216311-000 rev1

INSTALLATION & OPERATION MANUAL

OIL CIRCULATING HEATING SYSTEM

MODEL

OXM
OGM

HOTSTART®
ENGINE HEATING

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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 and pre-plumbed. Each heating system has an identification plate which includes the part number and serial number.

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:

HOTSTART.

SPOKANE, WA
U.S.A.

REF. SERIAL NUMBER WHEN ORDERING REPLACEMENT PARTS

MODEL _____
VOLTS _____ **HERTZ** _____
AMPS. _____ **PHASE** _____
CONTROL CIRCUIT VOLTS _____
CONTROL CIRCUIT AMPS. _____ **MAX**
SERIAL NUMBER _____

U.S. PATENTS 4,245,593, 4,249,491
CAN. PATENTS 1,087,473, 1,082,541

CAUTION
OPEN CIRCUITS BEFORE WORKING ON THIS EQUIPMENT OR REMOVING COVERS.
KEEP COVERS TIGHTLY CLOSED WHILE CIRCUITS ARE ALIVE.

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

⚠ 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 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 2006/95/EC 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:** Proper rigging and safety equipment must be used to move this equipment. Do not lift the heating system by any cords, electrical conduit or cabling. Create a plan before attempting to move. Proper lifting locations are identified 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 heater for safety and ease of use.

NOTICE

EU Countries only: Equipment rated for the conditions listed in EN 601010-1 1.4.1 Ingress protection rating IP55. (Special conditions for specific applications may apply.)

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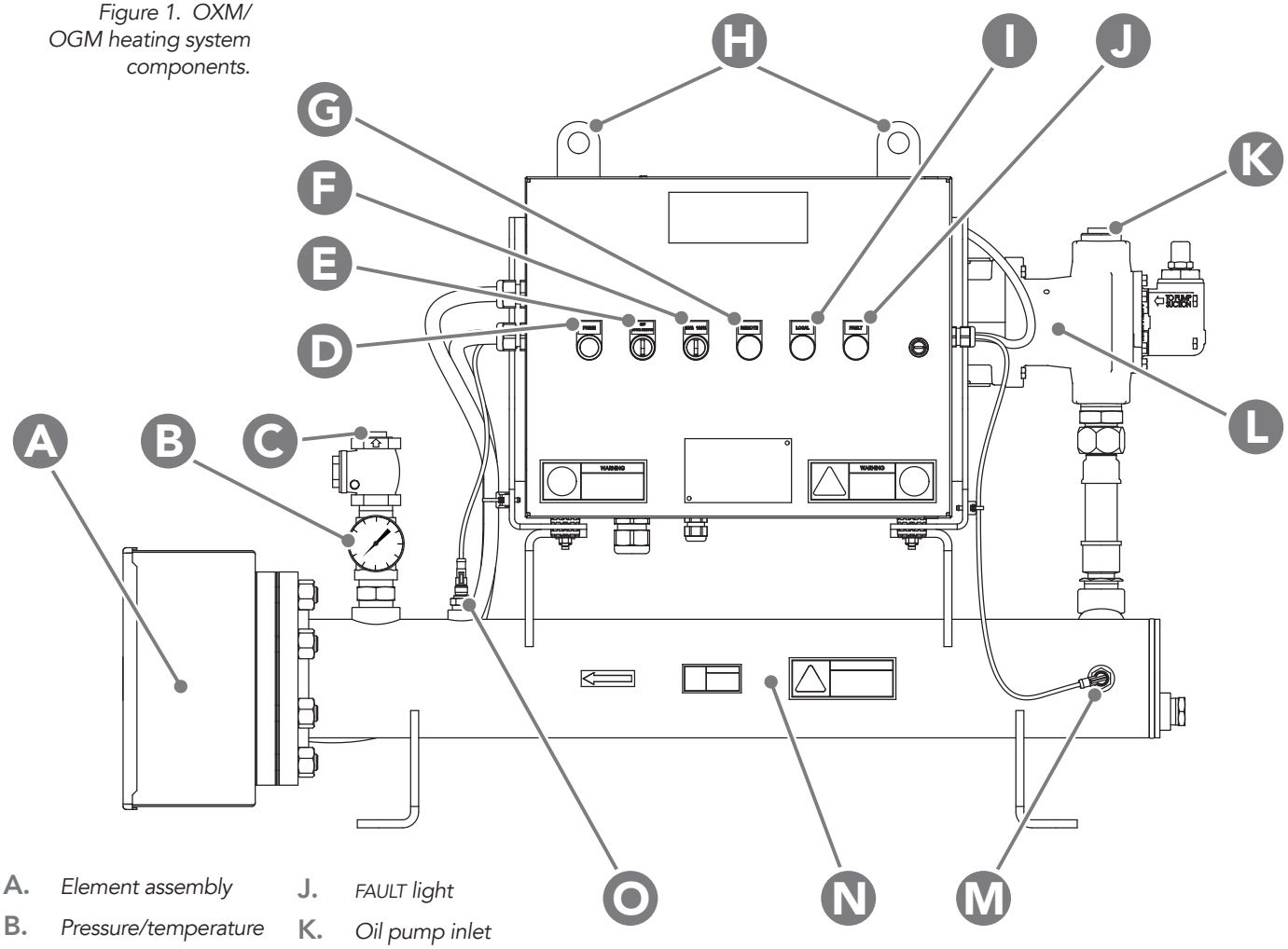
1 OVERVIEW

1.1 HEATING SYSTEM COMPONENTS

The OXM/OGM heating system consists of the following main components: *See Fig. 1.*

NOTE: Component illustrations are for reference only and are not to scale. See part drawings for dimensions and specifications. OGM model shown. OXM model incorporates two heater circuits; 50%/100% switch and heater lights not available.

Figure 1. OXM/ OGM heating system components.



- **A.** *Element assembly*
- **B.** *Pressure/temperature gauge*
- **C.** *Oil outlet (1.25" NPT)*
- **D.** *PRIME button*
- **E.** *LOCAL/OFF/REMOTE switch*
- **F.** *50%/100% switch*
- **G.** *REMOTE light*
- **H.** *Lift points*
- **I.** *LOCAL light*
- **J.** *FAULT light*
- **K.** *Oil pump inlet (OXM: 1.5" NPT) (OGM: 2.5" NPT)*
- **L.** *Pump/motor assembly*
- **M.** *Control RTD (resistance temperature device)*
- **N.** *Heating tank*
- **O.** *High-limit RTD (resistance temperature device)*

1.2 OPERATION OVERVIEW

The OXM/OGM heating system is intended to maintain an engine's optimal oil temperature while the engine is shut down. The heating system may be activated locally or by optional remote control (*see* **SECTION 2.6**). The OXM/OGM heating system should be deactivated upon engine start-up.

During heating system operation, a rotary gear pump takes oil from the sump and forces it through the heating tank to the oil return line. The oil pump will continuously circulate fluid. To maintain consistent fluid temperature, the heating elements will cycle on and off at the user-selected temperature control point.

A return line check (non-return) valve (included with the OXM/OGM unit and installed at the outlet) and a supply line check (non-return) valve (user-supplied, installed near the oil suction port) prevent backflow while the engine is operating. When the engine is shut down, the heating system should be activated locally or remotely to resume maintaining the fluid's optimal temperature.

