HOTSTART®

Coolant Circulating
Heating System

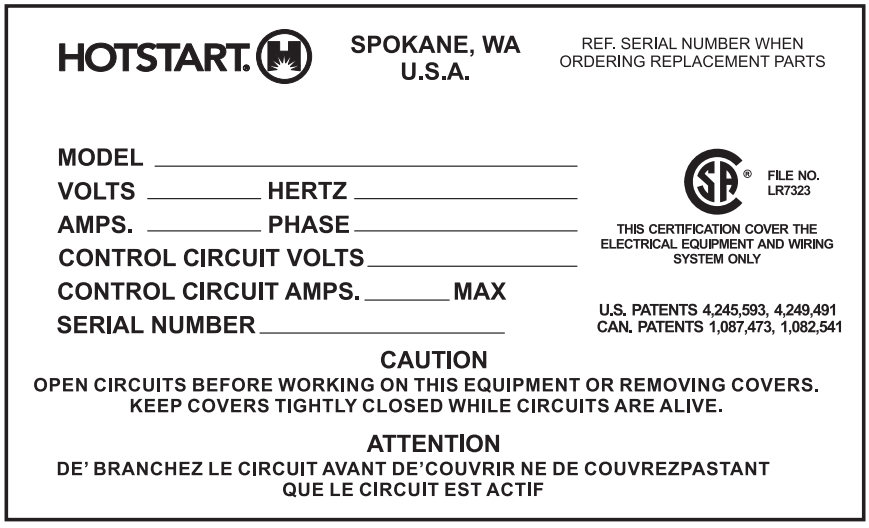
Installation & Operation Manual

216237-000 REV 2

Identifying Your System

The HOTSTART heating system is a compact heating system designed for use in marine propulsion, diesel-powered generator sets, gas compression, or any large-engine applications. The system is pre-wired, pre-plumbed, and assembled on a steel plate and mounting channel. Each heating system has an identification plate with the part number and serial number on it. Please reference those numbers when ordering replacement parts.

NOTE: When ordering replacement parts, be sure to reference your heating system's model and serial numbers found on the identification plate and the label above.



Example label—actual label may vary slightly from model to model, but the general layout is the same.

Product Specifications

16-19kW 380-415V 50Hz
15-18kW 440-480V 60Hz

CMM Coolant Preheater
Complete coolant preheater with thermostat, pump, controls and flow-switch. For engines with displacement between 100 and 400 liters.

Applications
The CMM was developed to preheat diesel and gas engines in stationary land power, marine, rail, large mining and construction equipment.

Product Specifications
Heating Fluid: Engine coolant (50% glycol/50% water)
Power: 18 kW
Tank material : Steel
Enclosure: IP44
Fluid capacity: 3L (including pump)
Weight: 55.4 kg (122lbs)
Pump Input Power: 0.20kW
Flow: 3.59 m^3/hr (15.8GPM)
Head: 5.37 m (17.6 foot)
Flow Switch: 0.4 m^3/hr (2GPM)
Rated Voltage: 3 phase 400V (380-415V) 50Hz, 3 phase 460V (440-480V) 60Hz
Thermostat : On at 50°C, Off at 60°C (120-140F)
Max Pressure: 8.61 bar (125PSI)
Pressure Loss: 0.20 bar (3PSI)
Pressure Relief Valve: 6.2 bar (90PSI)
Inlet/Outlet: DN25 (DIN2633)

Features
CE marked
Designed and tested to meet DNV Marine Classification
24VDC relay for auto ON/OFF
Flow switch for increased protection
Auxiliary contacts for remote monitoring
Optional E-stop

Product Specifications

30-36kW 380-415V 50Hz
30-36kW 440-480V 60Hz

CLM Coolant Preheater
Complete coolant preheater with thermostat, pump, controls and flow-switch. For engines with displacement between 250 and 800 liters.

Applications
The CLM was developed to preheat diesel and gas engines in stationary land power, marine, rail, large mining and construction equipment.

Product Specifications
Heating Fluid: Engine coolant (50% glycol/50% water)
Power: 36kW
Tank material : Steel
Enclosure: IP54
Fluid capacity: 3.5L (including pump)
Weight: 77.6 kg (171lbs)
Pump Input Power: 0.56kW (0.75HP)
Flow: 9.0 m^3/hr (40GPM) (60Hz)
Head: 12.20 m (40 foot)
Flow Switch: 0.4 m^3/hr (2GPM)
Rated Voltage: 3 phase 400V (380-415V) 50Hz, 3 phase 460V (440-480V) 60Hz
Thermostat : On at 50°C, Off at 60°C (120-140F)
Max Pressure: 8.61 bar (125PSI)
Pressure Loss: 0.20 bar (3PSI)
Pressure Relief Valve: 6.2 bar (90PSI)
Inlet/Outlet: DN32 Inlet, DN25 Outlet (DIN2633)

Features;
CE marked
Designed and tested to meet DNV Marine Classification
24VDC relay for auto ON/OFF
Flow switch for increased protection
Auxiliary contacts for remote monitoring
Optional E-stop

Product Specifications

18kW 690V 50/60Hz
33kW 690V 50/60Hz

CLM Coolant Preheater
Complete coolant preheater with thermostat, pump, controls and flow-switch. For engines with displacement between 100 and 800 liters.

