to start the compressor.

d. Verify that all three phases of the electrical power





LEFT SIDE



FRONT VIEW

supply voltages are within +/-5% required voltage.

e. Check that the pressure in the refrigerant circuits is shown on the control display and matches the gauge readings.

f. Allow the compressor crankcase heater to run until the bottom of the compressor is noticeably warmer than the surrounding ambient temperature. This warms the compressor oil to ensure the compressor is lubricated. This is most important in colder climates.
The HPWH will not allow the unit to start until the oil temperature criteria is met.

⚠ WARNING

Severe damage to the heat pump may occur during freezing temperatures. Preventative measures must be taken to ensure vulnerable components are protected from freezing.

⚠ AVERTISSEMENT

De graves dommages à la pompe à chaleur peuvent survenir par temps de gel. Des mesures préventives doivent être prises pour garantir que les composants vulnérables sont protégés du gel.

7.A.5 Initial Startup Sequence

a. Once the unit is placed into commissioned state at initial start-up, or upon return of power after a power outage, the heat pump must go through a start-up sequence. The start-up sequence is initiated by a heat demand, generated by either a tank aquastat, the tank sensors, or the tank system controller.

b. Once the start-up sequence is initiated the heat pump moves through the following steps:

1. The fans may cycle on depending on the outdoor ambient conditions.
2. Gas Cooler Valve will fully open to 98%.(This is a fast-acting stepper motor valve with positional feedback that opens in 3 seconds.)
3. Accumulator Isolation valve will begin to close. (This is a slow-acting rotary ball valve that closes in 75 seconds.)
4. Gas expansion reservoir shut off valve will remain open.
5. Once all valves are in their start up positions, the compressor will turn on.
6. The suction pressure will begin to decrease until it reaches approximately 15 bar. The compressor will stop and the isolation and shut off valves will return to their operational positions.
7. With the compressor off, the heat pump will transition to either standby mode (if there is no heat demand) or heat mode (if there is a heat demand).

7.B Normal Shut Down (Standby Mode)

Manually controlled shutdown or no heating demand, puts the following components in the following shutdown state:

a. Compressor: Off

b. Evaporator fans: Off

c. Water pump: Off

d. Heat trace: On, thermostatically controlled

e. Compressor crankcase heater: On, thermostatically controlled

7.C Loss of Electrical Power Shut Down

1. If a loss of electrical power occurs to the heat pump it will put the following components in the following states:

a. Compressor: Off

b. Evaporator fans: Off

c. Water pump: Off

d. Heat trace: Off

e. Compressor crankcase heater: Off

f. Start-up valve: Will slowly open

g. Gas Cooler valve: Reverts to minimum position

2 Upon the return of power, the unit will perform the initial startup sequence.

SECTION 8 System Maintenance

1. Routine maintenance of the unit is essential to the life of the machine. A lack of maintenance can cause poor performance and/or damage to the unit and render the warranty null and void.
2. It is good practice to carry out periodic inspections to verify the proper operation of the unit.

FREQUENCY	OPERATION
Monthly	Check function of all control and safety devices. Examples: Water PRV, water high limit switch, three refrigerant pressure transducers read the same pressure when unit is idle.
Monthly	Visually inspect for corrosion and open circuits in the electrical panels and junction boxes. Check the tightness of interconnecting wires to component terminals if visually suspect.
Monthly	Check for oil leaks on or under the compressor, CO2 PRVs and other components and piping. Superheat should be 20-40F while the unit is in normal operation. Suction pressure should be over 30bar in ambient temperatures over 50F.
Monthly	Check for water leaks in the hydronic system.
Monthly	Verify condensate pans and drains are clean and free draining.
Monthly	Verify there is no air in the water circuit.
Monthly	Verify crankcase heater is operational.
Monthly	Check water filters, screens, and strainers.
Monthly	Check evaporator coil fin surface. Clean if dirty. Comb out fins if flattened and blocked. Check filters if used. Clean or replace if dirty. Check control display screen for coil air pressure drop when operating to confirm operation within proper range.
Monthly	Perform manual defrost test.
4 Months	Verify fan operation for no unusual vibration or sound.
4 Months	Verify compressor operation for no unusual vibration or sound.
Seasonal	If the unit is to remain out of service for an extended period, drain the water from the pipes and the heat exchanger to prevent freezing. This is required to prevent damage to equipment especially when outdoor temperatures are expected to be below freezing during idle period.

