

INSTALLATION & OPERATION MANUAL

DUAL FLUID CIRCULATING HEATING SYSTEM

MODEL

OCSM

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IDENTIFYING YOUR SYSTEM

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 steel plate. Each heating system has an identification plate which includes the part number and serial number.

This operation manual describes the installation, operation and maintenance of the heating system. Model specifics, capabilities and features may vary. See part drawings for dimensions and specifications.

When ordering replacement parts, be sure to reference your heating system's **MODEL NUMBER** and **SERIAL NUMBER** found on the identification plate and following label:



	SPOKANE, WA U.S.A.	<small>REF. SERIAL NUMBER WHEN ORDERING REPLACEMENT PARTS</small>
	<p> MODEL _____ VOLTS _____ HERTZ _____ AMPS. _____ PHASE _____ CONTROL CIRCUIT VOLTS _____ CONTROL CIRCUIT AMPS. _____ MAX SERIAL NUMBER _____ </p>	
<p align="center">CAUTION</p> <p align="center">OPEN CIRCUITS BEFORE WORKING ON THIS EQUIPMENT OR REMOVING COVERS. KEEP COVERS TIGHTLY CLOSED WHILE CIRCUITS ARE ALIVE.</p>		<small>U.S. PATENTS 4,245,593, 4,249,491 CAN. PATENTS 1,067,473, 1,062,541</small>

NOTE: Typical heating system identification plate. Your identification plate may vary.

WARRANTY INFORMATION

Warranty information can be found at www.hotstart.com or by contacting our customer service department at (509)536-8660. Have your **MODEL NUMBER** and **SERIAL NUMBER** ready when contacting the warranty department.

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IMPORTANT SAFETY INFORMATION

DANGER

Hazardous voltage: Before wiring, servicing or cleaning the heating system, turn off the power and follow your organization's lockout and tagout procedure. Failure to do so could allow others to turn on the power unexpectedly, resulting in harmful or fatal electrical shock.

WARNING



Electrical hazard: All electrical work must be done by qualified personnel in accordance with national, state and local codes.

CAUTION

Read instructions 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 2014/35/EU in EU countries.)

- **Read carefully:** Installers and operators of this equipment must be thoroughly familiar with the instructions in this manual before commencing work.
- **Hot surfaces:** Avoid contact with the system while it is in service. Some surfaces may remain hot even if the system is not energized.
- **Proper lifting:** 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; use these locations when lifting and mounting the system.
- **Rotating equipment:** The heating system can start automatically and without warning. Avoid contact unless a lockout at the service panel has been installed.
- **Grounding:** The heater must be connected to a suitable ground (protective earthing conductor).
- **Overcurrent limiting:** The power supply must be protected by a suitable overcurrent limiting device.
- **Power disconnection:** A means to disconnect the heater from the power supply is required. HOTSTART recommends that a power switch or circuit breaker be located near the heating system for safety and ease of use.

NOTICE

EU Countries only: Equipment rated for the conditions listed in EN 61010-1 1.4.1 Ingress protection rating IP54. (Special conditions for specific applications may apply.)

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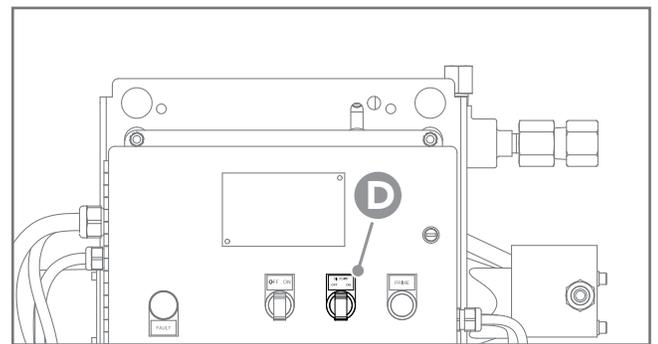
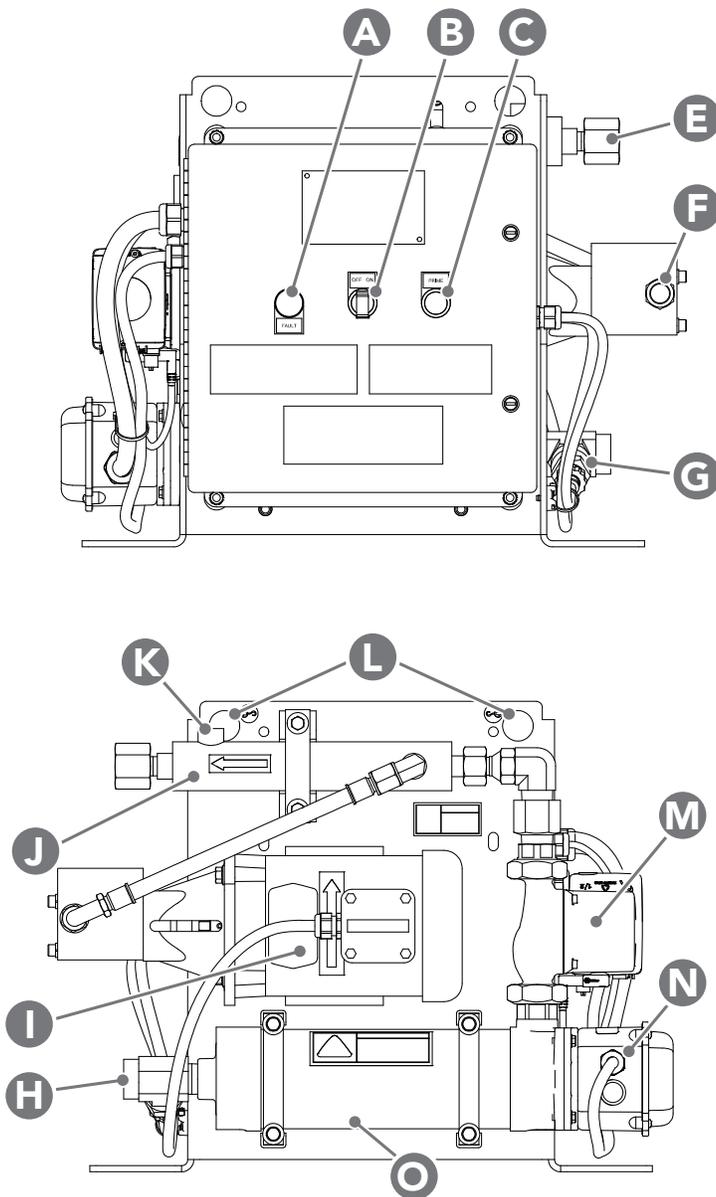
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1 OVERVIEW

1.1 HEATING SYSTEM COMPONENTS

NOTE: Component illustrations are for reference only and are not to scale. See part drawings for dimensions and specifications.