Applications
The CLM was developed to preheat diesel and gas engines in stationary land power, marine, rail, large mining and construction equipment.

Product Specifications
Heating Fluid: Engine coolant (50% glycol/50% water)
Power: 18kW, 33kW
Tank material : Steel
Enclosure: IP54
Fluid capacity: 3.5L (including pump)
Weight: 77.6 kg (171lbs)
Pump Input Power: 0.56kW (0.75HP)
Flow: 9.0 m^3/hr (40GPM) (60Hz)
Head: 12.20 m (40 foot)
Flow Switch: 0.4 m^3/hr (2GPM)
Rated Voltage: 3 phase 690V 50/60Hz
Thermostat : On at 50°C, Off at 60°C (120-140F)
Max Pressure: 8.61 bar (125PSI)
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Pressure Relief Valve: 6.2 bar (90PSI)
Inlet/Outlet: DN32 Inlet, DN25 Outlet (DIN2633)

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24VDC relay for auto ON/OFF
Flow switch for increased protection
Auxiliary contacts for remote monitoring
Optional E-stop

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Important Safety Information

⚠ WARNING

All electrical work must be done by qualified personnel in accordance with the national electrical code and applicable state and local codes.

System can start automatically and without warning. Before wiring, servicing, or cleaning the system turn off the power and install a lockout on the heater circuits at the service panel.

⚠ CAUTION

Installers and operators of this equipment must be thoroughly familiar with the instructions in this manual before commencing work.

Use proper lifting equipment and rigging to move this equipment. Create a plan before attempting to move.

Hot surfaces: avoid contact with the system while it is in service—some surfaces may stay hot *even if the system is not energized*. Use common sense when performing any maintenance on this equipment.

Rotating equipment: system can start automatically and without warning—avoid contact unless a lockout at the service panel has been installed.

Warranty Information

The warranty below has been drafted to comply with the Federal Law applicable to products manufactured after December 31, 1976. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

HOTSTART products are warranted against defects in workmanship and materials. No other express warranty, written or oral, applies. No person is authorized to give any other warranty or assume any liability except by written statement from an officer of HOTSTART, Inc.

The warranty extends for twelve months from date of shipment from factory or authorized distributor.

Products must be installed and maintained in accordance with HOTSTART, Inc. instructions. Users are responsible for the suitability of the products to their application. There is no warranty against damage resulting from corrosion, misapplication, improper specification or other operating conditions beyond our control. Claims against carriers for damage in transit must be filed by the buyer.

Unauthorized alterations to factory supplied equipment voids this warranty. Consult the factory if modifications are required.

Absolutely no material can be returned to HOTSTART, Inc. without prior factory authorization.

Upon factory authorization, return the defective part or product, freight prepaid, to: HOTSTART, Inc., 5723 E. Alki, Spokane, WA 99212. Telephone (509) 534-6171; FAX (509) 534-4216.

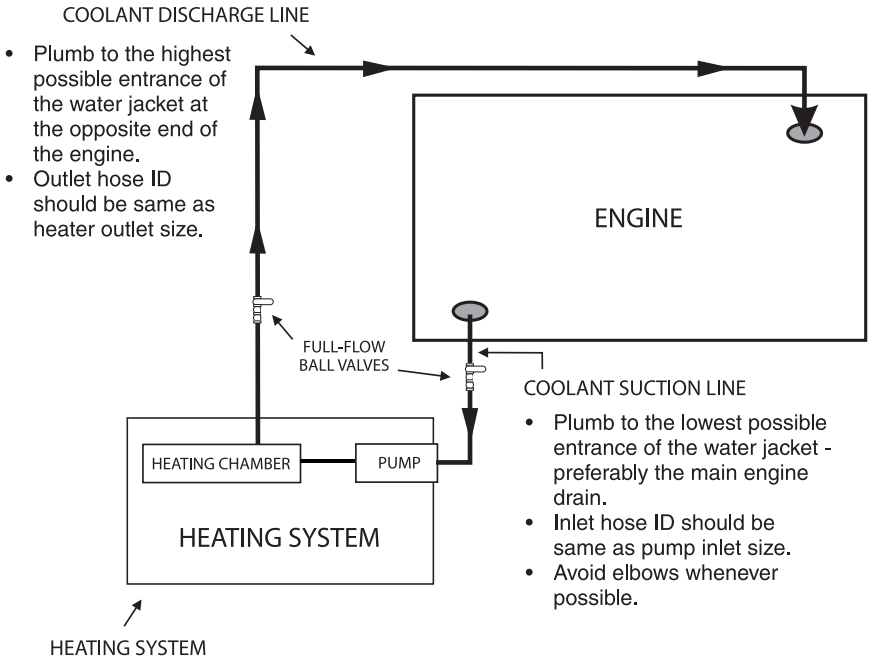
Defective items will be repaired or replaced, at our option, at no charge. Such repair or replacements is the exclusive right of HOTSTART, Inc. HOTSTART, Inc. is not liable for labor costs incurred in removal, reinstallation, or unauthorized repair of the product or for damage of any type whatsoever including incidental or consequential damage. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the preceding limitation or exclusion may not apply to you.

HOTSTART, INC.