SECTION 9 Alarms

Within the Alarm Status Viewer, click on the Action icon to display details of the error, including causes and corrective actions.

The following table describes each alarm, limit and fault, with corrective action. Section G has detailed service information for each component type. The corrective actions are displayed in the alarm status popup from the banner when there is an active alarm. You need to press the "i" button. The corrective actions do not show up in the history or alarm status that is accessible from the settings menu.

Table 5.

Alarm ID	Annunciated Alarm/Fault	Description	Indicates	Corrective Action
1	High Discharge Pressure Switch Limit Exceeded	Upon a heat demand, whether in heat or defrost mode, if the compressor discharge pressure exceeds the compressor high discharge pressure switch (PSH1) threshold, the unit will exit heat or defrost on a compressor high discharge pressure condition. If conditions are safe to operate upon stopping the compressor, the unit may restart a heat or defrost cycle.	High pressure condition at the discharge side of the compressor.	Verify that SUV2 is energized and open. Verify manual ball valves are in the correct position. Verify GCV1 control parameters P, I, & D are at or near factory default settings and that the valve is moving freely. Verify PT1, 2, and 3 all read the same while unit is in standby. Sample files can be exported, allowing the history of GCV1 to be analyzed. Discharge pressure history can also be viewed via the H2O Heating file. This switch should only trip above 106 Bar, if that pressure was never observed, or if the switch fails to reset after pressure is reduced, the switch is bad.
2	Evaporator Differential Pressure Switch Fault	There is an issue with either the analog input module or the evaporator differential pressure signal.	A faulty analog input module, faulty wiring, faulty evaporator differential pressure sensor, or an issue with the VDC power supply.	Check that DPT1 is installed correctly and operating properly.
3	Low Water Flow Limit Exceeded	In start-up or heat mode, if the flow switch opens, indicating inadequate water flow, the heat pump will fault on a low flow condition.	There may be an issue with safety chain voltage (24VDC), flow switch wiring, or the water pump/VFD.	Water flow switch failed to close or could not return signal to controller. Verify manual valves in the water loop are open. Confirm flow switch continuity when flow is present and no continuity when no flow is not present. Verify flow switch wiring and voltage (24VDC) to and from the controller. Check water pump VFD and pump wiring. Verify VFD settings. Verify proper voltage is applied to the VFD. Confirm correct rotation of pump motor. Confirm the Water Pump Margin is high enough (generally 7% or greater).
4	High Water Temperature Fault	If the water temperature leaving the gas cooler exceeds the high temperature setting at TSH1, the heat pump will fault on a high-water temperature condition.	Low flow on the water side of the GC1 or high temperature on the refrigerant side.	Water Flow: Verify water pump VFD settings. Refrigerant: Verify GCV1 PID settings. To restart the heat pump, the TSH1 will reset once temperature is below the setpoint - differential, then the heat pump can be reset via the touch screen.
5	Compressor Thermal Overload Fault	The compressor thermal overload monitors the internal temperature of the compressor.	Compressor working too hard, creating a high internal compressor temperature or faulty wiring/overload.	Verify the compressor VFD settings are correct. Verify compressor voltage. Verify manual ball valves V01-V08 are all open with V07 at a 45 degree angle. Verify GCV1 is operating correctly. Verify voltage (24VDC) and wiring at the overload.
6	Compressor Oil Level Fault	Inadequate oil level in the compressor detected.	The compressor oil differential pressure switch monitors the oil level in the compressor, indicating inadequate oil level in the compressor, or faulty oil differential pressure switch.	On the first occurrence of this condition, verify the oil level in the sight glass on the compressor. With the compressor not running, the oil level may not be visible in the sight glass. Press the reset button on the oil differential pressure switch, as well as on the heat pump display. Allow the compressor to operate and verify the oil level is visible in the sight glass. If there is no oil visible in the sight glass, the unit should trip again. Investigate the oil solenoid operation. Determining how the oil became low is crucial. If there is oil visible in the sight glass and the unit trips again, the oil differential pressure switch is most likely faulty and will need to be replaced.

