



**HOTSTART®**

**Coolant Circulating  
Heating System  
Hazardous Location**

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**Installation & Operation Manual**

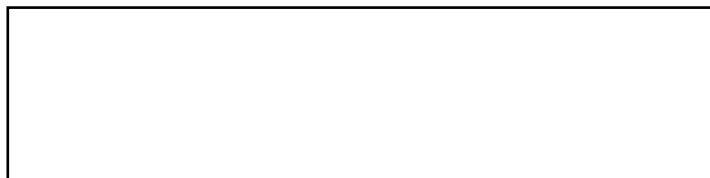
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# Identifying Your System


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The HOTSTART heating system is designed to heat fluids for use in marine propulsion, diesel-powered generator sets, locomotives, gas compression, or any large-engine applications. The system is pre-wired, pre-plumbed, and assembled on a steel plate. Each heating system has an identification plate which includes the part number and serial number.

Warranty information can be found at [www.hotstart.com](http://www.hotstart.com) or by contacting our customer service department at (509)536-8660. Have your model and serial numbers ready when contacting the warranty department.



**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.

<b>HOTSTART.</b> 	<b>SPOKANE, WA U.S.A.</b>	REF. SERIAL NUMBER WHEN ORDERING REPLACEMENT PARTS
<b>MODEL</b> _____		
<b>VOLTS</b> _____	<b>HERTZ</b> _____	
<b>AMPS.</b> _____	<b>PHASE</b> _____	
<b>CONTROL CIRCUIT VOLTS</b> _____		
<b>CONTROL CIRCUIT AMPS.</b> _____ <b>MAX</b>		
<b>SERIAL NUMBER</b> _____	U.S. PATENTS 4,245,593, 4,249,491 CAN. PATENTS 1,087,473, 1,082,541	
<b>CAUTION</b> OPEN CIRCUITS BEFORE WORKING ON THIS EQUIPMENT OR REMOVING COVERS. KEEP COVERS TIGHTLY CLOSED WHILE CIRCUITS ARE ALIVE.		
<b>ATTENTION</b> DE' BRANCHEZ LE CIRCUIT AVANT DE'COUVRIR NE DE COUVREZPASTANT QUE LE CIRCUIT EST ACTIF		

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



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# Important Safety Information

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## **WARNING**

**Hazardous voltage:** All electrical work must be done by qualified personnel in accordance with all 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**

**Please read carefully:** The safety of any system incorporating this heater is the responsibility of the assembler. The safe and proper use of this heater is dependent upon the installer following sound engineering practices. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. All applicable electrical safety standards defined by local jurisdictions must be followed. (reference EU directive 2006/95/EC in EU countries)

The heater must be connected to a suitable ground (protective earthing conductor).

The power supply must be protected by a suitable overcurrent limiting device.

The means of disconnection from the power supply is required. Hotstart recommends that a power switch or circuit breaker be located near the heater for the safety and ease of use.

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. Proper lifting locations are identified with labels on each system, please use these locations when lifting and mounting the system.

Hot surfaces: avoid contact with the system while it is in service – some surfaces may stay hot even if the system is not energized.