Figure 1. Typical OCSM system components. Front view (left) and reverse view (below). Model style and configuration may vary. See part drawings for dimensions and specifications.



- A. *FAULT* light
- B. *ON/OFF* switch
- C. *PRIME* button
- D. *OIL PUMP ON/OFF* switch (optional)
- E. *Coolant outlet* (1.0" NPT)
- F. *Oil inlet* (0.5" NPT)
- G. *Control thermostat*
- H. *Coolant inlet* (1.0" NPT)
- I. *Oil pump/motor assembly*
- J. *Coolant-to-oil heat exchanger*
- K. *Oil outlet* (0.5" NPT)
- L. *Lift points*
- M. *Coolant pump/motor assembly*
- N. *Element assembly*
- O. *Tank assembly*

1.2 OPERATION OVERVIEW

The OCSM heating system is intended to maintain optimal engine operating temperature while the engine is shut down. The heating system may be activated locally or by a 24 V DC signal (see **SECTION 2.4.3**) and must be deactivated upon engine start-up.

During heating system operation, a centrifugal pump takes coolant from the water jacket and forces it through the heating tank and heat exchanger to the coolant return line. Simultaneously, a positive displacement rotary gear pump takes oil from the engine sump and forces it through the heat exchanger. Heat is transferred from the coolant to the oil before the oil exits via the oil return line. When preheating an engine from a cold soak, or during other periods where oil viscosity prevents oil circulation, the heating system oil pump may be disabled using the oil pump on/off switch (available as an option on specified heating system models).

The coolant and oil pumps will continuously circulate fluid. To maintain consistent fluid temperature, the heating element will cycle on and off. When the engine is started, the heating system should be turned off or automatically deactivated using the 24 V DC signal connection. When the engine is shut down, the heating system should be reactivated locally or via the 24 V DC signal connection to resume maintaining the optimal engine operating temperature.

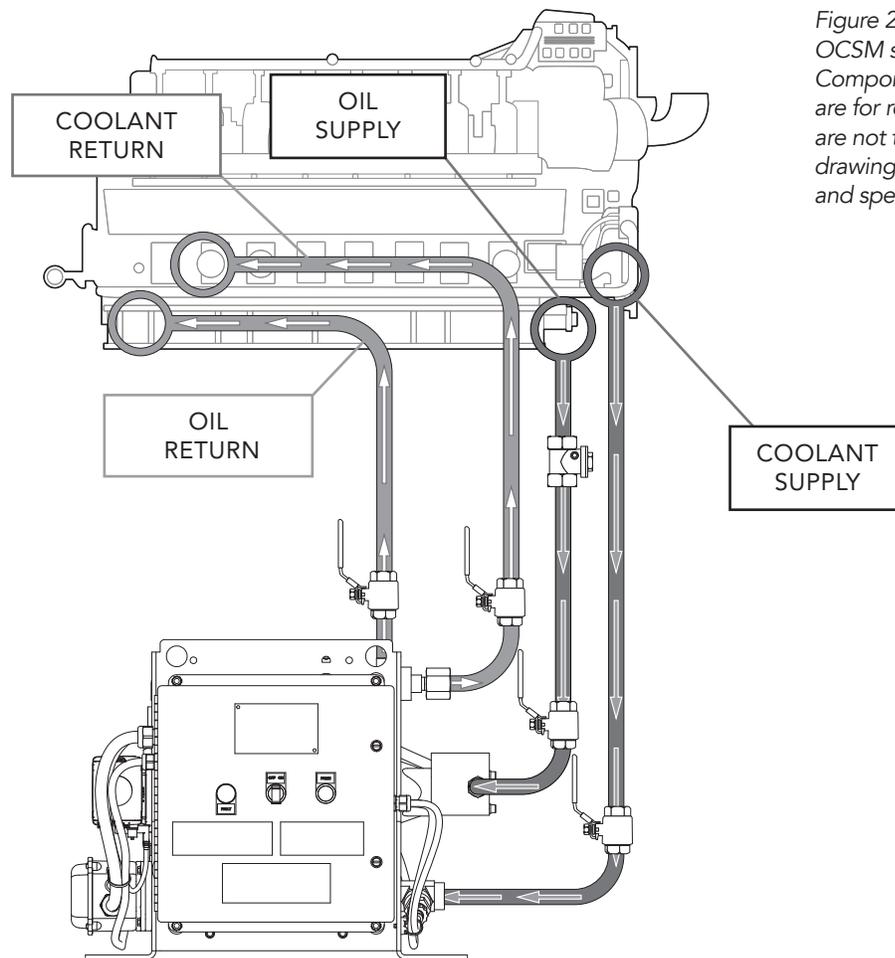


Figure 2.
OCSM system operation.
Component illustrations
are for reference only and
are not to scale. See part
drawings for dimensions
and specifications.

2 INSTALLATION

CAUTION

Isolation valves: HOTSTART recommends installing full-flow ball valves to isolate the heating system in order to allow the engine and heating system to be independently drained of coolant and/or oil during servicing.

Pressure hazard: Power must be turned off and locked out at the service panel when the isolation valves are in the closed position. This product generates heat during operation. Failure to do so may cause damage to heating system components, leaks and unexpected release of heated coolant. It is the responsibility of the installer and operator to ensure that no unsafe condition can result from the generation of pressure. In EU countries, PED (97/23/EC) compliant pressure relief may be required.