Alarm Identification (continued)

Alarm ID	Annunciated Alarm/Fault	Description	Indicates	Corrective Action
7	Compressor VFD Fault	Shutdown on a Compressor VFD fault.	VFD will fault based on the following conditions: over temperature, seized compressor, under/over voltage and/or current.	Verify all valves in the refrigeration loop are in the correct position for the current state of the heat pump (start-up/heat/defrost modes). Check VFD and compressor wiring. Verify VFD settings. Verify proper voltage is applied to the VFD. Cycling power to heat pump off for 5-10 minutes should reset VFD faults, once problem is corrected, the main control will also need to be reset.
8	Fan 1 Alarm	Fan 1 has faulted.	Fans will fault based on the following conditions: over temperature, locked rotor, overvoltage, under voltage, and power (over current).	Verify nothing is blocking fans from rotating. Check fan wiring and ensure that 480VAC voltage is applied and within specifications. Note: heat pump can continue to operate at a reduced capacity on a single fan.
9	Fan 2 Alarm	Fan 2 has faulted.	Fans will fault based on the following conditions: over temperature, locked rotor, overvoltage, under voltage, and power (over current).	Verify nothing is blocking fans from rotating. Check fan wiring and ensure that 480VAC voltage is applied and within specifications. Note: heat pump can continue to operate at a reduced capacity on a single fan.
10	Fan 1 & Fan 2 Fault	If both fans are faulted, the heat pump will shut down on a fan fault.	Fans will fault based on the following conditions: over temperature, locked rotor, overvoltage, under voltage, and power (over current).	Verify nothing is blocking fans from rotating. Verify evaporator fins are clean (clear of debris) Check fan wiring, and that proper voltage is applied.
11	H2O Pump VFD Fault	The water pump VFD has an active fault condition.	VFD will fault based on the following conditions: over temperature, blocked impeller, under/over voltage and/or current.	Verify manual valves in the water loop are open. Check VFD and pump wiring. Verify VFD settings. Verify proper voltage is applied to the VFD. Confirm correct rotation of pump motor.
12	H2O Flow Switch Fault	While trying to determine the minimum water pump speed, the flow switch did not open properly.	There may be an issue with the flow switch wiring, or the water pump/VFD.	Verify flow switch wiring and voltage (24VDC) is not shorted. Check for stuck flow switch paddle or shorted switch. Check water pump VFD and pump wiring. Verify VFD settings and operation.
13	Compressor Delta P Timeout Fault	Upon a heat demand, once minimum water flow has been achieved and GCV1 has opened, but the differential pressure across the compressor isn't within allowable differential pressure threshold in time, shut down on a compressor differential pressure fault.	A valve might be in the incorrect position.	Verify that SUV2 is energized and open. Verify manual ball valves are in the correct position.
14	GCV1 Open Timeout Fault	Upon a heat demand, once minimum water flow has been achieved, if the gas cooler valve doesn't open in time, shut down on a gas cooler valve fault.	This is indicative of the gas cooler or controller not functioning properly	Verify 24VDC supply power at the gas cooler valve, verify 0-10VDC control signal, verify gas cooler valve parameter settings. Sample files can be exported, allowing the history of GCV1 to be analyzed. Ensuring the Control Valve Values (x .01) and Feedback Values match.
15	Compressor High Suction Pressure Limit Exceeded	The compressor suction pressure has exceeded normal operating pressure.	This is indicative of faulty wiring/transmitter or potential refrigerant charge issue.	Remove the call and verify PT2 and PT3 (Suction Pressure and Redundant Suction Pressure) reads on the display (+/- 5 bar) the same as PT1 (Discharge Pressure). If pressures are reading properly, the high suction pressure can be caused by a high ambient temperature and high inlet water temperature conditions. Confirm inlet water is not exceeding 125F.
16	GCV1 Feedback Out of Tolerance Alarm	The gas cooler valve feedback is greater than +/-5% of the commanded position.	This could indicate that the valve fully closed/open positioning is off or that the valve might be stuck or blocked from moving to the correct position.	Verify valve is getting the correct signal voltage (0-10VDC). Inspect the valve to ensure might it is not stuck or blocked from moving to the correct position.