Table of Contents

Installation

Coolant System Diagram



NOTICE

After completing coolant line installation, top-off the coolant level to compensate for the coolant used to fill the lines and heating tank. The system should be configured with user supplied full flow ball valves in the coolant lines allowing maintenance on the heating system without draining the engine coolant.

⚠ CAUTION

Pressure and steam hazard: power must be turned off and locked out at the main service panel when the ball valves are in the closed position. Failure to do so may result in the release of pressurized steam.

Open ball valves before operating system.

Mounting

⚠ CAUTION

Heavy equipment:
Proper rigging and safety equipment must be used to move this equipment—weight is not centered. Plan ahead before attempting to move this equipment.

Mount the HOTSTART Heating System as low and as close to the suction port on the engine as possible. The use of elbows in the suction line should be reduced or eliminated if possible. The discharge line should be plumbed to the opposite end of the engine that the suction port is taken from: this creates a "cross-flow" through the engine that enables an even heating of the engine.

Note: Clearance is required for heating element removal—before permanently mounting the heating system, verify that sufficient clearance exists.

NOTICE

Do not mount the heating system directly to the engine

- Mount the system on the floor next to the engine or to the skid
- To avoid vibration related problems, properly vibration-isolate the heating system from the engine

Coolant Supply Line

Connect a coolant supply line from the main coolant drain of the engine to the inlet of the HOTSTART Heating System as shown on the coolant system diagram. The inside diameter (ID) shall be no smaller than the suction port of the pump for short [< 10' (3m)] runs. For suction lines longer than 10' (3m) the ID shall be greater than the suction port of the pump. Increase the ID of the suction line by one standard pipe size for every 10' (3m) of piping added. Do not exceed 20' (6m) in length on the supply line.

Coolant Discharge Line

Connect a coolant return line from the outlet of the heating system to the highest possible location on the engine coolant system opposite the main coolant drain (see "Coolant System Diagram"). The ID shall be no smaller than the discharge port of the heating system. This connection enables heated coolant to be circulated through the entire engine. Additional lines may be needed to heat auxiliary components.

Fill cooling system following engine manufacturer's recommendations. Bleed air from the heating system and top-off the coolant.

NOTICE

Do not reduce the inlet line.

- Reducing the inlet line will result in pump damage

Position the heating tank so that it is completely full of coolant while in operation.

- Failure to completely fill the heating tank with coolant will result in element damage.

Prime the pump and fill the suction line before starting the system.

- Pump is not self-priming. Liquid must be present in the pump before startup. Trapped air inside the pump will cause pump and seal damage.

Follow engine manufacturer's recommendations for coolant mixture.

- HOTSTART recommends using pre-mixed coolant. **Do not** use tap water to mix with coolant—element damage will occur. Tap water contains calcium and other minerals which will precipitate from the solution and attach to the element and other engine components providing insulation from heat transfer.

Pressure Relief Valve

The system is equipped with a pressure relief valve that is pre-set to relieve at 90 psi. Attach pipe that is sized to the outlet of the pressure relief valve and direct it toward a safe area. When operating properly releases are rare, but it is recommended that a bucket or other catch-basin be located under the release pipe to avoid damage to surrounding items if a release occurs.

⚠WARNING

Pressurized steam hazard:

Outlet must be plumbed to a safe place in case an over-pressure release of hot coolant occurs.

Pressure Relief Valve
P/N: PRP203018-000

Main Power Supply

Connect the specified power (+ or – 10% of the rated voltage) to the terminal blocks located in the main control box. For 3-phase applications, the terminal blocks are labeled L1, L2, and L3. For single phase applications, use the terminal blocks labeled L1 and L3.

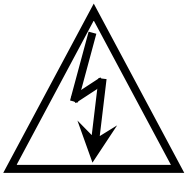
The main power ground wire must be connected to the ground lug on the electrical panel located inside the electrical box.

The main power supply operates the heating elements and the circulating pumps. A transformer, used to operate the control circuit, drops the main supply voltage to 120V. The transformer and control circuits are overload protected with fuses and/or a circuit breaker.

Reference the control box drawing and wiring diagram for all other connection points.

⚠WARNING

Hazardous Voltage: A lockout must be used at the main service panel when work is being done inside the control box to avoid electrocution.



All wiring shall be done by qualified personnel in accordance with national, state, and local codes. Each system shall be grounded in accordance with the National Electrical Code. Failure to properly ground the system may result in electric shock.

Heating System Start-Up and Operation

Step 1 Check and tighten all electrical and plumbing connections.

Step 2 **Check for proper rotation of the motor** by quickly turning the system on and then back off again while watching the motor shaft or fan. Some systems are equipped with lights inside the electrical box to verify correct rotation—consult pump/motor documentation in the back of this manual before continuing. It may be necessary to remove the screw in the top of the pump in order to see the shaft spin. Single phase systems are pre-wired to rotate the correct direction. If the pump is not rotating the correct direction; switch any two electrical leads on a three-phase system at the power-in block.

NOTICE

DO NOT RUN MOTOR/PUMP ASSEMBLY DRY MORE THAN A FEW SECONDS.