Overheating hazard: After completing line installation, top off the fluid levels to compensate for the fluid used to fill the lines and heating tank. Do not operate the heating system without the presence of fluid. Position the heating tank to ensure it is completely full of fluid while in operation.

Pump priming: Fill supply line with fluid. Pump is not self-priming. Fluid must be present in the pump before start-up. Trapped air inside the pump will cause pump and seal damage.

Pump seal damage: Do not reduce the oil supply line to an inner diameter smaller than the pump inlet; pump seal damage could occur.

Check valve: HOTSTART recommends installing a customer-supplied swing-type or full-flow check (non-return) valve to prevent oil from flowing back into the oil sump. If the pump is installed above the minimum oil level, a check valve **must** be installed.

2.1 PLUMBING INSTALLATION

NOTICE

Heating system damage: Engine vibration will damage the heating system; isolate the heating system from vibration. Never mount the heating system or components directly to the engine. If the heating system is installed using rigid pipe, use a section of flexible hose to the supply and return ports to isolate the heating system from engine vibration.

Pump rotation (three-phase only): For three-phase applications, check for proper pump rotation prior to introducing fluid to the pump (see **SECTION 2.4.2**). Reverse rotation while the pump is filled with fluid will cause pump seal failure.

2.1.1 COOLANT SUPPLY

When installing the OCSM coolant supply line, refer to the following HOTSTART guidelines:

- At a minimum, size the coolant supply line per the coolant inlet. **NOTICE!** Do not reduce the supply line inner diameter; heating effectiveness may be reduced.
- Install the coolant suction port as low as possible on the engine's water jacket.
- To minimize flow restriction, the coolant supply line must be as short and as straight as possible. Use elbow fittings sparingly; HOTSTART recommends using sweeping bends or 45° fittings.

2.1.2 COOLANT RETURN

When installing the OCSM coolant return line, refer to the following HOTSTART guidelines:

- Size the coolant return line per the coolant outlet. **NOTICE!** Do not reduce the return line inner diameter.
- Install the coolant discharge port as high as possible on the engine's water jacket at the end of the engine opposite the suction port, typically at the rear of the engine block.

2.1.3 OIL SUPPLY

When installing the OCSM oil supply line, refer to the following HOTSTART guidelines:

- At a minimum, size the oil supply line per the pump inlet. **NOTICE!** Do not reduce the supply line inner diameter; pump seal damage will occur.
 - NOTE:** If the connection to the equipment is smaller than this port size, immediately increase the inner diameter to reduce pressure losses in the plumbing.
- To minimize flow restriction, the oil supply line must be as short and as straight as possible. Use elbow fittings sparingly; HOTSTART recommends using sweeping bends or 45° fittings.

2.1.4 OIL RETURN

When installing the OCSM coolant return line, refer to the following HOTSTART guidelines:

- Size the oil return line per the oil outlet. **NOTICE!** Do not reduce the return line inner diameter.
- Install the oil discharge port at the end of the sump opposite the suction port to ensure even heating.

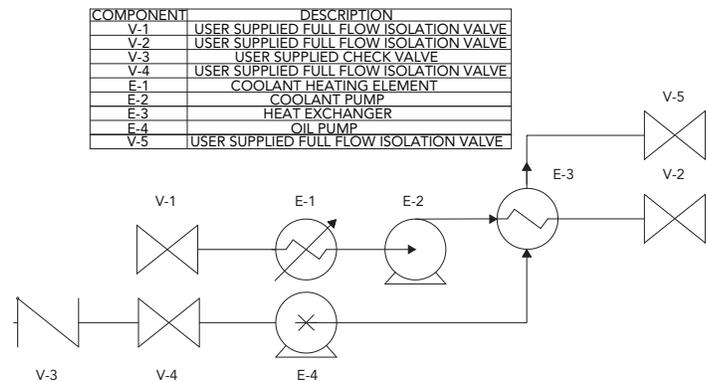
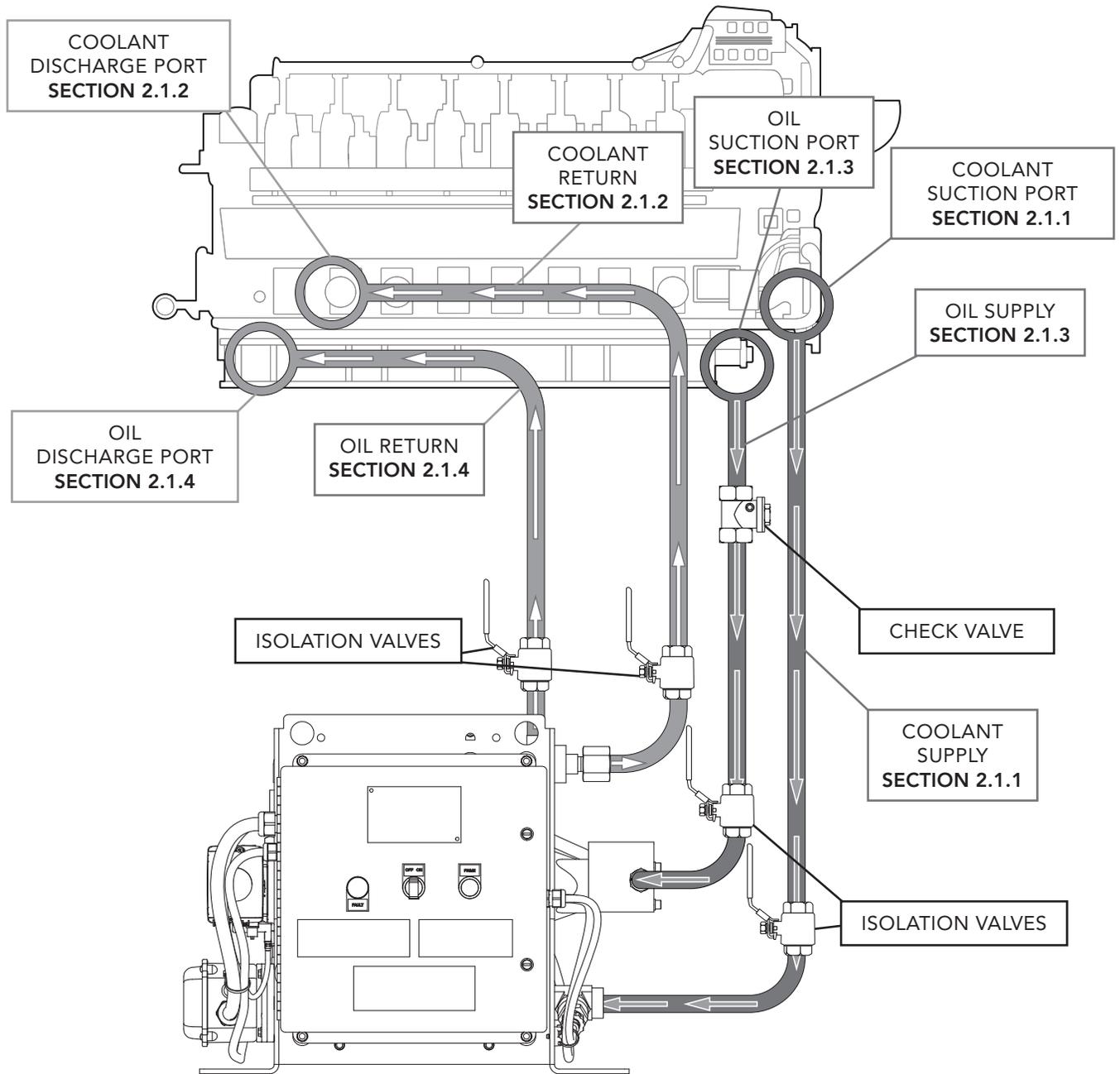