Alarm ID	Annunciated Alarm/Fault	Description	Indicates	Corrective Action
17	Compressor High Discharge Pressure Sensor Limit Exceeded	Upon a heat demand, whether in heat or defrost mode, if the compressor discharge pressure gets too high, shut down on a compressor high discharge pressure fault. If conditions are safe to operate upon stopping the compressor, the unit may restart a heat or defrost cycle.	High pressure condition at the discharge side of the compressor.	Verify manual valves V03 and V04 valve are in "open" position. Verify gas cooler valve and accumulator isolation valve operation. Verify PG1 and the discharge pressure values approach the high discharge pressure switch lockout value just prior to lockout.
18	Compressor Outlet Temperature Sensor Fault	There is an issue with either the TC input module or the compressor outlet temperature sensor TC.	A faulty analog input module, faulty wiring, failed temperature sensor, or an issue with the VDC power supply.	Verify the power LED on the analog input module is illuminated green, verify the TC sensor functionality with a multimeter with T-type thermocouple reader or use ohms function.
19	High Suction Pressure Limit Exceeded	Upon a heat demand, whether in heat or defrost mode, if the compressor suction pressure_ gets too high, shut down on a compressor high suction pressure fault. If conditions are safe to operate upon stopping the compressor, the unit may restart a heat or defrost cycle.	High pressure condition at the suction side of the compressor.	Verify the inlet water temperature is not too high. May also indicate a high ambient condition.
20	Start-up Low Suction Pressure Timeout Fault	If a start-up sequence is initiated, compressor oil temperature has been achieved, minimum water flow established, and the gas cooler valve has opened properly, but the compressor suction pressure doesn't drop-in time, the heat pump will shut down on a start-up suction pressure fault.	This is indicative of the compressor not working properly, an issue with the suction pressure transmitter value, or the accumulator isolation valve is in the wrong position.	Compressor Troubleshooting: Verify power at compressor VFD and VFD settings. Verify compressor VFD enable (dry contact) and speed wiring (0-10VDC). Suction Pressure Transmitter Troubleshooting: Verify transmitter supply voltage and wiring. Verify transmitter signal (4-20mA) to PLC. Isolation Valve Troubleshooting: Verify valve V01 and V08 are in the open position.
21	Start-up Low Suction Pressure Timeout Fault	If a start-up sequence is initiated, compressor oil temperature has been achieved, minimum water flow established, and the gas cooler valve has opened properly, compressor suction pressure lowered beyond the low suction pressure threshold.	This indicates that low suction pressure RTD isn't working correctly or is not wired correctly.	Verify suction pressure reading on the HMI matches (+/- 5 bar) to PG2, the pressure gauge on the suction side of the compressor. Verify the three RTDs read the same when the compressor is off. Verify wiring.
22	Compressor High Oil Temperature Alarm	The compressor oil temperature has exceeded normal operating temperature.	Compressor oil heater thermostat might be having issues of the oil temperature sensor is reading incorrectly.	Use a thermal imager or sensor to compare the compressor surface temperature, near the sensor location, with oil temperature reading on the display. Check electrical connections at the sensor. If sensor checks out, investigate operating conditions: If ambient is low (5F), inlet water is high (100F+) and/or a high setpoint (180F), the oil temperature may be too high due to exceeding output capacity, compressor is working too hard.