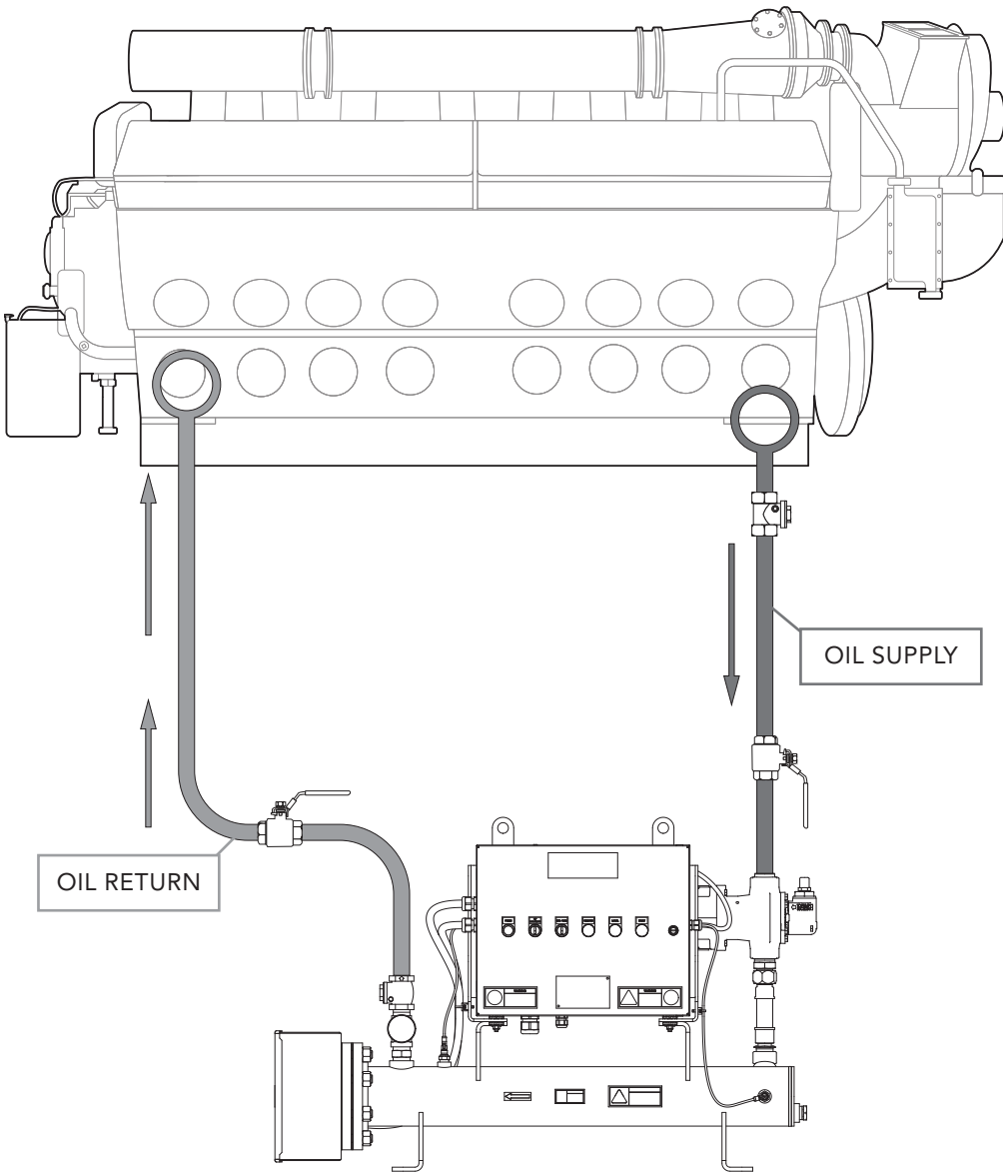


Figure 2. OXM/OGM operation overview, showing oil circulation. While the heating elements cycle on and off to maintain the preset temperature, the pump circulates fluid continuously during operation.

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

2 PLUMBING INSTALLATION

⚠ CAUTION

Pressure 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 cause damage to heating system components, damage to lubrication oil, fluid leaks and unexpected release of heated fluid.

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 the supply line with fluid. Pump is self-priming. However, 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 will occur.

Check valve: HOTSTART recommends installing a user-supplied swing-type or full-flow check valve (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.

Pressure relief valve: If the OXM/OGM heating system is for use with a closed, pressurized fluid system, additional, user-supplied pressure relief must be installed along the heating system outlet plumbing. User-supplied pressure relief valve plumbing must be routed back to oil sump, oil tank or atmospheric pressure. Do not route pressure relief plumbing back to heating system tank.

Isolation valves: HOTSTART recommends installing full-flow ball valves to isolate the heating system in order to perform service on the system or engine without draining oil.

2.1 OIL PLUMBING INSTALLATION

2.1.1 OIL SUPPLY

Installing a short, straight oil supply line with a minimum of flow restriction is the most important step toward ensuring heating system longevity. When installing the OXM/OGM oil supply line, refer to the following HOTSTART guidelines:

PUMP INLET	HOSE INNER DIAMETER	MAX. LINE LENGTH	MAX. ELBOW COUNT
1-1/2 inch NPT	1-3/8 inch	20 feet (6 meters)	4
2-1/2 inch NPT	2-3/8 inch	20 feet (6 meters)	4

Table 1. HOTSTART recommended hose inner diameters, line lengths and elbow counts for OXM/OGM oil supply lines.

- Due to the increased viscosity of lubrication oil, the oil supply line must be as short and as straight as possible. Any 90° elbows will reduce the maximum recommended oil supply length. *See Table 1* for HOTSTART OXM/OGM oil supply recommendations:

  NOTE: Each additional pair of 90° elbows will reduce the maximum recommended line length by five feet (1.5 meters). To minimize flow restriction, HOTSTART recommends using sweeping bends or 45° fittings.

- 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: To maximize flow and allow the longest possible supply line, install the largest practical inner diameter hose; for most installations, HOTSTART recommends using a hose with a size larger inner diameter than the pump inlet.

- Install the oil suction port as low as possible in the oil sump. **NOTICE!** Avoid installing the oil suction port in a location that may allow debris or sediment to enter the heating system.

- HOTSTART recommends installing a user-supplied, swing-type or full-flow check (non-return) valve to prevent oil flowing into the sump. Install the check valve as close to the oil supply port as possible.

2.1.2 OIL RETURN

When installing the OXM/OGM oil return line, refer to the following HOTSTART guidelines:

- At a minimum, size the oil return line per the heating system outlet. **NOTICE!** Do not reduce the return line inner diameter.
- Install the oil discharge port near the engine oil pump or to the opposite end of the oil sump.

2.1.3 OIL PRESSURE RELIEF VALVE

The oil pump pressure relief valve is internal to the pump and releases pressure from the discharge side of the pump to the suction side of the pump at 75 psi (525 kPa). No plumbing for this component is required.

2.2 PRESSURIZED SYSTEM INSTALLATION

⚠ CAUTION

Pressure hazard: The OXM/OGM heating system is rated for a maximum pressure of 125 psi (862 kPa). Excessive pressure may cause unexpected release of heated fluid.