Figure 3. OCSM system diagram.

2.2 PLUMBING ILLUSTRATION



2.3 MOUNTING

NOTICE

Heating system damage: Engine vibration will damage the heating system; isolate both the tank assembly and control box from vibration. Never mount the heating system or components directly to the engine.

2.3.1 TANK AND PUMP

NOTICE

Overheating hazard: When mounting the heating tank assembly, position the tank and heat exchanger so that they are completely full of fluid while in operation.

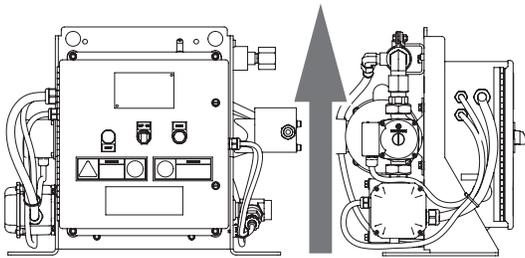


Figure 4. Mount unit in orientation shown. Do not mount at an angle or in any other orientation.

Mount the heater in a horizontal orientation with heat exchanger directly above tank. Reference drawings for mounting position. When installing the heating system, note that the tank requires a minimum of 18 to 20 inches (46 to 51 cm) of clearance to remove element for maintenance. See **SECTION 4.2.7**.

2.4 ELECTRICAL CONNECTIONS



WARNING

Hazardous voltage: Before wiring, servicing or cleaning the heating system, turn off the power and follow your organization's lockout and tagout procedure. Failure to do so could allow others to turn on the power unexpectedly, resulting in harmful or fatal electrical shock.

Electrical hazard: 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 electrical shock.

2.4.1 MAIN POWER SUPPLY

1. Connect the specified power from the customer-supplied circuit breaker to the terminal blocks located in the main control box. See *Figure 6* on following page.

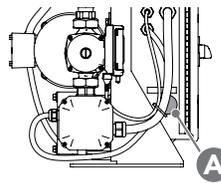


Figure 5. OCSM control box side view, showing 0.75" NPT main power entrance (A).

- NOTE:** The specified power source must be within plus or minus 10% of the rated voltage.
- NOTE:** The circuit breaker must be near the heating system and easily accessible. HOTSTART recommends connecting the heating system to a circuit breaker rated for 125% of the system's maximum load.
- NOTE:** The main power supply operates the heating element and the oil pump. A transformer is used to operate the control circuit and coolant pump. The transformer and control circuits are overload-protected.
- For **three-phase applications**, the terminal blocks are labeled **L1, L2** and **L3 (A)**.
 - For **single-phase applications**, use the terminal blocks labeled **L1** and **L2** or **L** and **N (A)**.
2. Connect the main power ground wire to the ground block (B).

2.4.2 MOTOR ROTATION CHECK

NOTICE

Pump rotation (three-phase only): For three-phase applications, check for proper pump rotation prior to introducing fluid to the pump. Reverse rotation while the pump is filled with fluid will cause pump seal failure.

Pump damage: Do not run the motor/pump assembly dry for more than a few seconds. Running a motor/pump for a prolonged period without being completely filled with fluid may cause damage to the pump seal.

The following procedures are for three-phase applications only. Single-phase systems are prewired to ensure the pump motor rotates in the correct direction.

1. With main power connected to the heating system (see **SECTION 2.4.1**), press and hold the **PRIME** button while observing the rotation of the oil pump motor fan at the rear of the motor. Refer to rotation decal on motor for correct rotation.