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

## **NOTICE**

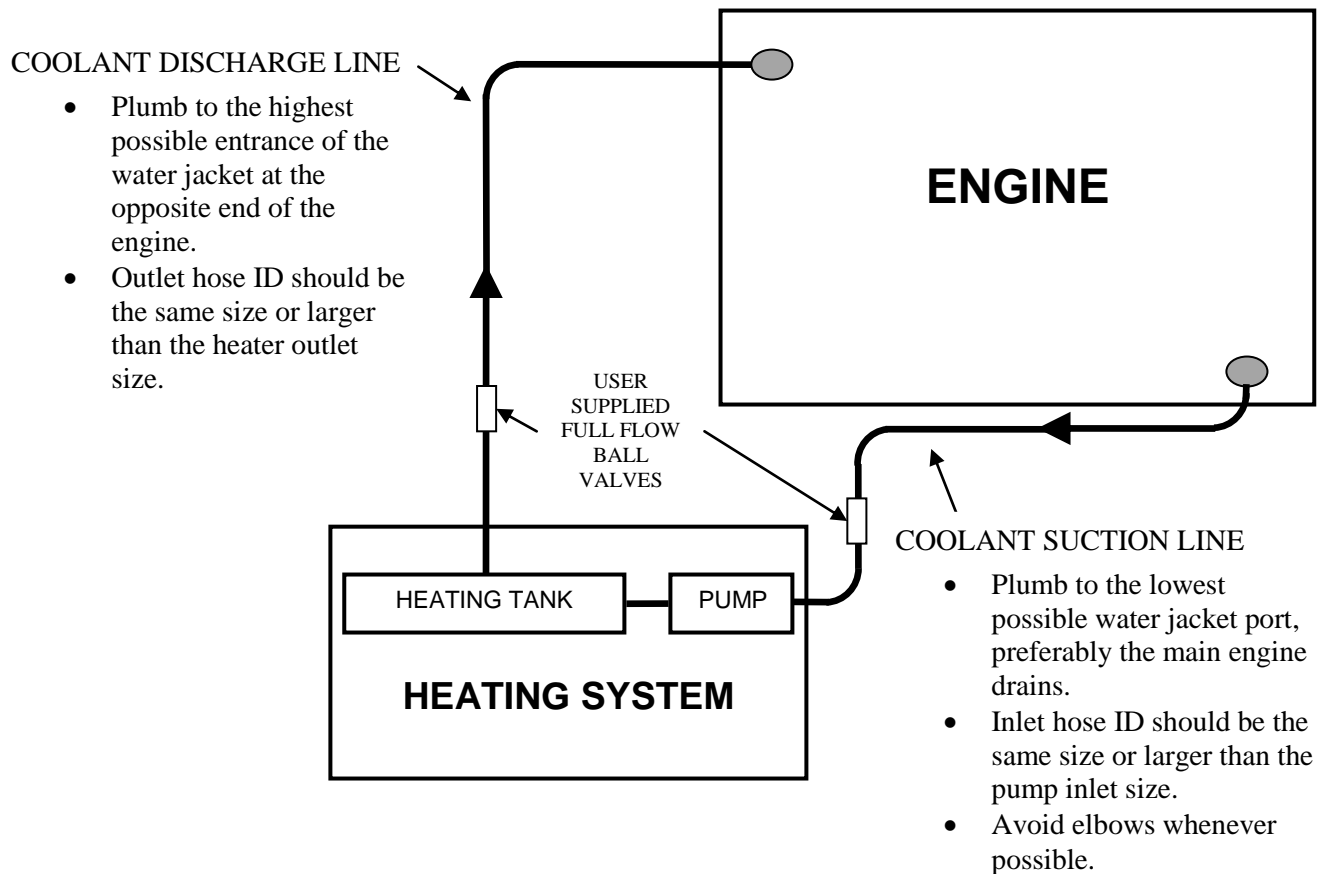
**EU Countries Only:** Equipment rated for the conditions listed in EN 601010-1 1.4.1 Ingress protection rating IP54. (Special conditions for specific applications may apply)

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# 1 Installation

## 1.1 Coolant Plumbing Diagram



### HEATING SYSTEM

- Must be mounted at or below engine coolant level.
- Mount heater in a location that minimizes the length of the coolant suction line.
- **DO NOT** mount directly to the engine. Mount on the floor or skid next to the engine and properly isolate from vibration.
- Pressure relief valve must be plumbed to a safe location.
- Clearance is required for heating element removal. Before permanently mounting the heating system, verify that sufficient clearance exists.

For alterations to the recommended coolant plumbing diagram please consult HOTSTART for authorization.

## NOTICE

Do not reduce the inlet line. Pump seal damage will occur.

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

Fill the suction line with coolant. Pump is **not** self-priming. Liquid must be present in the pump before start-up. Trapped air inside the pump will cause pump and seal damage.

HOTSTART recommends using pre-mixed coolant. Follow engine manufacturer's recommendations for coolant mixture

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 port 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 service panel when the isolation valves are in the closed position. Failure to do so may result in the release of pressurized steam.

## CAUTION

Lifting hazard: Proper rigging and safety equipment must be used to move this equipment – weight is not centered.

## 1.2 Main Power Supply

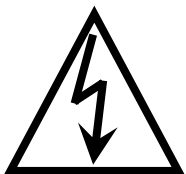
Connect the specified power from the customer supplied circuit breaker to the terminal blocks located in the main control box. For three phase applications, the terminal blocks are labeled L1, L2, and L3. For single phase applications, use the terminal blocks labeled L1 and L3 or L and N. The circuit breaker must be near the heating system and easily accessible.