If the heating system is for use with a closed, pressurized system, HOTSTART requires:

- Additional, user-supplied isolation valves (such as solenoid valves) must be installed on the oil supply and return lines to isolate the heating system from pressure greater than 125 psi (862 kPa).
- An additional, user-supplied pressure relief valve **must** be installed along the heating system outlet plumbing. User-supplied pressure relief valve plumbing must be routed back to oil sump, oil tank or atmospheric pressure. Do not route pressure relief plumbing back to heating system tank. *See Fig. 3.*

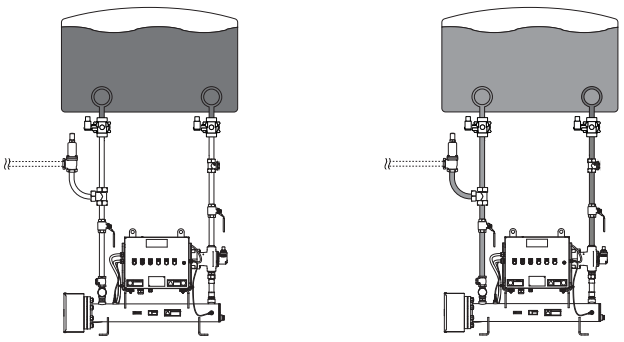
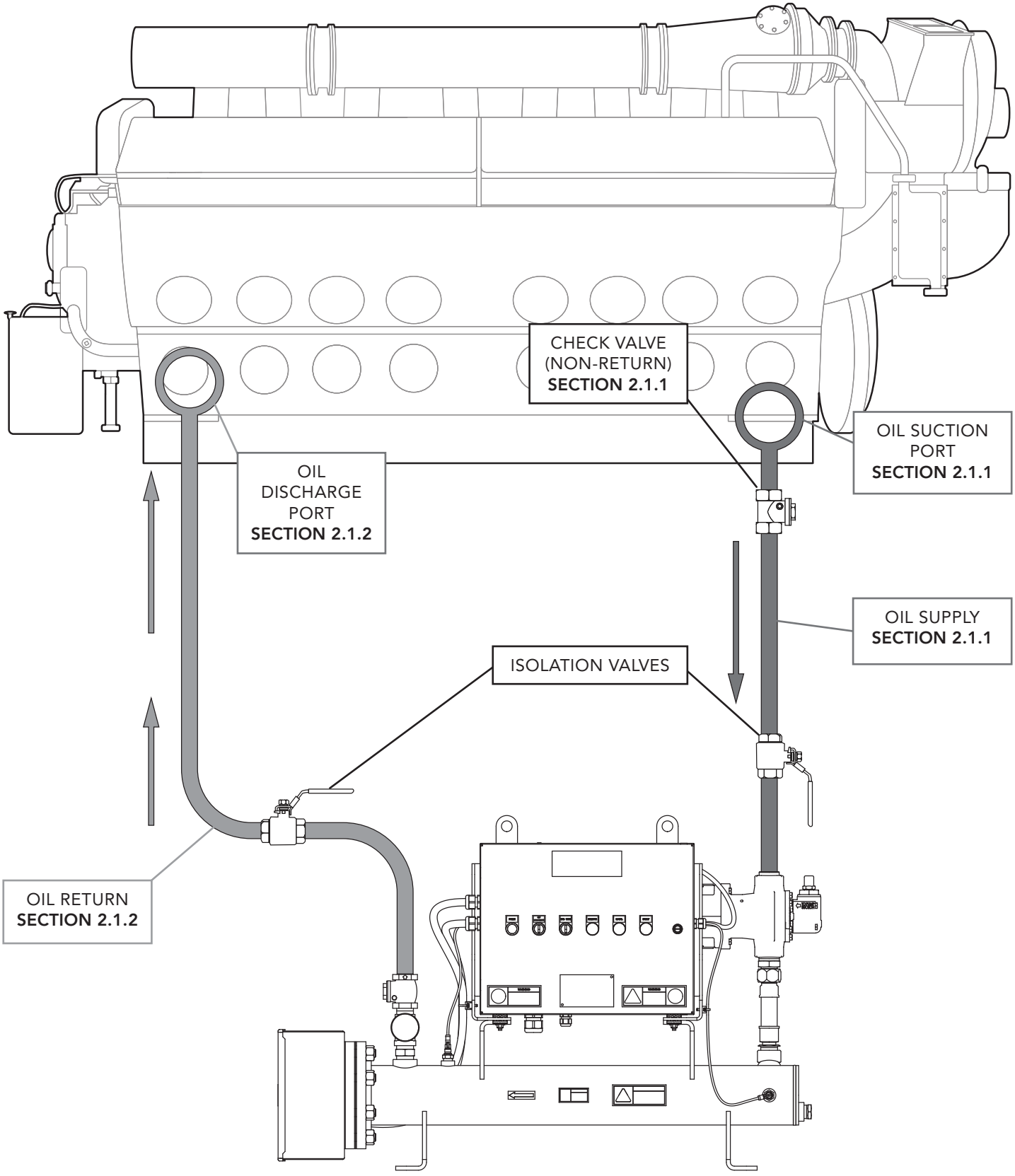


Figure 3. OXM/OGM operation in a closed, pressured system. When the pressurized system is active (left), solenoid valves isolate the heating system from excessive pressure. When the system is in a non-pressurized standby state (right), solenoid valves open.

2.3 OIL PLUMBING ILLUSTRATION

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



2.4 MOUNTING

⚠ CAUTION

Lifting hazard: Proper rigging and safety equipment must be used to move this equipment. Do not lift the heating system by any cords, electrical conduit or cabling. Create a plan before attempting to move. Proper lifting locations are identified on each system; use these locations when lifting and mounting the system.

Overheating hazard: When mounting the heating tank, position the tank so that it is completely full of fluid while in operation.

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.

Improper mounting hazard: Reference heating system component drawings before mounting the system. Unless mounted properly, the heating system will be unstable.

2.4.1 TANK AND PUMP

Mount the heater in a horizontal orientation with the heating tank directly below the control box and pump. Reference drawings for mounting position. When installing the heating system, note that the tank requires a minimum of 37 inches (94 cm) of clearance to remove element for maintenance. *See* **SECTION 5.2.12**.

2.5 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.

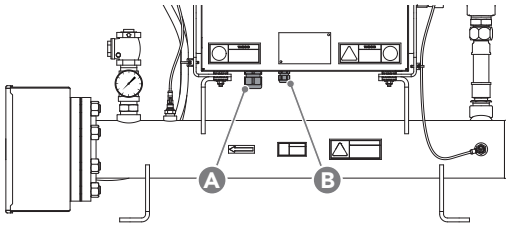


Figure 4. OLE/OLA underside, showing main power entrance **(A)** *and customer interface wiring entrance* **(B)**.

2.5.1 MAIN POWER SUPPLY

1. Connect the specified power from the user-supplied circuit breaker to the terminal blocks located in the main control box. The terminal blocks are labeled **L1**, **L2** and **L3**. *See Fig. 5.*

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.