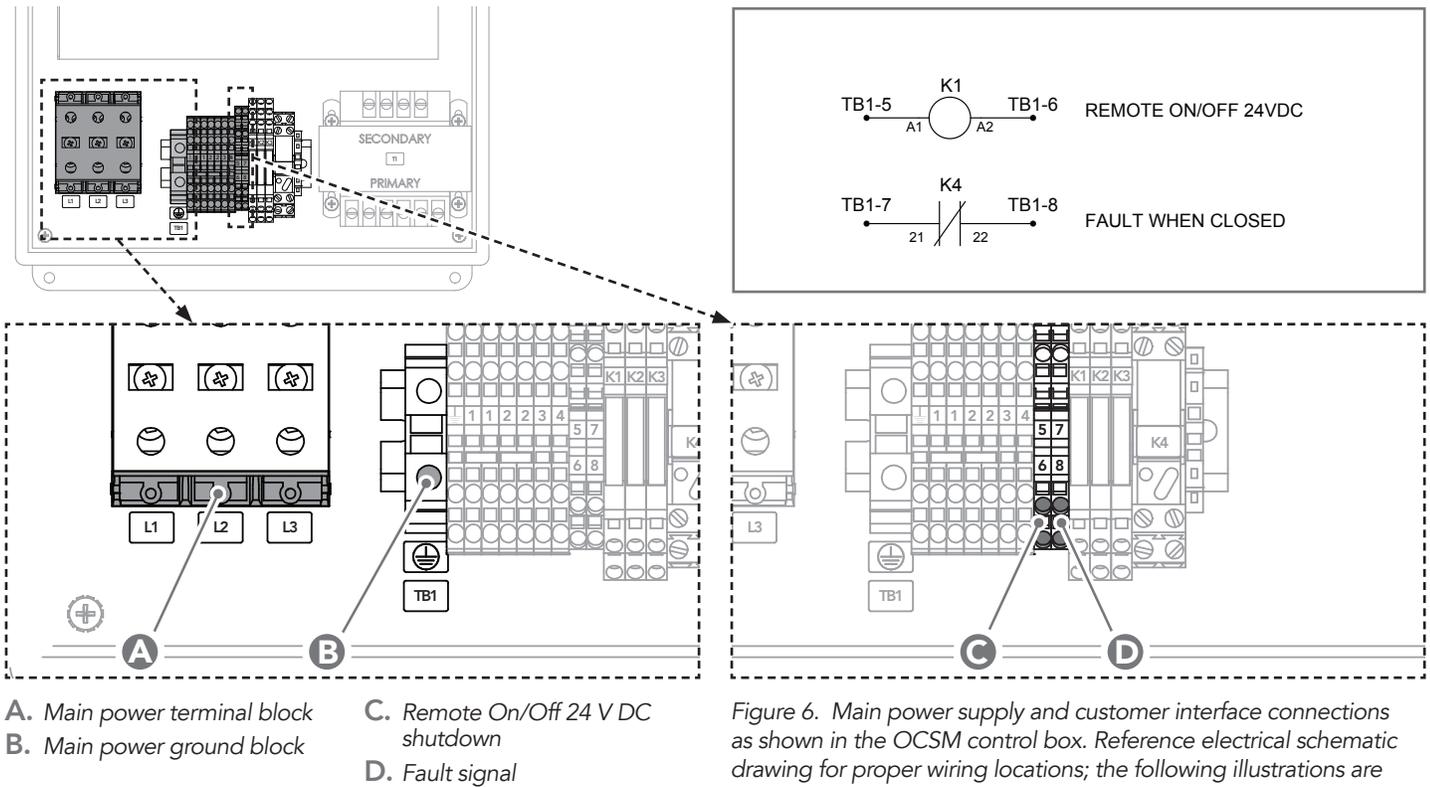


Figure 6. Main power supply and customer interface connections as shown in the OCSM control box. Reference electrical schematic drawing for proper wiring locations; the following illustrations are typical customer interface locations.

- If the pump motor does not rotate in the correct direction, disconnect power and switch any two electrical leads at the main power terminal block (L1, L2, L3). Reconnect power. Repeat step 1 to ensure motor rotates in the correct direction.

2.4.3 CUSTOMER INTERFACE CONNECTIONS

The following customer interface connections are available for remote control and monitoring (See Figure 6):

- **TB1:5/TB1:6 Remote On/Off 24 V DC shutdown (C)**
When activated, the remote on/off connection shuts down the heating system. When deactivated, normal heating will resume. Use this connection for remote operation of the heater when the **LOCAL/OFF/REMOTE** switch is turned to **REMOTE**.

NOTE: The **24 V DC shutdown** connection is wired **NC (normally closed)** from the factory. To switch to NO operation disconnect the wire from K1:12 terminal and reconnect wire to K1:14 terminal.

- **TB1:7/TB1:8 Fault Signal (D)**

The fault signal will indicate a heating system shutdown, triggered by either the high-limit temperature control relay or the motor protection switch (see SECTION 4.1.1).

3 COMPONENTS AND OPERATION

The following is an operational description for each of the OCSM interface and system components.

NOTE: Components installed in control box may vary depending on the particular system configuration purchased.

3.1 INTERFACE COMPONENTS

3.1.1 ON/OFF SWITCH

- **ON** – The system is **on**. If connected, the system will turn on and shut off on a signal from the 24 V DC remote connection. See SECTION 2.4.3.
- **OFF** – The system is shut **off**.

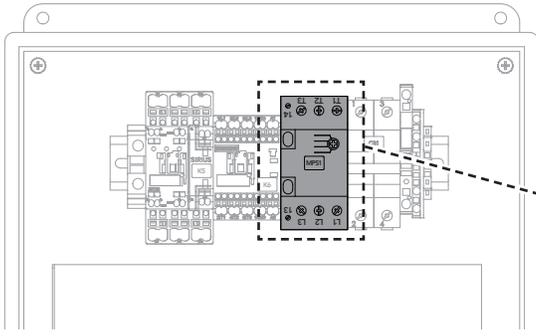
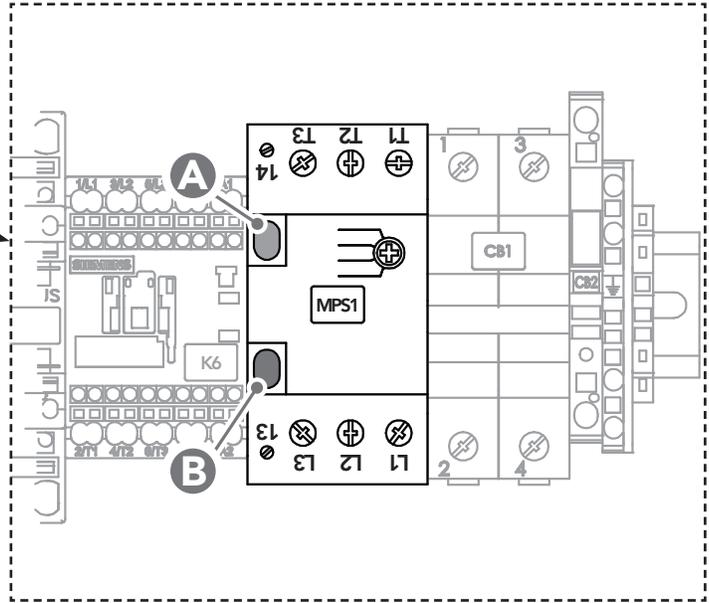