Alarm Identification (continued)

Alarm ID	Annunciated Alarm/Fault	Description	Indicates	Corrective Action
23	Compressor High Oil Temperature Fault	The compressor oil temperature is too high.	Compressor oil heater thermostat might be having issues, or the oil temperature sensor is reading incorrectly.	Use a thermal imager or sensor to compare the compressor surface temperature, near the sensor location, with oil temperature reading on the display. Check electrical connections at the sensor. If sensor checks out, investigate operating conditions: If ambient is low (5F), inlet water is high (100F+) and/or a high setpoint (180F), the oil temperature may be too high due to exceeding output capacity, compressor is working too hard.
24	3-Way Heat/Defrost Limit Switch Fault	Whether in heating or defrost, the heat/defrost valve is in the incorrect position.	The valve may be in the incorrect position, or the limit switches may need adjustment.	If the valve position indicator is in the correct position (based on the current operating state of the heat pump as well as indication on the HMI), verify limit switch position at the switch - adjust as needed. Verify both wiring (continuity) and voltage (24VDC) for proper feedback to the PLC.
25	Defrost Valve Limit Switch Fault	Whether in heating or defrost, the defrost valve is in the incorrect position.	The valve may be in the incorrect position, or the limit switches may need adjustment.	If the valve position indicator is in the correct position (based on the current operating state of the heat pump as well as indication on the HMI), verify limit switch position at the switch - adjust as needed . Verify both wiring (continuity) and voltage (24VDC) for proper feedback to the PLC.
26	Start-up Low Oil Temperature Fault	If a start-up sequence is initiated, but the compressor oil temperature takes too long to heat up, shutdown on a start-up compressor oil temperature fault.	The compressor oil heater isn't working properly	Check heater resistance, verify heater power. Amperage should be around 0.4 to 1.25 Amps. Note: Compressor heater has a built-in thermostat.
27	Compressor Low Oil Temperature Fault	Upon a heat demand (or defrost cycle), if the compressor oil temperature takes too long to heat up, shutdown on a compressor low oil temperature fault.	The compressor oil heater isn't working properly	Check heater resistance, verify heater power. Amperage should be around 0.4 to 1.25 Amps. Note: Compressor heater has a built-in thermostat.
28	Start-up Gas Cooler Valve Timeout Fault	If a start-up sequence is initiated and compressor oil temperature has been achieved, but the gas cooler valve has not opened in time, the heat pump will shut down on a start-up gas cooler fault.	The gas cooler valve or controller aren't working properly.	Verify 24VDC supply power at the gas cooler valve, verify valve 0-10VDC control signal, verify the gas cooler valve PID parameter settings.
29	Low Superheat Fault	Superheat is too low.	Potential gas cooler outlet temperature sensor issue or compressor suction pressure sensor issue. Low superheat potentially indicates too much charge.	Compressor suction pressure sensor troubleshooting: Verify supply voltage and wiring. Verify signal (4-20mA) to PLC. Gas cooler out temperature troubleshooting - verify thermocouple wiring. Use a multimeter T-type thermocouple reader to verify thermocouple. Adjust manual bypass (recuperator) valve (See service manual)
30	Inlet Water Temperature Limit Exceeded	Inlet water temperature to the heat pump has exceeded the threshold of 135F for 5 seconds.	Heat pump return temperature has exceeded its maximum allowable temperature, storage tanks are full or plumbed incorrectly.	Verify TT1 sensor is reading correctly and that the return temperature is below 135F.