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

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

## WARNING

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

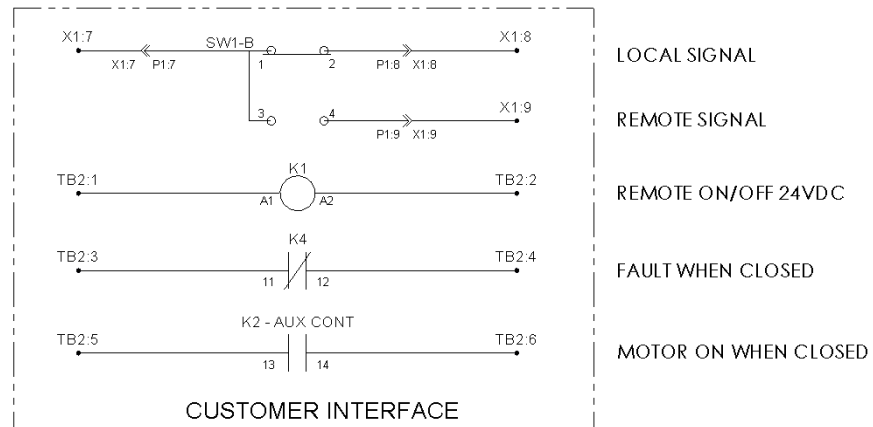
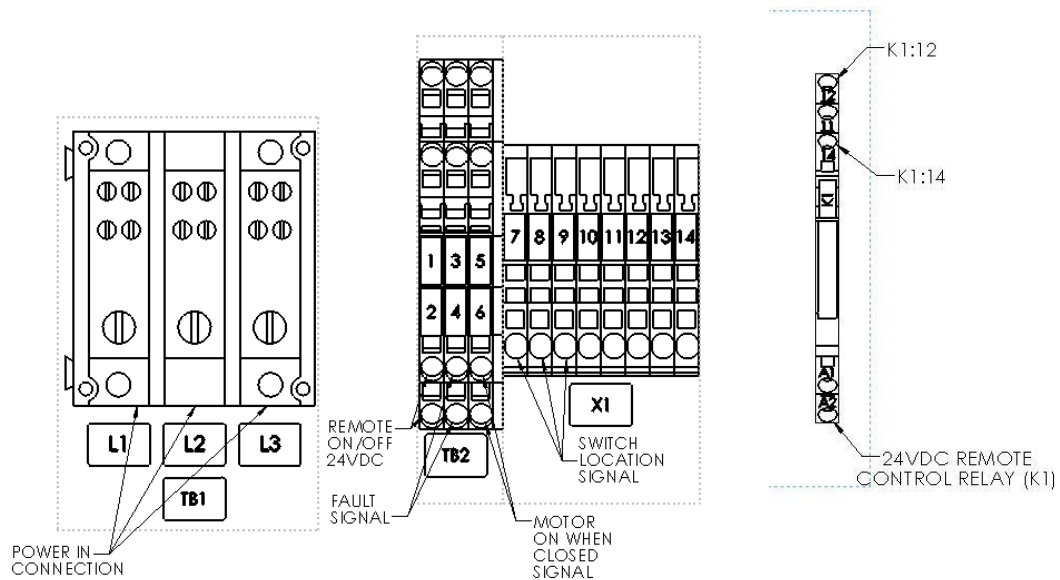


All wiring shall be done by qualified personnel in accordance with national, state, and local codes. Each system shall be grounded in accordance with the National Electrical Code. Failure to properly ground the system may result in electric shock.

### 1.3 Customer Interface Connections

Reference electrical schematic and control box drawing for proper wiring locations. Shown below are typical customer interface locations.

Local and Remote signals indicate switch position. The Fault signal indicates a fault. The Run signal indicates the pump is running. The 24 VDC connections are for remote control of the heater while the switch is in the Remote position. Typical wiring on 24VDC remote control relay is N/C, to switch to N/O move the wire from K1:12 to K1:14.



**Typical Customer Interface: see included drawings and wiring diagram for specific system locations.**

## 2 Heating System Start-Up

**Step 1** Check and tighten all electrical and plumbing connections.

**Step 2** Ensure isolation valves are open before energizing the system.

**Step 3** **Check for proper rotation of the motor** by pressing the prime button while watching the motor shaft or fan. Single phase systems are pre-wired to rotate in the correct direction. On a three phase system, if the pump is not rotating in the correct direction, switch any two electrical leads at the main power terminal block.

### **NOTICE**

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

Running a pump that is not completely filled with liquid will cause damage to the pump seal.