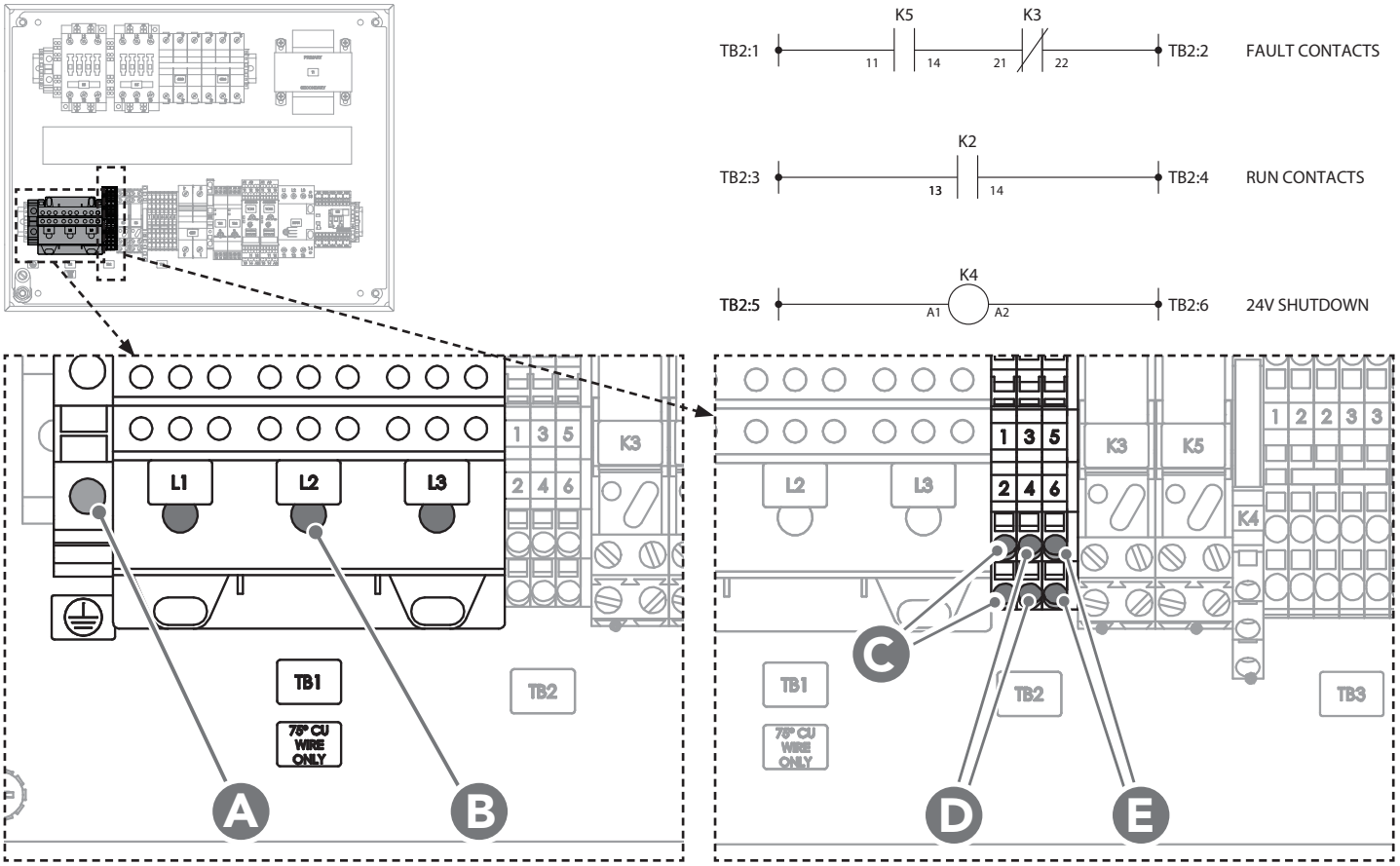
NOTE: The main power supply operates the heating elements and the circulating pumps. A transformer is used to operate the control circuit. The transformer and control circuits are overload-protected.

2. Connect the main power ground wire to the ground lug or ground block on the electrical panel located inside the electrical box.

2.5.2 CUSTOMER INTERFACE CONNECTIONS

Reference electrical schematic drawing for proper wiring locations; the following illustrations are typical customer interface locations. *See Fig. 5.*

The following customer interface connections are available for remote control and monitoring:



A. *Main power ground block*

B. *Main power terminal block*

C. *Fault signal*

D. *Motor run signal*

E. *Remote On/Off 24 V DC shutdown*

Figure 5. Main power supply and customer interface connections as shown in the OXM/OGM control box. Reference electrical schematic drawing for proper wiring locations; the following illustrations are typical customer interface locations.

- **TB2:1/TB2:2**
  Fault Signal (C)
  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 5.1**).

- **TB2:3/TB2:4**
  Motor Run Signal (D)
  A motor run signal indicates the pump motor is running. If no signal is present, the pump motor is not running.

- **TB2:5/TB2:6**
  Remote On/Off 24 V DC shutdown (E)
  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; see system wiring schematic for directions to switch to NO (normally open) operation.

3 SYSTEM COMPONENTS AND OPERATION

The following is an operation description for the standard parts located in the system.

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

3.1 LOCAL/OFF/REMOTE SWITCH

- **LOCAL** – The system is **on**. This mode is independent of the remote control relay. The **LOCAL** light will illuminate.
- **OFF** – The system is shut **off**.
- **REMOTE** – The system will turn **on** or **off** via the remote control relay. *See* **SECTION 2.6**. The **REMOTE** light will illuminate.

3.2 50%/100% SWITCH

The 50%/100% switch allows manually switching between employing the unit's full heating power or half of the overall heating power when the heating system is active. This switch can only be toggled locally.

3.3 PRIME BUTTON

Press and hold the **PRIME** button to energize the pump motor in order to remove any air in the heating system without energizing the elements.

3.4 OIL PRESSURE/ TEMPERATURE GAUGE

The OXM/OGM model features a temperature/pressure gauge mounted at the outlet of the heating tank. The gauge will indicate a pressure increase when the pump motor is engaged by pressing the **PRIME** button or during normal operation. The gauge will also indicate the current fluid temperature.

NOTE: Your system's operating pressure may vary depending on the configuration of the engine.

3.5 PRESSURE RELIEF VALVE

⚠ CAUTION

Pressure relief valve: If the OXM/OGM heating system is for use with a pressurized fluid system, additional, user-supplied pressure relief must be installed along the heating system outlet plumbing. User-supplied pressure relief valve plumbing must be routed back to oil sump or to atmospheric pressure. Do not route pressure relief plumbing back to heating system tank.

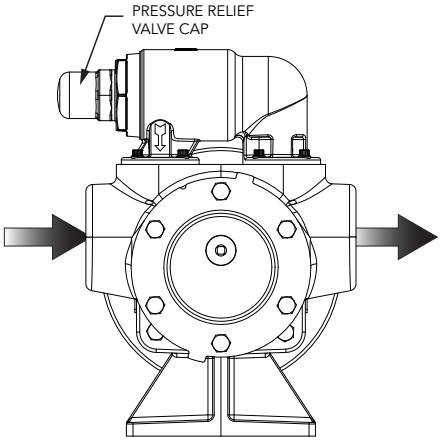


Figure 6. OXM/OGM pump assembly. Note that the pressure relief valve cap must always point toward the inlet side of pump.

The oil pump pressure relief valve is internal to the pump and releases pressure from the discharge side of the pump to the suction side of the pump at 75 psi (525 kPa). No plumbing for this component is required. The pressure relief valve cap must always point toward the inlet side of the pump. *See Fig. 6.*

The OXM/OGM heating system is designed to not exceed 125 psi (862 kPa); however, the oil pump will not exceed 75 psi (517 kPa). In the event the pressure relief valve is activated, the pump will continue to produce flow, but will not exceed a pressure of 75 psi (517 kPa).