Alarm ID	Annunciated Alarm/Fault	Description	Indicates	Corrective Action
31	Gas Cooler Outlet High Temperature Limit Exceeded	The gas cooler outlet temperature has exceeded the alarm threshold.	In heating mode, if the gas cooler temperature has exceeded 160F for a period of time, the unit will alarm on high gas cooler outlet temperature. This indicates poor heat transfer from the refrigerant to the water (refrigerant side of the gas cooler) or inadequate water flow (water side of the gas cooler).	Verify the piping is sized properly for the water pump. Verify the water pump PID loop is tuned properly. Verify all manual valves are in the correct position. Check strainers and/or flush the water side of the gas cooler. Ensure return water is not remaining at elevated temperatures.
32	Gas Cooler High Outlet Temperature Fault	The gas cooler outlet temperature has exceeded the alarm threshold.	In heating mode, if the gas cooler temperature has exceeded 170F for a period of time, the unit will alarm on high gas cooler outlet temperature. This indicates poor heat transfer from the refrigerant to the water (refrigerant side of the gas cooler) or inadequate water flow (water side of the gas cooler).	Verify the piping is sized properly for the water pump. Verify the water pump PID loop is tuned properly. Verify all manual valves are in the correct position. Check strainers and/or flush the water side of the gas cooler. Ensure return water is not remaining at elevated temperature.
33	High Water Temperature Limit Exceeded	The water temperature supplied to the tank(s) has exceeded the alarm threshold.	In heat mode, the heat pump outlet water temperature has been higher than 10F above the set point for more than 20 minutes. This might indicate that speed of the pump isn't enough to lower the delta T to reach set point.	Verify water pump VFD settings. Verify the piping is sized properly for the water pump. Verify the water pump PID loop is tuned properly. Verify all manual valves are in the correct position. Check strainers and/or flush the water side of the gas cooler.
34	High Water Temperature Fault	The water temperature supplied to the tank(s) has exceeded the shutdown threshold.	This indicates low water flow on the water side of the gas cooler or high temperature on the refrigerant side. There could also be an issue with the heat pump outlet water temperature sensor.	Verify water pump VFD settings. Verify the piping is sized properly for the water pump. Verify the water pump PID loop is tuned properly. Verify all manual valves are in the correct position. Check strainers and/or flush the water side of the gas cooler.
35	High Superheat Limit Exceeded	Superheat has exceeded the alarm threshold for 5 minutes.	Potential sensor issues at TT6 - compressor suction temperature or at PT2 - compressor suction pressure. Might also indicate not enough refrigerant charge.	Confirm proper operation of the Differential Pressure Transducer and defrost settings. Verify PT1, 2 and 3 all read the same when unit is in standby. Verify TT6 is reading properly. On a power cycle to the heat pump, or by using the commissioning feature, verify the heat pump is properly transitioning through the start-up sequence. Adjust manual bypass (recuperator) valve (See service manual).
36	High Superheat Fault	Superheat is too high.	This could be indicative of a potential compressor suction temperature sensor issue or compressor suction pressure transmitter issue. High superheat could also indicate that there is not enough refrigerant charge.	Confirm proper operation of the Differential Pressure Transducer and defrost settings. Verify PT1, 2 and 3 all read the same when unit is in standby. Verify TT6 is reading properly. On a power cycle to the heat pump, or by using the commissioning feature, verify the heat pump is properly transitioning through the start-up sequence. Adjust manual bypass (recuperator) valve (See service manual).
37	High Discharge Pressure Sensor Fault	There is an issue with either the analog input module or the pressure transmitter.	A faulty analog input module, faulty wiring, faulty transmitter, or an issue with the VDC power supply.	Verify the power LED on the analog input module is illuminated green, verify transmitter functionality, verify 24 VDC.
38	Low Suction Pressure Sensor Fault	There is an issue with either the analog input module or the primary or redundant pressure transmitter.	A faulty analog input module, faulty wiring, faulty transmitter, or an issue with the VDC power supply.	Verify the power LED on the analog input module is illuminated green, verify transmitter functionality, verify 24 VDC.