- *Running a pump that is not completely filled with liquid will cause damage to the pump*

Step 3 **The pump must be primed**. It is important to remove all trapped air in the suction side of the system. If necessary, disconnect a fitting near the pump on the suction line and fill with fluid. **Bleed all trapped air from the pump prior to energizing the system.**

⚠ CAUTION

Pressurized steam hazard:

- Open ball valves before energizing the system

Step 4 Energize the heating system by switching the control switch to either the Local or Remote position and applying a 24V signal if necessary. You should be able to hear fluid moving through the lines. If not, loosen a fitting on the discharge line of the pump to verify flow or install a pressure gauge in the output side of the system. If the minimum flow rate is not achieved, or flow restriction in the suction line has occurred, the heating system will automatically shut down approximately 3 minutes after start-up. Turn the system OFF and check plumbing lines for any leaks or restrictions. Remove trapped air from the pump and suction line. Repeat steps 2, 3, and 4.

NOTE: On initial start-up, it may take several attempts to achieve proper flow.

Step 5 Once operation is satisfactory; turn the control dials on the time delay relay to the desired setting. HOTSTART recommends a setting of 30 seconds. Turn the heating system off and then back on to activate the new setting.

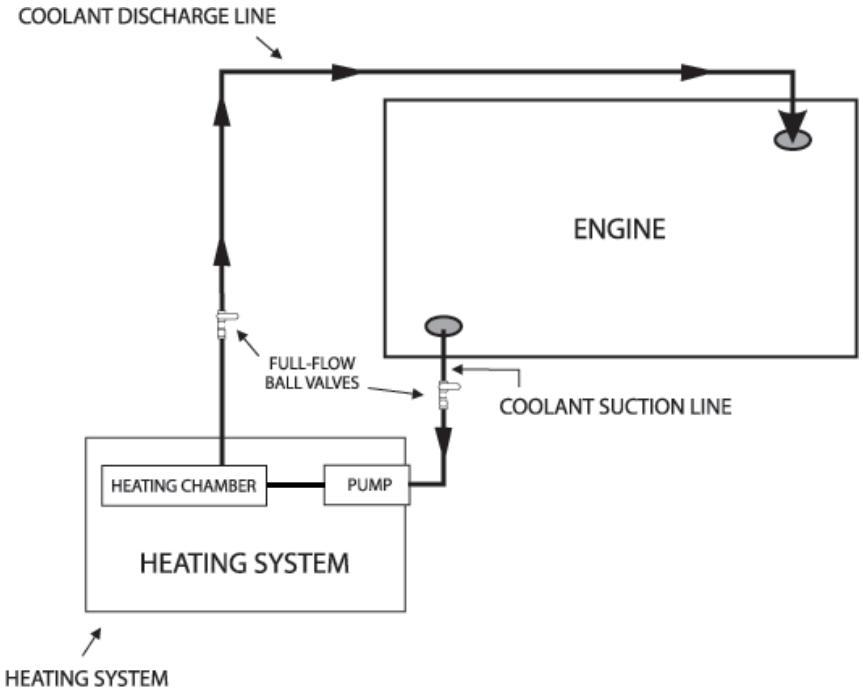
System Controls

Coolant Inlet/Outlet Process

Upon energizing the system, engine coolant, taken from the coolant drain area in the lower section of the engine, is circulated through the heating tank via a centrifugal pump.

Coolant then passes through a check valve, which limits coolant backflow while the engine is operating. Finally, heated coolant is returned to the back top of the engine at its optimum starting temperature.

The heating system is designed to run continuously while the engine is not running. The heating element will cycle on and off with the system thermostat to maintain the temperature while the pump runs continuously to circulate the coolant and maintain an even temperature.



System Components

The control box contains the electrical control components for the heating system. Following is an overview of operation for the standard parts located on the system, including:

Local/Off/Remote 3-position Switch
Indicator Lights
24V Remote Control Relay
Flow Fault Relay and Light
Time Delay Relay
Flow Switch
Thermostat

Parts in the control box may vary, depending on the particular system configuration purchased.

Remote/Local Control

For systems equipped with a "Local/Off/Remote" switch the heating system operates different in each setting. In the "Local" position the 24V relay is bypassed and the system operates regardless of the presence of a 24V signal. In the "Remote" position, the system requires that a 24V signal be applied to nodes A1 and A2 (see wiring diagram) for the system to run.

The relay can also be set as normally closed where the lack of a signal would allow the system to operate and a 24V signal applied to the A1 and A2 nodes would shut the system down. This is accomplished by moving the wire at node 14 to the node labeled 12 on the relay.

24V Remote Control Relay
Flow fault relay is similar, but the coil operates on 120V

NOTICE

Do not energize heating system while the engine is running
- Energizing the system with the engine running will cause pump and/or heating element damage

Flow-Fault Relay and Light

A second relay is provided in the control box which provides a "fault-signal" set of contacts. This relay closes a set of contacts as soon as the time-delay relay reaches its set time (for more information see "Time-Delay Relay""). It can be used to trigger an alarm or to energize a user supplied indicator light. These contacts are labeled B1 and B2 and they can switch up to 8A at 250VAC. A fault light is also mounted on the control box which lights whenever the flow switch detects a loss of flow.