3.6 MOTOR PROTECTION SWITCH (MPS)

The motor protection switch (MPS) protects the pump motor from overloads. *See Fig. 7.* The MPS will be set at the full load amperage of the motor when shipped from the factory. To reset the MPS, the **LOCAL/OFF/REMOTE** switch must be switched to **OFF** and the operator must press the MPS reset/on button. *See* **SECTION 5.1**.

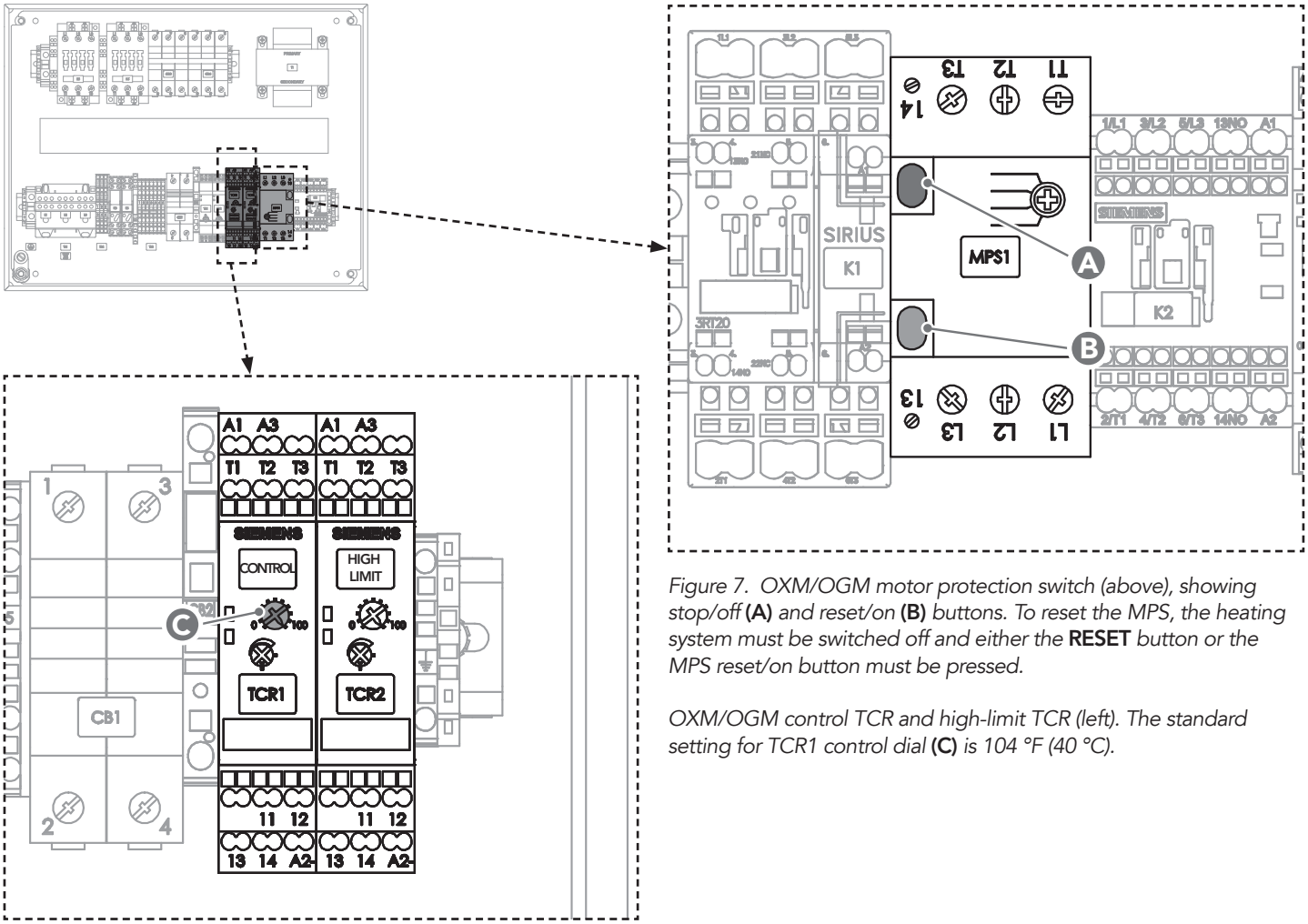


Figure 7. OXM/OGM motor protection switch (above), showing stop/off **(A)** *and reset/on* **(B)** *buttons. To reset the MPS, the heating system must be switched off and either the* **RESET** *button or the MPS reset/on button must be pressed.*

OXM/OGM control TCR and high-limit TCR (left). The standard setting for TCR1 control dial **(C)** *is 104 °F (40 °C).*

3.7 HIGH-LIMIT TCR (TEMPERATURE CONTROL RELAY)

The high-limit TCR (TCR2) is a protection device to prevent oil overheating. The high-limit TCR uses a resistance temperature device (RTD) located near the tank outlet. The default setting for the high-limit TCR is 194 °F (90 °C) at 0% hysteresis and should always be at least 18 °F (10 °C) higher than the control TCR set point. The high-limit TCR hysteresis is not used in the high-limit control. *See Fig. 7.*

3.8 CONTROL TCR (TEMPERATURE CONTROL RELAY)

The control TCR (TCR1) is used to control the temperature of the oil. The control TCR uses a resistance temperature device (RTD) to sense the temperature of the fluid as it enters the heater and will deactivate the element when the set temperature is reached. The standard setting for the control temperature relay (TCR1) set point is 104 °F (40 °C) at 10% hysteresis. *See Fig. 7.*

4 HEATING SYSTEM START-UP

⚠ 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.

NOTICE

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

Proper heating operation: The high-limit temperature control relay (TCR2) must be set at least 18 °F (10 °C) higher than the control temperature control relay (TCR1) for proper heating operation. This will prevent nuisance tripping of the high-limit circuit.

1. Check and tighten all electrical and plumbing connections.

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

3. Check the pump for proper rotation. **NOTICE!** Do not run the motor/pump assembly dry for more than a few seconds.

   - For three-phase heating systems, press and hold the **PRIME** button while observing the rotation of the pump motor fan at the rear of the motor. If the pump motor is not rotating in the correct direction, switch any two electrical leads at the main power terminal block. *See* **SECTION 2.5**.

   - Single-phase systems are prewired to ensure the pump motor rotates in the correct direction.

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: When priming the pump, the pressure gauge should indicate an increase in pressure. Your system's operating pressure may vary depending on the configuration of the engine.

5. Turn the **LOCAL/OFF/REMOTE** switch to **LOCAL** or **REMOTE** to energize the heating system.

6. Once operation is satisfactory, turn the control dial on the temperature control relay TCR1 to the desired temperature setting for engine oil. HOTSTART recommends a control temperature on TCR1 of 104 °F (40 °C). The high-limit temperature setting on TCR2 should be set at 194 °F (90 °C). *See* **SECTION 3.7** *and* **SECTION 3.8**.

5 MAINTENANCE, REPAIR AND TROUBLESHOOTING

5.1 FAULTS

The fault light will display if:

- The oil pump motor protection switch is tripped (MPS1).
- The oil high-limit temperature is exceeded (TCR2).