Figure 7. OCSM motor protection switch (above), showing stop/off (A) and reset/on (B) buttons. To reset the MPS, the heating system must be switched off and the MPS reset/on button must be pressed.



3.1.2 OIL PUMP ON/OFF SWITCH (OPTIONAL)

- **ON** – The oil pump is **on**. If the heating system is active, the oil pump will circulate oil through the heat exchanger.
- **OFF** – The oil pump is shut **off**. If the heating system is active, coolant will be heated normally but the oil pump will not circulate oil through the heat exchanger and no oil heating will occur.

3.1.3 PRIME BUTTON

Press and hold the **PRIME** button to energize the pump motors in order to remove any air in the heating system without energizing the element. **NOTICE!** Do not run the motor/pump assembly dry for more than five seconds at a time.

NOTE: The **PRIME** function is intended for use during the first run procedure (see **SECTION 3.3.1**) or after performing maintenance on the heating system or plumbing (see **SECTION 4.2**).

3.1.4 FAULT LIGHT

The fault light will illuminate if either the motor protection switch (MPS1) is tripped or the fluid high-limit temperature is exceeded (see **SECTION 4.1.1**).

3.2 CONTROL BOX INTERNAL COMPONENTS

3.2.1 MOTOR PROTECTION SWITCH

The motor protection switch (MPS) protects the oil pump motor from overloads. The MPS will be set at the full load

amperage of the motor when shipped from the factory. To reset the MPS, the heating system off/on switch must be switched to off and the operator must press the MPS reset button (see *Figure 7*). See **SECTION 4.1.1**.

3.3 HEATING SYSTEM START-UP



Hazardous voltage: Before wiring, servicing or cleaning the heating system, turn off the power and follow your organization's lockout and tagout procedure. Failure to do so could allow others to turn on the power unexpectedly, resulting in harmful or fatal electrical shock.



Pump rotation (three-phase only): For three-phase applications, check for proper oil pump rotation prior to introducing fluid to the pump. Reverse rotation while the pump is filled with fluid will cause pump seal failure.

Pump damage: Do not run the motor/pump assembly dry for more than five seconds at a time. Running a pump that is not completely filled with fluid will cause damage to the pump seal.

3.3.1 FIRST RUN PROCEDURE

1. For three-phase applications, ensure a motor rotation check has been performed prior to introducing fluid to the oil pump (see **SECTION 2.4.2**).

NOTE: Single-phase systems are prewired to ensure the pump motor rotates in the correct direction. A motor rotation check is not necessary.

2. Check and tighten all electrical and plumbing connections.
3. Ensure isolation valves are **open** before energizing the system.
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.

NOTE: If equipped, the oil pump on/off switch must be in the on position for the oil pump to prime.

5. Turn the **ON/OFF** switch to **ON** to energize the heating system.
6. If installed, activate the 24 V DC signal to verify the 24 V DC remote signal connection is operational.

4 MAINTENANCE, REPAIR AND TROUBLESHOOTING

4.1 SYSTEM FAULTS

4.1.1 FAULTS

A fault signal will be transmitted if:

- The motor protection switch is tripped (MPS1).
- The high-limit temperature is exceeded.

A failure in the pump motor that causes the motor protection switch (MPS1) to trip will disable oil circulation. Coolant heating will not be affected but a fault signal will be transmitted and the fault light will illuminate. If this failure occurs, the **ON/OFF** switch must be switched to **OFF** and the operator must press the MPS reset/on button to reset the fault. (See **SECTION 3.2.1.**)

If MPS faults are caused by the oil pump drawing excess current due to high oil viscosity, the oil pump may be disengaged using the Oil Pump On/Off switch (optional on specified heating system models only). Disengaging the oil pump will not reset an MPS fault. To reset the fault, the MPS reset/on button must be pressed.

If there is a failure that causes a high temperature to occur, the heating system will shut down, including the coolant and oil pump motors. A fault signal will be transmitted and the fault light will illuminate. To restart the system and reset the fault, the **ON/OFF** switch must

be switched to **OFF**. Once the coolant temperature drops below the high-limit turn the switch to **ON** to resume operation.

For additional troubleshooting, see **SECTION 4.5.**

4.2 SYSTEM MAINTENANCE



Hazardous voltage: Before wiring, servicing or cleaning the heating system, turn off the power and follow your organization's lockout and tagout procedure. Failure to do so could allow others to turn on the power unexpectedly, resulting in harmful or fatal electrical shock.

Instructions for the following maintenance procedures are provided to ensure trouble-free operation of your heating system. Replacement parts not obtained through HOTSTART must meet or exceed original part requirements in order to maintain the compliance level of the original heating system.

NOTE: After maintenance is performed, refer to **SECTION 3.3.1** for system start-up procedures.

4.2.1 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.

4.2.2 ELECTRICAL CONNECTIONS

Vibration may cause terminals to loosen. At start-up, tighten electrical connections. Check connections again in a week. Tighten all electrical connections every three months.