Time-Delay Relay

The system is provided with a time-delay relay which is adjustable from 0.5s – 100h. To set the timing, adjust the "Range" dial to the desired maximum setting, then adjust the "Time" dial to the desired actual setting. For example: HOTSTART recommends a setting of 30s after initial setup – set the "Range" dial to 100s and the "Time" dial to 3. This will delay the closing of the contacts for 30s after the flow switch determines that a loss of flow occurred. There are both normally open and normally closed contacts on the relay; the normally closed contacts open the motor control contactor and the normally open contacts close the fault relay contacts if the timer is allowed to reach its set-point.

Time Delay Relay

Flow Switch Operation

The flow switch is located in the outlet line of the heating system. It contains a SPDT (Single Pole Double Throw) switch which provides a signal in both the normally-open and normally-closed positions. The normally closed signal is used to activate the time-delay relay and the fault light when a loss of flow occurs. The normally open signal is used to energize the element contactor when sufficient flow is present.

Following the inlet and circulation through the heating tank, the fluid passes through the flow detection switch, which immediately shuts off the heating element anytime there is an interruption or loss of flow, and activates the time delay relay. The pump continues to circulate the fluid in order to restore flow. If proper flow is not reestablished, the time delay relay shuts down the entire heating system according to a preset time (see "Time-Delay Relay" for more details). Upon a system shut down, the heating system must be reset. Turn the system off and then back on again to reset.

Temperature Sensor

This heating system is equipped with a bi-metal thermostat switch which is pre-set to turn on and off within a fixed range. Several ranges are offered, but the typical coolant range is 120 - 140° F (49 – 60° C). The thermostat is located in the end of the heating tank opposite of the heating element and the range is printed on the label affixed to the service entrance.

Thermostat Replacement

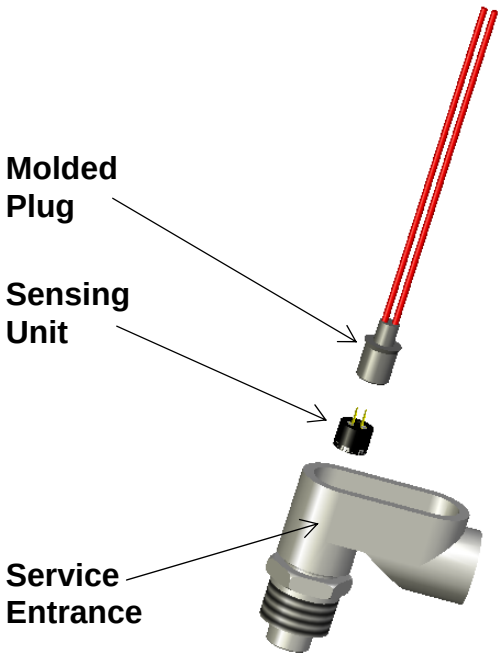
Step 1. Remove service entrance cover

Step 2. Disconnect wires

⚠ WARNING

Hazardous Voltage:

A lockout must be used at the main service panel when work is being done on the system.



Step 3. Pull on the two wires protruding from the service entrance to remove the molded plug and the sensing unit

Step 4. Pull the sensing unit away from the molded plug to remove it

Step 5. Remove heat-shrink tubing from the "plug-end" of the sensing unit and place on the new sensing unit if it is not already so equipped

Step 6. Insert new sensing unit

Step 7. Re-install through service entrance and press firmly into the thermostat housing to ensure contact between the thermostat and the housing

Step 8. Re-install wire connections and service entrance cover

Maintenance, Repair, and Troubleshooting

System Maintenance

The following maintenance procedures are provided to ensure trouble-free operation of your heating system:

- Plumbing Connections
- Electrical Connections and Contacts
- Heating Tanks/Elements
- System Mounting

⚠ WARNING

HAZARDOUS VOLTAGE:

BEFORE WIRING, SERVICING OR CLEANING THE SYSTEM, TURN OFF THE POWER AND INSTALL A LOCKOUT ON THE HEATER CIRCUITS AT THE SERVICE PANEL. FAILURE TO DO SO COULD ALLOW OTHERS TO TURN ON POWER UNEXPECTEDLY, WHICH MAY CAUSE FATAL ELECTRICAL SHOCK.

Plumbing Connections

- Periodically check plumbing connections for leaks and, if necessary, tighten connections. A loose connection on the suction side will cause a loss of flow and cavitation in the pump. It can also pull air into the heating tank and cause an element failure.