A failure in the oil pump motor that causes the motor protection switch (MPS1) to trip will shut down the heating system. A fault signal will be transmitted and the fault light will illuminate. *See Fig. 8.* If this failure occurs, the **LOCAL/OFF/REMOTE** switch must be switched to **OFF** and the operator must press the MPS reset/on button to reset the fault. (*See* **SECTION 3.6.**)

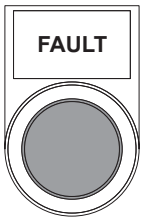


Figure 8. Fault light as shown on OXM/OGM control box.

If there is a failure that causes a high temperature to occur, the high-limit temperature controller (TCR2) will shut down the heating system, including the pump motor. A fault signal will be transmitted and the fault light will illuminate. To restart the system, the **LOCAL/OFF/REMOTE** switch must be switched to **OFF** and then back to **LOCAL** or **REMOTE** to resume operation once the oil temperature drops below the high-limit preset (*See* **SECTION 3.7**.)

NOTE: A high-limit fault can only occur when the heating element is energized.

For additional troubleshooting, *see* **SECTION 5.5**.

5.2 SYSTEM MAINTENANCE

⚠ 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.

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 heating system.

NOTE: After maintenance is performed, *refer to* **SECTION 4** for system start-up procedures.

5.2.1 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.

5.2.2 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.

5.2.3 SYSTEM MOUNTING

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

5.2.4 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.

5.2.5 PUMP SEAL

Pump mechanical seals are **controlled leakage devices** and are not intended to create a zero leak seal. Some leaking from the seal is expected during normal operation. If seal becomes worn, replacement pump seals are available for oil pumps. To ensure pump seal longevity, ensure the supply line does not restrict flow excessively (*see* **SECTION 2.1.1**) and run the heating system for 20 minutes monthly during offseason periods (*see* **SECTION 5.4**).

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

5.2.6 MOTOR LUBRICATION

Motors are installed with initial lubrication. If your motor has provisions for relubrication, refer to the motor manufacturer for recommended relubrication schedule intervals. For recommended lubrication type, refer to the motor nameplate.

NOTE: New motors installed on heating systems placed in extended storage for a year or longer may require relubrication. *See* **SECTION 5.4**.

5.2.7 OIL PRESSURE RELIEF VALVE

The oil pump pressure relief valve is internal to the pump and releases pressure from the discharge side of the pump to the suction side of the pump. No maintenance for this part is required.

5.2.8 OIL PRESSURE/TEMPERATURE GAUGE

The oil pressure/temperature gauge will indicate a pressure increase when the pump motor is engaged by pressing the **PRIME** button or during normal heater operation. The gauge will also indicate the current temperature of the fluid. No maintenance for this part is required.

5.2.9 VOLATILE CORROSION INHIBITOR (VCI)

A volatile corrosion inhibitor (VCI) is provided with each control box and should be replaced once a year.

NOTE: Heating systems placed in extended storage will require that the VCI is replaced at six month intervals. *See* **SECTION 5.4**.

5.2.10 TEMPERATURE CONTROL RELAY (TCR)

⚠ 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.

If the OXM/OGM heating system does not maintain the desired preset control temperature or signals a high-limit temperature fault immediately upon system start-up, the TCR (temperature control relay), the RTD (resistance temperature device), or the RTD cable may require replacement. To perform this troubleshooting, you will need:

- Ohmmeter

1. De-energize the heating system. Verify fluid is present and flow is not restricted. Check temperature gauge to ensure the liquid in the tank is below 122 °F (50 °C).

2. Verify the control TCR is set correctly. Verify that high-limit TCR is set at least 18 °F (10 °C) higher than the control TCR set point.

3. Using the ohmmeter, measure the resistance between TCR terminals **T1** and **T2** *(See Fig. 9)*:
   - ➤ If the measured resistance is **between 80 and 120 ohms** continue troubleshooting. *Proceed to step 4.*
   - ➤ If the resistance is **lower than 80 ohms** or **higher than 120 ohms**,contact HOTSTART for further assistance.

4. Using the ohmmeter, test for continuity between TCR terminals **T2** and **T3**:
   - ➤ If there **is continuity** between TCR terminals **T2** and **T3**, the TCR, RTD and RTD cable are functioning correctly. Close control panel. Allow fluid to cool below high-limit preset temperature. Perform system start-up *(see* **SECTION 4***)*. If fault or temperature problems persist after start-up, contact HOTSTART for further assistance.
   - ➤ If there **is no continuity** between TCR terminals **T2** and **T3**, locate connected RTD on the heating tank. Unscrew the RTD plug from RTD. *See Table 2 and Fig. 10, Fig. 11* on following page.

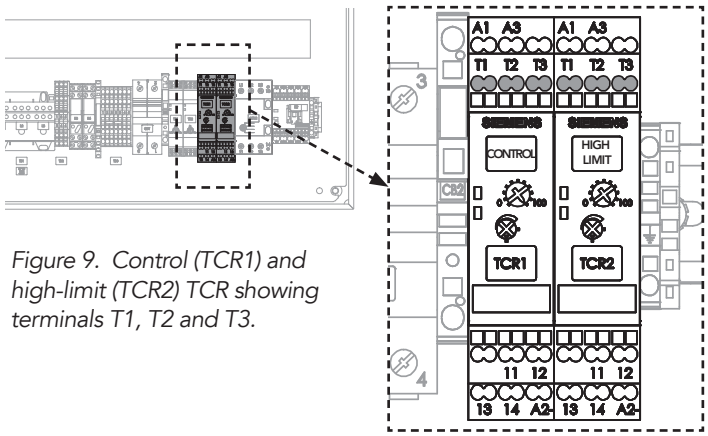


Figure 9. Control (TCR1) and high-limit (TCR2) TCR showing terminals T1, T2 and T3.

TCR		TYPE		RTD Position
TCR1	Oil	Control	40 °C	Tank Inlet
TCR2	Oil	High-limit	90 °C	Tank Outlet

Table 2. TCR types, default temperature settings and corresponding RTD positions.

5. Using the ohmmeter, touch the probes to RTD **pin 1** and **pin 3**. *See Fig. 10.* Note the resistance. Touch the probes to RTD **pin 1** and **pin 4** to check for continuity:
   - ➤ If the resistance between RTD **pin 1** and **pin 3** is **between 80 and 120 ohms** and there **is continuity** between RTD **pin 1** and **pin 4**, the RTD is functioning properly. Replace the RTD cable.
   - ➤ If the resistance between RTD **pin 1** and **pin 3** is **not between 80 and 120 ohms** or there is **no continuity between pin 1** and **pin 4**, the RTD is malfunctioning. Replace the RTD. *See* **SECTION 5.2.11**

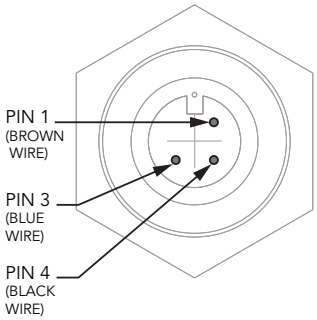


Figure 10. RTD pins 1, 3 and 4. The resistance between pin 1 and pin 3 should measure between 80 and 120 ohms. There should be continuity between pin 1 and pin 4.