Alarm Identification (continued)

Alarm ID	Annunciated Alarm/Fault	Description	Indicates	Corrective Action
39	Gas Cooler Valve Feedback Failure Fault	There is an issue with either the analog input module or the gas cooler valve positional feedback signal.	A faulty analog input module, faulty wiring, faulty gas cooler valve controller, or an issue with the VDC power supply.	Verify the power LED on the analog input module is illuminated green, verify gas cooler valve functionality, verify 24 VDC.
40	Heat Pump Inlet Temperature Sensor Alarm	There is an issue with either the TC input module or the inlet water temperature TC.	A faulty analog input module, faulty wiring, failed temperature sensor, or an issue with the VDC power supply.	Verify the power LED on the analog input module is illuminated green, verify 24 VDC. Investigate the TC sensor referring to Section G for more details.
41	Heat Pump Supply Water Temperature Fault	There is an issue with either the TC input module or the heat pump outlet water temperature sensor TC.	A faulty analog input module, faulty wiring, failed temperature sensor, or an issue with the VDC power supply.	Verify the power LED on the analog input module is illuminated green, verify the TC sensor, verify 24 VDC.
42	Gas Cooler Outlet Temperature Sensor Fault	There is an issue with either the TC input module or the gas cooler outlet temperature sensor TC.	A faulty analog input module, faulty wiring, failed temperature sensor, or an issue with the VDC power supply.	Verify the power LED on the analog input module is illuminated green, verify the TC sensor, verify 24 VDC.
43	Compressor Inlet Temperature Sensor Fault	There is an issue with either the TC input module or the compressor inlet temperature sensor TC.	A faulty analog input module, faulty wiring, failed temperature sensor, or an issue with the VDC power supply.	Verify the power LED on the analog input module is illuminated green, verify the TC sensor, verify 24 VDC.
44	Ambient Air Temperature Sensor Fault	There is an issue with either the TC input module or the ambient air temperature sensor TC.	A faulty analog input module, faulty wiring, failed temperature sensor, or an issue with the VDC power supply.	Verify the power LED on the analog input module is illuminated green, verify the TC sensor, verify 24 VDC.
45	Heat Pump Heat Demand-On Sensor Fault	There is an issue with either the TC input module or the heat pump heat demand on temperature sensor TC.	A faulty analog input module, faulty wiring, failed temperature sensor, or an issue with the VDC power supply.	Verify the power LED on the analog input module is illuminated green, verify the TC sensor, verify 24 VDC.
46	Suction Pressure Exceeds Discharge Pressure Fault	In heat or defrost mode, if the compressor is running, if the suction pressure is greater than the discharge pressure, after a short time delay lockout the heat pump on compressor differential condition.	Faulty wiring or swapping of sensor wiring (either at the sensor(s) or in the control panel) or a faulty pressure transmitter.	Verify pressure transmitter reading on the display versus actual gauges for accuracy. Verify wiring and transmitter functionality. Verify manual refrigeration valve V01 and V08 are both open.
47	Heat Pump Heat Demand-Off Sensor Fault	There is an issue with either the TC input module or the heat pump heat demand off temperature sensor TC.	A faulty analog input module, faulty wiring, failed temperature sensor, or an issue with the VDC power supply.	Verify the power LED on the analog input module is illuminated green, verify the TC sensor, verify 24 VDC.
48	Compressor Oil Temperature Sensor Fault	There is an issue with either the TC input module or the compressor oil temperature sensor TC.	A faulty analog input module, faulty wiring, failed temperature sensor, or an issue with the VDC power supply.	Verify the power LED on the analog input module is illuminated green, verify the TC sensor, verify 24 VDC.
49	Control Panel Enclosure Temperature Sensor Alarm	There is an issue with either the TC input module or the enclosure temperature sensor TC.	A faulty analog input module, faulty wiring, failed temperature sensor, or an issue with the VDC power supply.	Verify the power LED on the analog input module is illuminated green, verify the TC sensor, verify 24 VDC.
50	Control Panel High Temperature Alarm	Enclosure temperature has exceeded 125F. Extended exposure to high temperatures could reduce electronic life expectancy.	Might be indicative of high ambient temperature conditions, enclosure temperature sensor issues, or the control panel circulating fan is not working properly.	Confirm the control panel circulating fan is working using the manual feature and ensure the filters are not clogged (See Section G). Confirm the enclosure temperature sensor is reading correctly. If the ambient temperatures regularly exceed heat pump design temperatures, the equipment may have a reduced life however the unit will continue to run until a failure occurs. This warning will not prevent the HPWH from running.