Electrical Connections

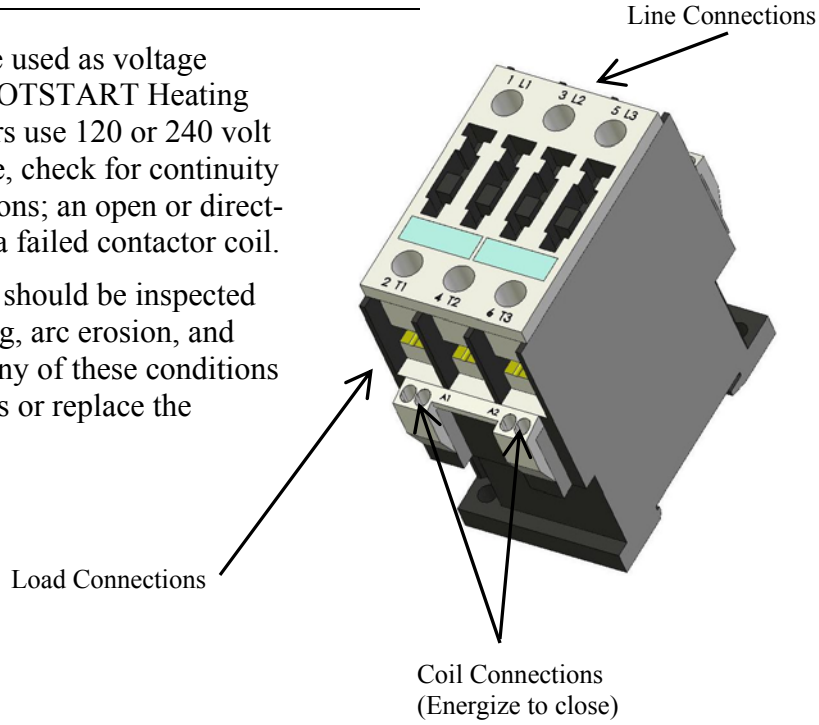
- Excessive vibration will eventually cause terminals to loosen. Tighten at startup and check again in a week. Periodically tighten all electrical connections every 3 months.

System Mounting

- Excessive vibration may cause mounting bolts to loosen. Periodically check and tighten all mounting bolts.
- Air must be evacuated from the system prior to starting or re-starting.

Magnetic Contactors

- Magnetic contactors are used as voltage switching controls in HOTSTART Heating Systems. The contactors use 120 or 240 volt coils. To test for failure, check for continuity across the coil connections; an open or direct-short reading indicates a failed contactor coil.
- The contactor contacts should be inspected periodically for welding, arc erosion, and mechanical wear. If any of these conditions exist, clean the contacts or replace the contactor.



Heating Tanks

- At least once per year, clean the interior of the heating tank and the heating element with a wire brush and/or damp cloth. Periodically check the element for sediment build-up around the element loops. Any scaling or build-up will shorten element life. Maintenance and replacement procedures for the heating element are described in a later section.
- Following lengthy system shut downs, remove the terminal covers of the element assembly as shown in System Components and check for any moisture or condensation. Electric tubular heating elements contain a granular refractory material called magnesium oxide (MGO) to insulate the resistor coil from the outer metal sheath. MGO is hygroscopic, which means it has the ability to absorb moisture from the air. MGO contaminated with moisture reduces the insulating value of the MGO which is measured with an Ohm meter by connecting one leg of the meter to the element and the other leg to ground. It is read as resistance in the meg-Ohms range (1 meg-Ohm = 1 million Ohms = 1M Ohms). Low resistance (less than 1M Ohms) is a transient condition experienced on first heat-up under normal periodic heater usage. Moisture absorption under normal conditions does not affect heater efficiency or life.

  The minimum required resistance value is 1.0M Ohms for full power voltage operation. However, heating elements with a moisture barrier sealant such as RTV silicone or epoxy potting will require a minimum value of 5.0M Ohms. Resistance values should be measured with an Ohm meter by applying one lead to the termination and the other to ground. When the heater does not meet the required resistance value, the unit will have to be dried out prior to full power operation.

  If the heater has 0.1M Ohms (100K Ohms), or better, but less than 1M Ohms, the heater should be operated at half the rated voltage for 30 minutes to dissipate the accumulated moisture. Disconnect the power after 30 minutes and check the resistance. An alternative to applying voltage is to manually dry the heaters in an oven at 300°F for 4 hours then check its resistance again.

  If the resistance is higher than it was originally, repeat the process until the value reaches the minimum requirement of 1M Ohms. The heater can then be operated at full rated voltage.

Flow Detection Switch

- Inspect the flow detection (flow control) switch periodically for foreign buildup on the shuttle body. To clean the flow detection switch, follow these steps:

Step 1 Shut OFF fluid supply to the heating system.

Step 2 Remove the bonnet nut and lift out the entire switch assembly.

Step 3 Remove accumulated sediment from the switch body with a damp cloth.

Step 4 Check the switch for proper operation by sliding the shuttle and magnet up over the main shaft as shown below. If the shuttle hangs up or does not slide smoothly, remove the lock ring from the bottom of the switch assembly and slide the shuttle, magnet and spring off.

P/N: PRP224033-000

Step 5 Remove foreign matter and rough spots from the shaft with denatured alcohol.

Step 6 Reassemble the switch and check it again for proper operation (reference step 4).

⚠ WARNING

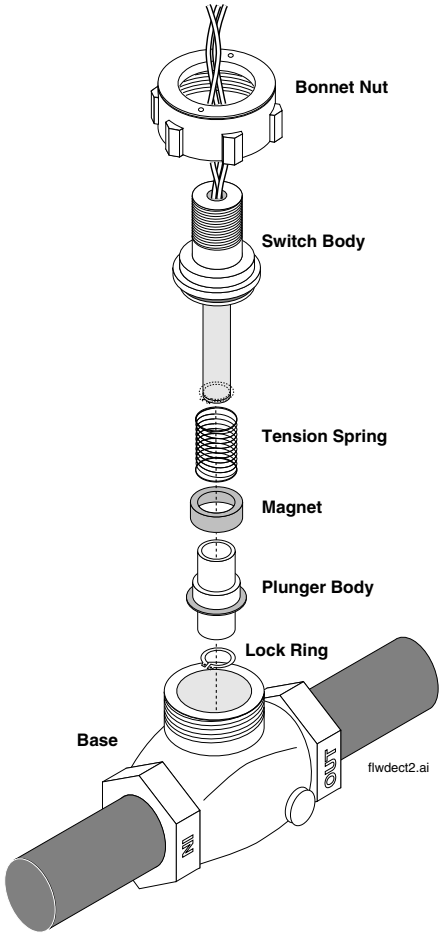
Hazardous Voltage
Do not open the service entrance during this test.