**Step 4** Bleed all trapped air from the heating system by opening a plug or pipe fitting at or near the pump. Press and hold the prime button to evacuate any remaining air in the lines. When all the air is evacuated, the discharge pressure gage should indicate pressure.

**Step 5** Energize the heating system by switching the control switch to the Local position. A pressure gage should indicate pressure if the system is working correctly.

### **⚠ WARNING**

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

**Step 6** Once operation is satisfactory, turn the control dials on the Temperature Control Relay TCR1 to the desired temperature setting. HOTSTART recommends a control temperature (on TCR1) of 50 °C (122 °F). The high limit temperature setting (on TCR2) should be set at 90 °C (194 °F).

### **NOTICE**

The high limit TCR must be set at least 10 °C (18 °F) higher than the control TCR for proper heating operation. This will avoid nuisance tripping of the high limit circuit.

**Step 7** Change the switch to the Remote position and verify that the 24 V DC controls operate properly (refer to Section 4.3 for operation).



### **3 Overview of Operation**

The heating system is designed to automatically start following engine shut-down if the switch is in Remote. There is a 24 VDC relay in the system that receives a signal from the engine or equipment control to start and stop the heater. Upon heater start-up, the pump motor runs continuously and the heating element cycles on and off to maintain the set temperature of the heater. The heater acts as an after-cooler as it circulates coolant through the engine. When the engine has cooled to the set temperature minus the hysteresis, the heating element turns on and raises the temperature to the set temperature, and continues the cycle.

If there is a failure in the system that causes a high temperature to occur, the high temperature controller shuts down the entire heating system, including the pump motor. To restart the system, the power switch or the 24 VDC start/stop signal has to be cycled off and back on. A failure in the motor that causes the motor protective switch to trip also shuts down the entire system. In this circumstance, the user must press the motor protective switch start button to reset the fault.

## 4 System Components and Operation

The control box contains the electrical control components for the heating system. The following is an operational description for the standard parts located on the system, including:

- Prime Button
- 3-Position Switch (Local/Off/Remote)
- Remote Control Relay
- Control TCR (Temperature Control Relay)
- High Limit TCR (Fault)
- Motor Protective Switch (MPS)
- Pressure Relief Valve

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

### 4.1 Prime Button

The prime button is used to assist with removal of remaining air in the suction and discharge lines (without energizing the heating elements). This can be verified by an increase in pressure on the pressure gage.

### 4.2 Local/Off/Remote 3-Position Switch

- Local – Manual control: the system turns on independent of the remote control relay.
- Off – The system is shut off.
- Remote – Automatic control: the system turns on and off via the remote control relay.

### 4.3 Remote Control Relay

Typical wiring on 24VDC remote control relay is N/C. In this position the automatic control relay allows the system to run and requires a 24 V DC signal to de-energize the system. To switch to N/O move the wire from K1:12 to K1:14.

### 4.4 Control TCR (Temperature Control Relay)

The control TCR is used to control the temperature of the engine coolant. It uses a Resistance Temperature Device (RTD) to sense the coolant temperature of the fluid coming from the engine to the heater. The standard setting for the control TCR is 50 °C (122 °F) and 10% (5 °C/9 °F) hysteresis. The TCR will turn the heater off at the set point of 50 °C (122 °F) and turn the heater on at 45 °C (113 °F) with these set points.

### 4.5 High Limit TCR

The high limit TCR is a protective device to prevent overheating of the coolant in the system, and the RTD is located in the element enclosure. This relay default setting is preset at 90 °C (194 °F) and should always be at least 10 °C (18 °F) higher than the control TCR set point. The high limit TCR hysteresis is not used in the high limit control.

## **4.6 Motor Protective Switch (MPS)**

The MPS protects the motor from overloads. The MPS will be set at the full load amperage of the motor when shipped from the factory. On hazardous location models, press the RESET button on the control box lid to reset the motor protective switch (inside the control box).

## **4.7 Pressure Relief Valve**

The system is equipped with a pressure relief valve that is preset to relieve at 100 psi, 6.9 bar. During normal operation, pressure releases are rare but it is recommended that piping from the discharge port be routed to a safe location in case of pressure release.



**Pressure Relief Valves**

## 5 Maintenance, Repair, and Troubleshooting

### 5.1 System Maintenance

Instructions for the following maintenance procedures are provided to ensure trouble-free operation of your heating system. Replacement parts must meet or exceed original part requirements in order to maintain the compliance level of the original heater.