Alarm ID	Annunciated Alarm/Fault	Description	Indicates	Corrective Action
51	Compressor Short Cycle Alarm	The compressor is short cycling.	The compressor has started at least 10 times within the last hour.	Double check heat demand inputs for proper wiring, voltage and signal. Check for high discharge pressure and high water inlet temperatures.
52	Compressor Short Cycle Fault	The compressor is short cycling.	The compressor has started at least 10 times per hour for the last two hours or has started 20 times in the last hour.	Double check heat demand inputs for proper wiring, voltage and signal. Check for high discharge pressure and high water inlet temperatures.
53	Inlet/Exhaust Proof of Fans Alarm	Inlet / Exhaust Fans have not proven for 10 minutes, or proof has dropped out.	This may indicate a wiring issue with the proof of fans connection, or a faulty fan.	Double check Inlet / Exhaust fans output for proper wiring, voltage and signal. Double check Proof of Inlet / Exhaust Fans inputs for proper wiring, voltage and signal.
54	Low Ambient Temperature Alarm	Flag low ambient temperature.	Indicates that the ambient temperature sensor is reading a value equal to or less than -10F.	Flag will turn off when the ambient temperature is warm enough.
55	Clogged Evaporator Alarm	Evaporators are dirty.	Possible blockage from dust, dirt, pollen that requires the coils to be cleaned. Evaporator differential pressure is high and ambient temperatures are warm.	Inspect and clean evaporator coils. Ensure the pressure differential switch is working properly.
56	Battery Low Alarm	The internal PLC battery is low.	Retained settings have been saved to the SD card. Any further changes to retained settings may not be saved automatically.	Replace CR2032 battery. Then reboot the PLC. If retained settings were not maintained through battery replacement, import the retained settings manually.
57	Tank Controller Communications Alarm	Communication connection lost to Tank Controller	This indicates an Ethernet communication disruption between the Tank System Controller and the heat pump	Inspect Ethernet cable connection between the heat pump and Tank System Controller
58	Battery Not Detected Alarm	There is no battery detected.	Retained settings will not be saved through a power cycle of the PLC. Retained settings must be manually saved and re-imported upon PLC restart.	Replace CR2032 battery. Then reboot the PLC. Import any retained settings manually.
59	Low Gas Cooler Temperature Differential Fault	The compressor outlet temperature (TT4) and the gas cooler outlet temperature (TT5) are close to the same temperature.	Indicates an operational condition that is not expected. The two sensors are not expected to be within 3F of each other, in heat mode.	Check that DV1 is installed correctly and is operating properly.
60	Low Suction Pressure (Transducer) Fault	If the compressor suction pressure gets too low, shut down on a compressor low suction pressure fault.	This might indicate the fan speed is too low or that there is an air lock. The unit might also be iced up, requiring a defrost cycle. The lowest suction pressure as measured by either suction pressure transducer is used to set this fault.	Verify fan operations. There is potentially an issue with the refrigerant charge - please contact the factory for guidance.
61	Low Suction Pressure Transducer Difference Fault	The two suction pressure transducers disagree by more than 1 bar.	Likely one sensor is inaccurate.	Verify readings of the compressor and redundant pressure transducers in the Analog Inputs menu. The readings should not differ by more than 1Bar. When the heat pump compressor is not running, the compressor discharge and suction pressure readings should be the same.

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All Manuals (Install & Operate, Start Up, and Service Manuals) can be downloaded at

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