Step 7 To test operation of the switch assembly, turn ON the main power. When the magnet on the shuttle is slid up the shaft, the magnetic contactor that operates the heating element should close.

NOTICE

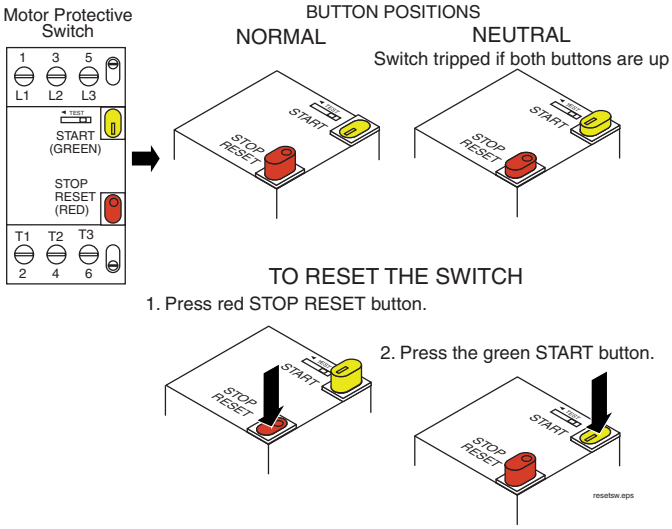
When testing the flow switch, do not operate the heating system longer than 5 seconds or damage to the heating element may occur.

Step 8 Once the switch assembly is working properly, reassemble the flow switch and set the time delay relay to the desired setting. The recommended setting is 30 seconds.



Motor Overload Switch

This heating system is equipped with an overload switch which opens the line connection to the motor if the current used by the motor exceeds 125% of the setting on the indicator dial and in the case of a short circuit. It uses an inverse-time trip curve which will allow longer times if the current draw is lower and will open the contacts quickly if the current draw is high.



To reset the switch first depress the stop button fully. If the button will not latch, the thermal overloads are still warm and must be given time to cool off. When the stop button is latched in the fully down position, press the start button down until it latches. The switch is now reset.

The relays are factory set and no adjustments are necessary.

Some models are equipped with motors that contain internal thermal overloads (see Wiring Diagram). When the thermal overload is activated, the heating system will shut down. The thermal overload will reset automatically, but the heating system will not. To restart the heating system, turn the power switch off and then back on again.

MPS Part Numbers

Amp Rating (Range)	Part Number
0.4 – 0.6	PRP232036-008
0.6 – 1.0	PRP232036-000
1.0 – 1.6	PRP232036-001
1.6 – 2.5	PRP232036-002
2.5 – 4.0	PRP232036-003
4.0 – 6.3	PRP232036-004
6.3 – 10.0	PRP232036-005
10.0 – 16.0	PRP232036-006

Note: The current draw on the MPS must be set to within 10% of the motor's FLA (Full Load Amp) rating. Failure to set the MPS properly can result in the premature failure of the motor.

Heating Element Replacement

To replace the heating element or perform routine maintenance, follow these steps. The wattage and phase of the heating element are listed on the identification label on the outside of the element. Reference this label for the replacement element part number.

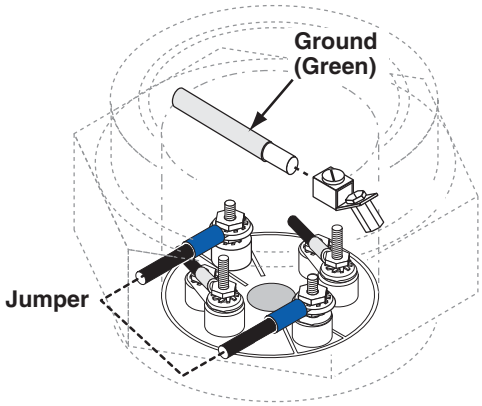
⚠ WARNING

Hazardous Voltage

Before wiring, servicing or cleaning the system, turn off the power and install a lockout on the heater circuits at the service panel. Failure to do so could result in electrical shock.

Step 1 Turn the HOTSTART Heating system OFF and lock out at the service.

Step 2 Drain the fluid from the heating tank.



Step 3 Remove the cap from the heating element.

Step 4 The wire connections inside the cap of the heating element correspond to one of the phase configurations shown on the following page. Note your unit's phase configuration.

*****Replacement elements can be a different phase configuration. Wire replacement elements to the cup washers on the replacement element studs.

Remove the ground (green) and power electrical wires from the posts inside the cap.