- Plumbing Connections
- Electrical Connections and Contacts
- System Mounting
- Magnetic Contactors
- Pump Seal
- Volatile Corrosion Inhibitor
- Heating Tanks/Elements

After maintenance is performed, refer to the start-up section of this manual.

#### WARNING

**Hazardous voltage:** Before wiring, servicing or cleaning the system, turn off the power and install a lockout at the service panel. Failure to do so could allow others to turn on power unexpectedly, which may cause fatal electrical shock.

#### 5.1.1 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.

#### 5.1.2 Electrical Connections

Vibration may eventually cause terminals to loosen. Tighten at start-up and check again in a week. Tighten all electrical connections every 3 months.

#### 5.1.3 System Mounting

Vibration may cause mounting bolts to loosen. Periodically check and tighten all mounting bolts.

#### 5.1.4 Magnetic Contactors

Magnetic contactors are used as voltage switching controls for motors and heating elements in HOTSTART Heating Systems. The contactors use 120 or 240 V 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.

#### 5.1.5 Pump Seal

Leakage can occur at any time throughout the life of the seal. Always replace the seal at the first sign of leakage. If the heating system is installed on an engine that is used for a critical application, replace the seal annually. Instructions to replace the seal are included with the new seal.

#### 5.1.6 Volatile Corrosion Inhibitor (VCI)

A VCI is provided with each control box and should be replaced once a year.

### 5.1.7 Heating Element Replacement

To replace the heating element or perform routine maintenance, observe the following procedure. 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 at the service panel. Failure to do so could allow others to turn on power unexpectedly, which many cause fatal electrical shock.

**Step 1** Turn the heating system OFF, close isolation valves, and lock out at the service panel.

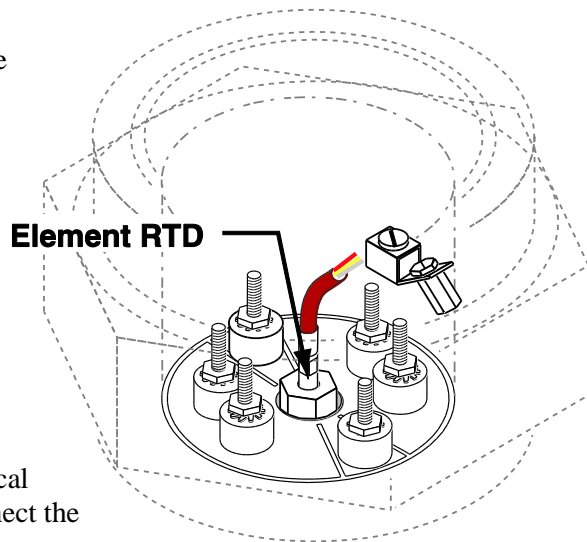
**Step 2** Drain the fluid from the heating tank.

**Step 3** Remove the cap from the heating element service entrance enclosure.

**Step 4** The wire connections inside the enclosure correspond to one of the phase configurations shown at the bottom of the 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.

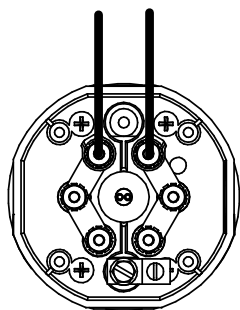
Disconnect the ground (green) and power electrical wires from the posts inside the cap. Also disconnect the element RTD wires.



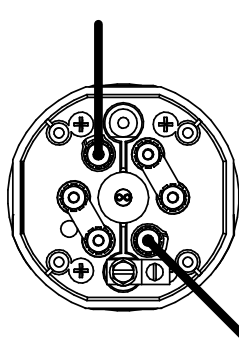
**Step 5** Remove the conduit connector and electrical wires from the heating element.

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

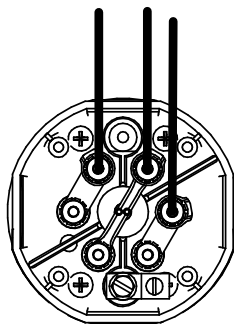
**Step 7** Replace the heating element or perform the necessary cleaning procedure. Ensure the O-ring is in place.