4.2.3 SYSTEM MOUNTING

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

4.2.4 MAGNETIC CONTACTORS

Magnetic contactors are used as voltage switching controls for motors and heating elements in HOTSTART heating systems. The contactors use 120 volt 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 contacts on the magnetic contactor should be inspected periodically for welding, arc erosion and

mechanical wear. If any of these conditions exist, replace the magnetic contactor. HOTSTART recommends contactors be replaced every five years.

4.2.5 PUMP SEAL

If seal becomes worn, replacement pump seals are available. To ensure pump seal longevity, ensure the supply lines do not restrict flow excessively (see **SECTION 2.1.1** and **SECTION 2.1.3**).

NOTE: Instructions to replace the pump seals are included with replacement seals.

4.2.6 CONTROL THERMOSTAT



Hazardous voltage: Before wiring, servicing or cleaning the heating system, turn off the power and follow your organization's lockout and tagout procedure. Failure to do so could allow others to turn on the power unexpectedly, resulting in harmful or fatal electrical shock.

To replace the control thermostat sensing unit, use the following procedures. See *Figure 8*.

1. De-energize the heating system. Follow your organization's lockout and tagout procedures.
2. Unscrew the hex nut (D) from well (A).

NOTE: Thermostat well (A) is shown separate from tank for illustration purposes. The thermostat well is a dry well; removing well from tank is not required to complete this procedure.

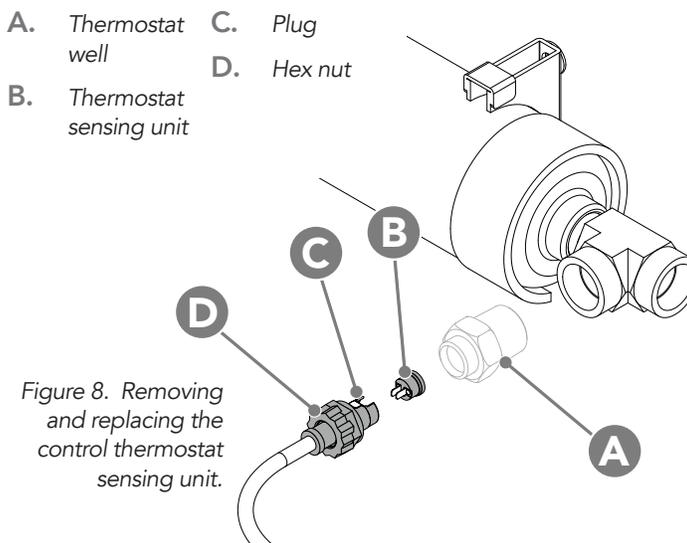


Figure 8. Removing and replacing the control thermostat sensing unit.

3. Pull plug (C) from well (A). Sensing unit (B) will be attached to plug.
4. Remove sensing unit (B) from plug (C).
5. Insert new sensing unit into plug. Push plug into well. Hand tighten hex nut to well.
6. To ensure proper installation and temperature regulation, re-energize and operate heating system. Refer to **SECTION 3.3.1** for system start-up procedures.

4.2.7 HEATING TANK/ELEMENTS



Hazardous voltage: Before wiring, servicing or cleaning the heating system, turn off the power and follow your organization's lockout and tagout procedure. Failure to do so could allow others to turn on the power unexpectedly, resulting in harmful or fatal electrical shock.

To replace the heating element or perform routine maintenance, use the following procedures. See *Figure 9*.

1. De-energize the heating system. Follow your organization's lockout and tagout procedures.
2. Close isolation valves. Unscrew tank drain (A). Drain fluid from tank.
3. Remove enclosure cover (F) from wiring enclosure (D).
4. The wire connections inside the enclosure correspond to one of the phase configurations shown on the following page. Note your unit's phase configuration and wire connection positions. See *Figure 10*.

NOTE: Replacement elements may be a different phase configuration.

5. Disconnect the ground (green/yellow) and power electrical wires from the element posts inside wiring enclosure (D).
6. Note the positions of the QD (quick disconnect) terminals on the high-limit thermostat (G) spade connectors. Remove the QD connections.

7. Remove wiring enclosure (D) from element plate (I).
8. Remove element plate screws (C). Remove element (B) from tank.
9. Replace the heating element (B) or perform the necessary cleaning procedure. Ensure the element O-ring (J) is in place.