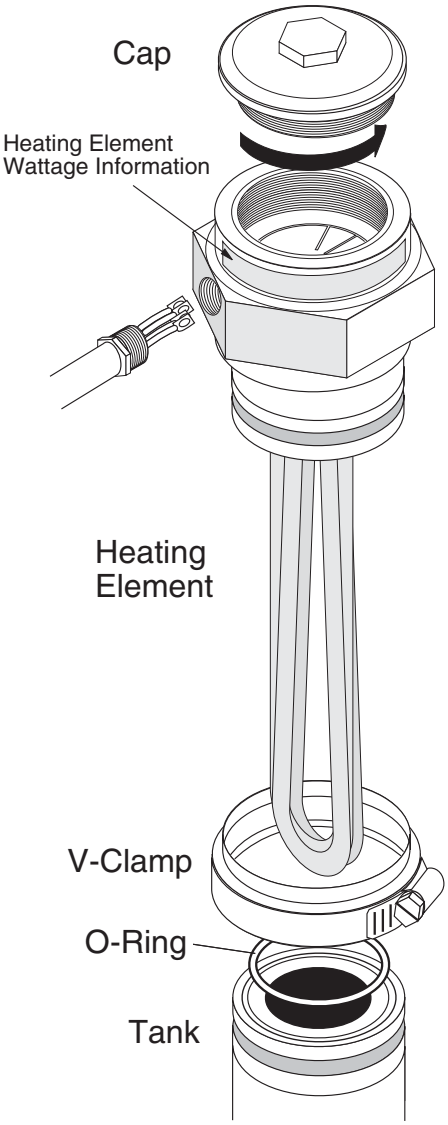
Step 5 Remove the conduit conductor and electrical wires from the heating element.

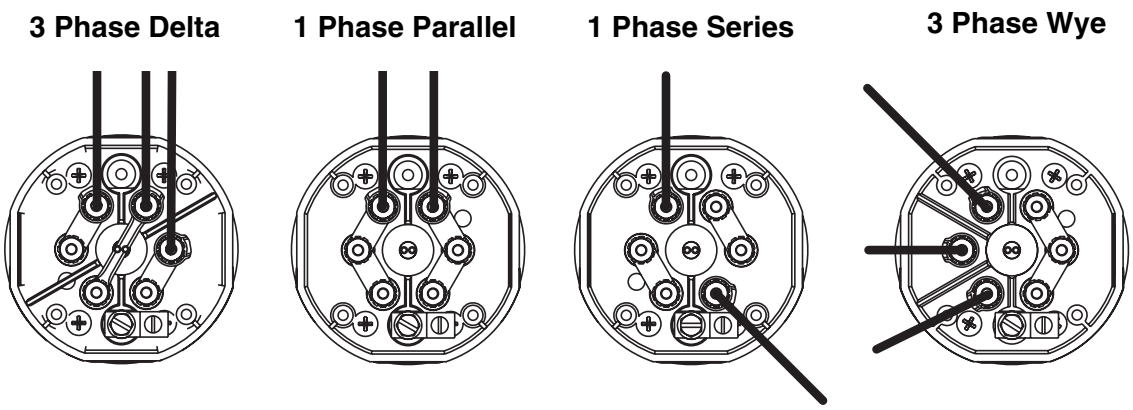
Step 6 Remove the V-clamp to remove the heating element from the heating tank as shown on the next page.

Step 7 Replace the heating element or perform the necessary cleaning procedure. Ensure the O-ring is in place.

Re-assembly of Heating Element and Tank

To reassemble the heating element and tank, follow the steps listed on page 3-6 in reverse order. Make sure the ground and power electrical wires are properly reconnected using the washers, cup washers and nuts supplied (please note diagram at bottom of page).





Troubleshooting

Symptoms	Possible Causes	Solutions
Lack of Flow	Pump not primed properly	Bleed all trapped air from lines
	Isolation valves may be closed	Open valves
	Hose kinked or mashed	Remove obstruction
	Leak in suction line	Repair leak
	Pump motor turning backwards	Reverse any two leads on power in (3 phase systems)
	Motor protective switch tripped	Check and reset, if problem happens again check motor
Low Temperature	Heater has been turned off, fluid is cold	Allow time for heater to heat fluid
	Heating element failed	Check elements for continuity and replace if needed
	Element fuses failed	Check all element fuses for continuity and replace as necessary
	Element contactor failed	Check contacts and coil. Replace if needed
	Motor protective switch tripped	Check and reset, if problem happens again check motor
	Motor contactor failed	Check contacts and coil replace if needed
	Motor failed	Check and replace if needed
	Thermostat failed	Check and replace if needed
	Flow switch shut down	See lack of flow above
Over Temperature	Motor contactor failure	Check contacts and coil replace if needed
	Motor failure	Check and replace if needed
	Pump not primed properly	Check for "Differential temp / lack of flow error", see above
	Isolation valves may be closed	Open isolation valves
	Hose kinked or mashed	Repair or replace
	Leak in suction line	Repair
	Flow switch failed	Check and replace if needed
	Thermostat failed	Check and replace if needed
Motor Overload Relay Tripped	Motor or wiring short circuit	Check motor and wiring, replace if needed
	Overloaded motor	Check plumbing and remove restrictions