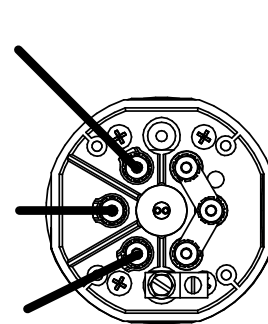
**1 Phase Parallel**



**1 Phase Series**



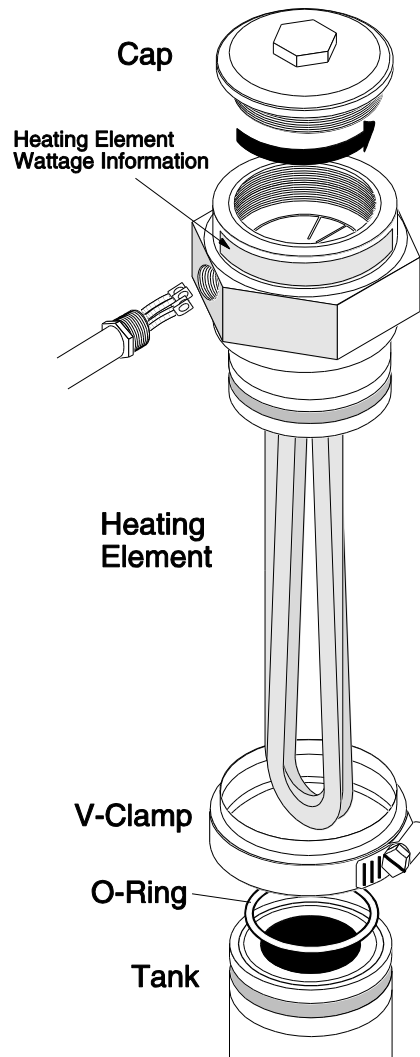
**3 Phase Delta**



**3 Phase Wye**

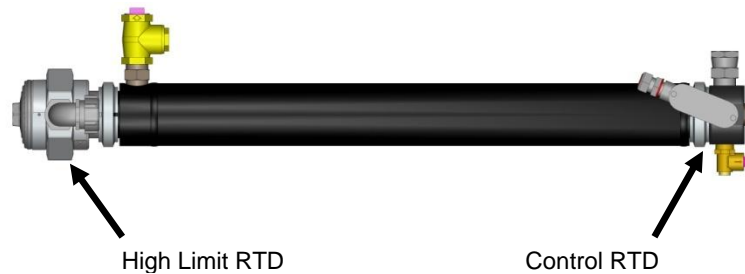
### 5.1.8 Reassembly of Heating Element and Tank

To reassemble the heating element and tank, follow the steps listed on the previous page 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 the previous page).



### 5.1.9 RTD Replacement

The high limit RTD is located inside the element enclosure and the other control RTD is located at the inlet side of the tank as shown below. To replace this RTD, follow the steps listed below.



#### **⚠ WARNING**

Hazardous voltage: Before wiring, servicing or cleaning the system, turn off the power and install a lockout at the service panel. Failure to do so could allow others to turn on power unexpectedly, which many cause fatal electrical shock.

- Step 1** Remove the cover of the service entrance enclosure.
- Step 2** Disconnect the RTD wires in the service entrance taking care to note current wiring.
- Step 3** Drain the tank and remove the RTD.
- Step 4** Reassemble in reverse order.

To remove the element RTD open the element enclosure and unscrew the RTD from the element burr using a 7/16 end wrench. To re-assemble screw the RTD back into the element burr.

## 5.2 Troubleshooting

Faults indicated by the system only occur from an overheating condition or a tripped motor protective switch.

Symptom	Possible Causes	Solution
Indicated System Fault	Pump not primed properly	Bleed all trapped air from lines, restart system
	Isolation valves may be closed	Open valves, restart system
	Hose kinked or crushed	Remove obstruction, restart system
	Leak in suction line	Repair leak, restart system
	Pump motor turning backwards	Reverse any two leads on power in (3 phase systems), restart system
	TCR1 failed closed	Check and replace if needed, restart system
	Motor failure	Check and replace if needed, restart system
	Motor contactor failure	Check contacts and coil replace if needed, restart system
	Motor protective switch tripped	Check and reset, if problem happens again check motor, restart system
Low Temperature	Motor failure	Check and replace if needed
	TCR1 failed	Check and replace if needed
	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 or Breaker Tripped	Check all element fuses for continuity and replace as necessary or reset breaker
	Element contactor failed	Check contacts and coil replace if needed
	Motor contactor failed	Check contacts and coil replace if needed
	Motor failed	Check and replace if needed
	TCR1 failed open	Check and replace if needed