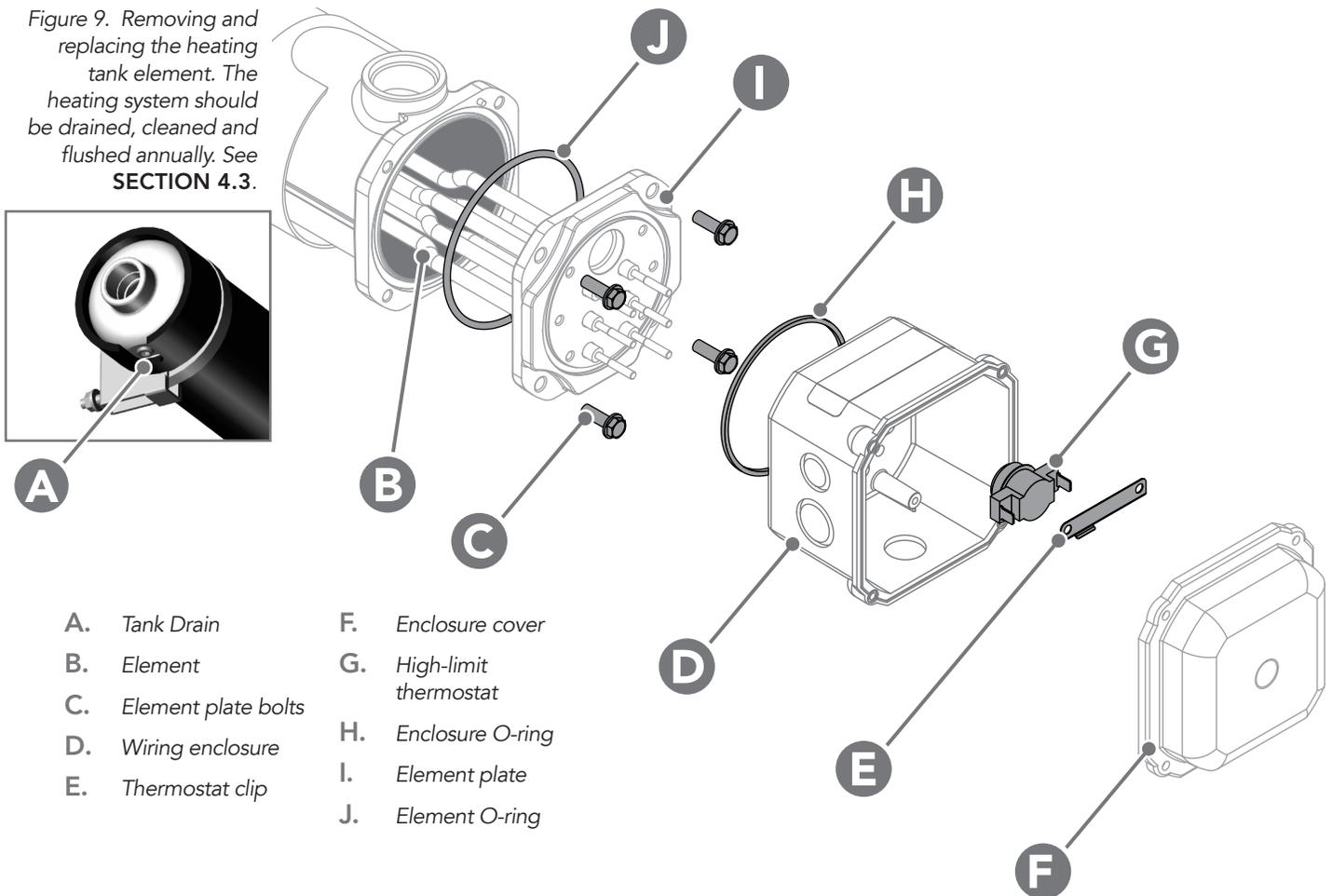
reconnected using the provided washers, cup washers and nuts. Ensure that the high-limit thermostat (G) is held in place with thermostat plate (E). Reconnect electrical connections to original positions. Ensure the enclosure O-ring (H) is in place.

NOTE: To prevent leaks, HOTSTART recommends tightening element plate screws (C) to 120 lbf · in (13.5 N · m).

4.2.8 REASSEMBLY OF HEATING ELEMENT AND TANK

To reassemble the heating element and tank, follow the steps listed in **SECTION 4.2.7** in **reverse order**. Make sure the ground and power electrical wires are properly

Figure 9. Removing and replacing the heating tank element. The heating system should be drained, cleaned and flushed annually. See **SECTION 4.3**.



- | | |
|------------------------|--------------------------|
| A. Tank Drain | F. Enclosure cover |
| B. Element | G. High-limit thermostat |
| C. Element plate bolts | H. Enclosure O-ring |
| D. Wiring enclosure | I. Element plate |
| E. Thermostat clip | J. Element O-ring |

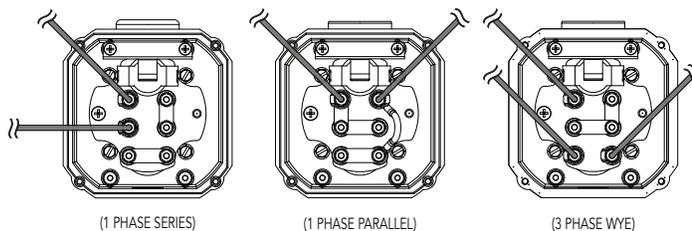


Figure 10. Heating tank element phase configurations. Replacement elements may be a different phase configuration.

4.3 RECOMMENDED MAINTENANCE

INTERVAL	MAINTENANCE TASK
At initial start-up	Tighten electrical connections. See SECTION 3.3.1 .
One week after initial start-up	Check and tighten electrical connections. See SECTION 4.2.2 .
Every three months	Tighten electrical connections.
Annually	Drain, clean and flush heating system.
	Check for cracked or weakened hoses and replace if necessary.
	Check electrical wiring and connections for signs of wear and excessive heat.
	Check mounting bolts and tighten if necessary.
Every three years or 25,000 hours of operation	Remove element and clean element and tank. See SECTION 4.2.7 .
	HOTSTART recommends replacing the control thermostat sensing unit every three years or 25,000 hours of operation. Thermostats are rated for 100,000 cycles. See SECTION 4.2.6 .
Every five years	Replace magnetic contactors. See SECTION 4.2.4 .

4.4 STORAGE REQUIREMENTS

If long-term storage is necessary, precautions must be taken to ensure that the heating system is operational for start-up. Steps must be taken to ensure that water ingress is mitigated at all locations. All plugs and caps must remain tight and a suitable cover must be provided for the system. The cover must shield the system from direct rain and protect from any directed spray that may occur.

4.5 TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSES	SOLUTION
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.
	Oil pump motor turning backwards	Reverse any two leads on power (in three-phase system). Restart system. See SECTION 2.4.2 .
	Control thermostat failure: closed	Check and replace if necessary. See SECTION 4.2.6 .
	Motor failure	Check and replace if necessary. Restart system.
	Motor contactor failure	Check contacts and replace if needed. Restart system.
	Motor protection switch tripped	Check and reset switch. If problem occurs again, check motor and check oil viscosity. Restart system. If oil is cold, leave MPS off (or turn Oil Pump On/Off switch to off) until heating system brings engine to optimal temperature.
Fluid temperature too low	Motor failure	Check motor. Replace if necessary.
	Heater has been turned off and fluid is cold	Allow time for the heating system to heat fluid.
	Heating element failed	Check elements for continuity. Replace element if necessary.
	Customer-supplied main circuit breaker tripped	Check for element short to ground. If no short, reset breaker.
	Element contactor failed	Check contacts and coil. Replace if necessary.
	Motor contactor failed	Check contacts and coil. Replace if necessary.
	Control thermostat failure: open	Check and replace if necessary. See SECTION 4.2.6 .