5.2.11 RESISTANCE TEMPERATURE DEVICE (RTD)

⚠ 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.

High-limit or control resistance temperature devices (RTDs) sense temperature to either control fluid temperature or protect the system and fluid from overheating. To replace a resistance temperature device (RTD), use the following procedures.

NOTE: Before removing and replacing an RTD, ensure the RTD is malfunctioning. *See* **SECTION 5.2.10**.

1. De-energize the heating system. Allow fluid to cool.
2. Close isolation valves. Drain fluid from the oil heating tank. Locate the RTD that requires replacement. *See Fig. 11.*
3. Unscrew RTD plug. Remove plug. *See Fig. 12.*
4. Unscrew RTD from tank.
5. Screw replacement RTD to tank. When tightening, ensure plug is aligned with notch toward top of tank. *See Fig. 13.*
6. Fit RTD plug to RTD. Ensure plug is aligned correctly with notch. Push plug in firmly. Screw RTD plug to RTD to secure in place.
7. To ensure proper installation and temperature regulation, re-energize and operate heating system. *Refer to* **SECTION 4** *for system start-up procedures.*

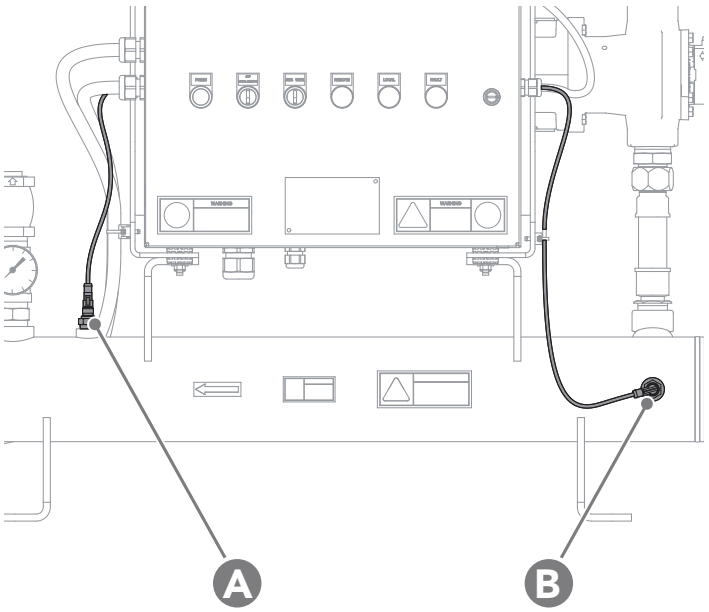


Figure 11. OXM/OGM high-limit RTD **(A)** *and control RTD* **(B)**.

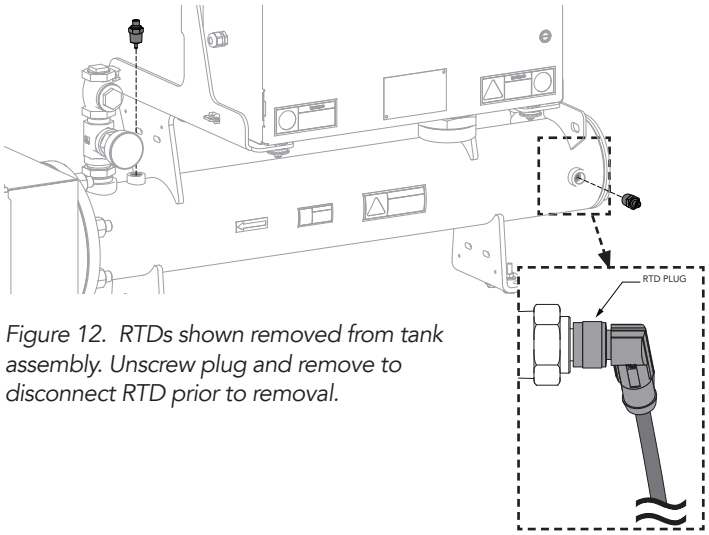


Figure 12. RTDs shown removed from tank assembly. Unscrew plug and remove to disconnect RTD prior to removal.

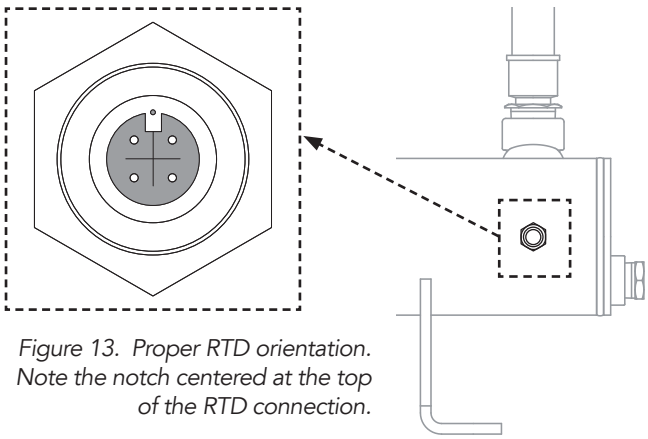


Figure 13. Proper RTD orientation. Note the notch centered at the top of the RTD connection.

5.2.12 HEATING TANK/ELEMENT

⚠ 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.

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 sediment build-up around the element loops. Any scaling or build-up will shorten element life.

To replace the heating element or perform routine maintenance, use the following procedures. *See Fig. 15.*

1. De-energize the heating system. Allow fluid to cool.
2. Close isolation valves.
3. Drain the fluid from the heating tank **(F)**.
4. Open heating element assembly **(B)** cover.
5. The wire connections inside the enclosure correspond to one of the phase configurations shown on the following page. Note your unit's phase configuration. *See Fig. 17.*

   NOTE: Replacement elements may be a different phase configuration.

6. Disconnect the ground (green/yellow) and power electrical wires from the posts inside the cap.
7. Unscrew cable gland **(G)** from heating element assembly **(B)**. *See Fig. 16.* Remove electrical cable and wires from the heating element.
8. Unscrew heating element assembly bolts **(A)**. Detach heating element assembly (B) from heating tank flange **(D)**. Remove assembly and heating elements **(E)** from tank **(F)**.
9. Replace the heating elements **(E)** or perform the necessary cleaning procedure. Ensure heating element gasket **(C)** is in place.

5.2.13 REASSEMBLY OF HEATING ELEMENT AND TANK

To reassemble the heating element and tank, follow the steps listed in **SECTION 5.2.12** in **reverse order**. Make sure the ground and power electrical wires are properly reconnected using the provided washers, cup washers and nuts. Tighten heating assembly bolts **(A)** uniformly, using pattern shown. *See Fig. 14.* Tighten bolts to snug-tight plus 30° rotation, or 200 lbf · ft (271 N · m)

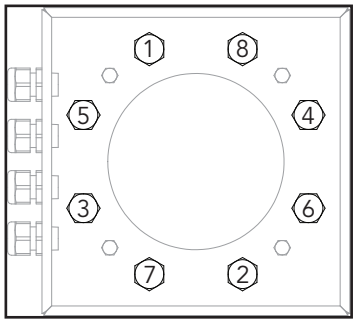
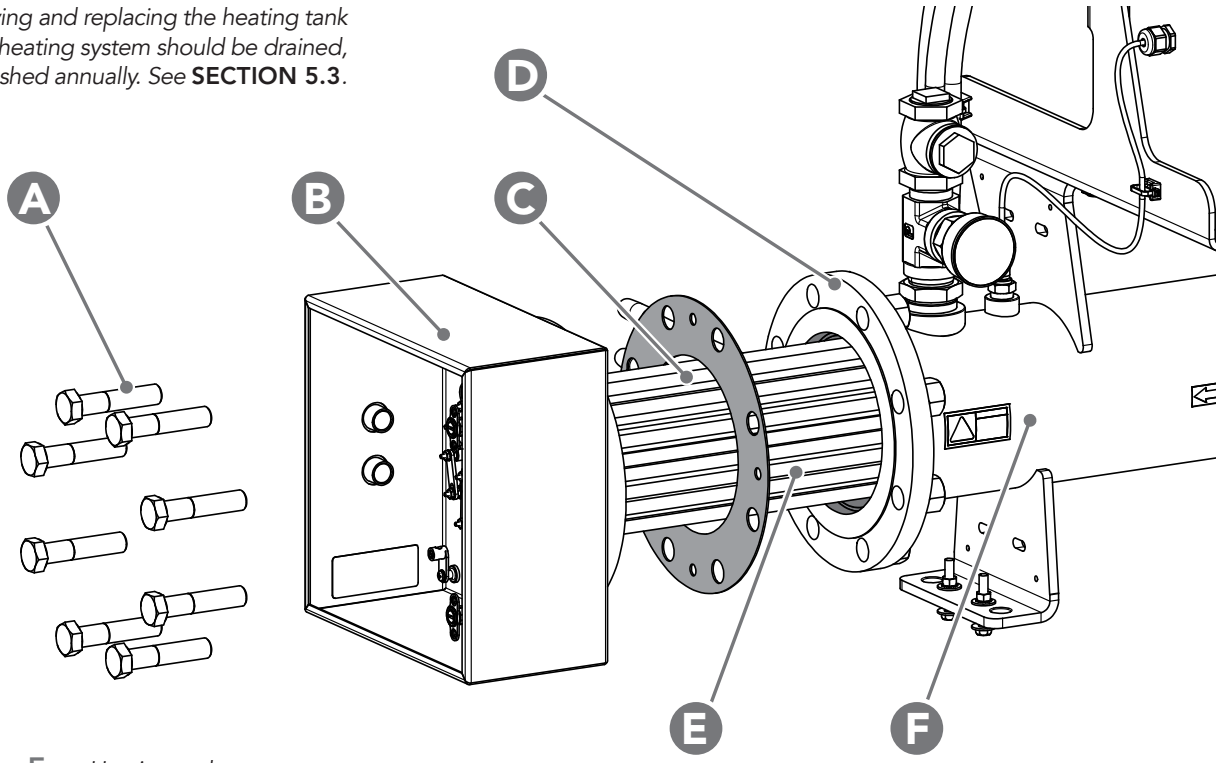


Figure 14. Heating assembly bolts, showing recommended tightening pattern.

Figure 15. Removing and replacing the heating tank element. The heating system should be drained, cleaned and flushed annually. See **SECTION 5.3**.



- **A.** *Element assembly bolts*
- **B.** *Element assembly*
- **C.** *Element gasket*
- **D.** *Heating tank flange*
- **E.** *Heating tank elements*
- **F.** *Heating tank*
- **G.** *Cable gland*

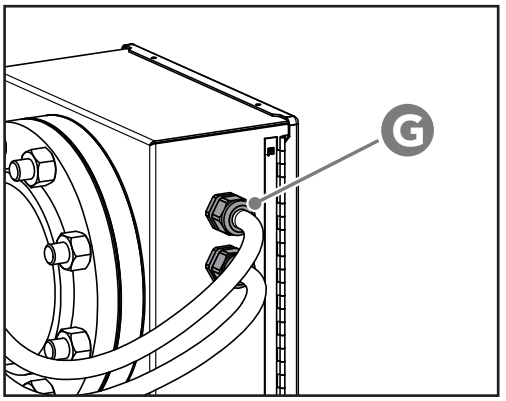
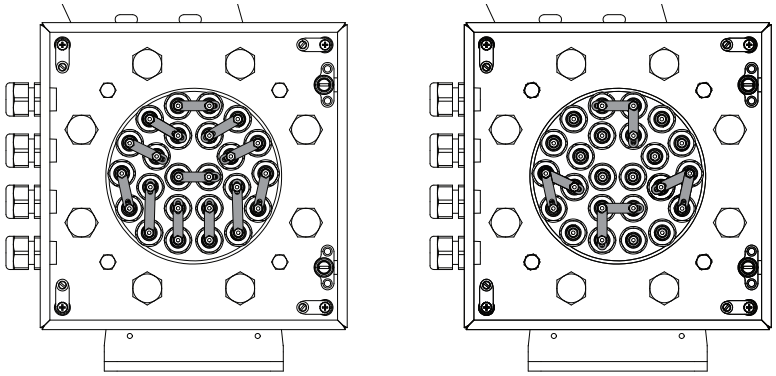


Figure 16. The cable gland as shown connected to the element assembly. Unscrew to remove element wiring.

Figure 17. Heating tank element phase configurations. Replacement elements may be a different phase configuration.



DELTA WYE

5.3 RECOMMENDED MAINTENANCE

INTERVAL	MAINTENANCE TASK
At initial start-up	Tighten electrical connections. *See* **SECTION 4**.
One week after initial start-up	Check and tighten electrical connections. *See* **SECTION 5.2.2**.
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 wear and excessive heat.
	Check mounting bolts and tighten if necessary.
	Remove element and clean element and tank. *See* **SECTION 5.2.12**.
Every five years	Replace magnetic contactors. *See* **SECTION 5.2.4**.

5.4 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.

For any storage longer than three months, desiccant bags must be placed next to the system if it is still in the original packaging and inside the control box. If the storage duration will be one year or longer, the volatile corrosion inhibitor inside the control box must be replaced at six month intervals.

New pump motors placed in long-term storage for a year or longer may require relubrication before initial use. If your pump motor has provisions for relubrication, refer to the pump motor manufacturer's relubrication recommendations. Refer to the pump motor nameplate for lubrication type.

During the offseason, or during periods in which the heating system is not active for a month or longer, HOTSTART recommends running the heating system for a minimum of 20 minutes each month. Circulating and heating fluid at regular intervals will reduce pump seal wear and promote pump seal longevity.

5.5 TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSES	SOLUTION
Heating 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 three-phase system). Restart system. *See* **SECTION 4**.
	Control TCR failure: closed	Check and replace if necessary. *See* **SECTION 5.2.10**.
	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. Restart system.
	RTD failure	Check TCR and RTD. See **SECTION 5.2.10**.
	RTD cable failure	Check TCR and RTD. See **SECTION 5.2.10**.
Oil temperature too low	Motor failure	Check motor. Replace if necessary.
	Heating element failed	Check elements for continuity. Replace element if necessary.
	Element 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 TCR failure: open	Check and replace if necessary. *See* **SECTION 5.2.10**.
	Control TCR set point too low	Adjust set point for control TCR. *See* **SECTION 3.8.**
	RTD failure	Check TCR and RTD. See **SECTION 5.2.10**
	RTD cable failure	Check TCR and RTD. See **SECTION 5.2.10**.