INSTALLATION & OPERATION MANUAL

OIL CIRCULATING HEATING SYSTEM
FOR HAZARDOUS LOCATIONS

MODEL
OSE
OSX
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.

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:

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.

Corporate & Manufacturing Headquarters
5723 E. Alki Ave.
Spokane, WA 99212 USA
509.536.8660
sales@hotstart.com

Oil & Gas Office
21732 Provincial Blvd.
Suite 170
Katy, TX 77450 USA
281.600.3700
oil.gas@hotstart.com

Europe Office
HOTSTART GmbH
Am Turm 86
53721 Siegburg, Germany
+49.2241.12734.0
europe@hotstart.com

Asia Pacific Office
HOTSTART Asia Pacific Ltd.
2-27-15-4F Honkomagome
Bunkyo-ku, Tokyo
113-0021, Japan
+81.3.6902.0551
apac@hotstart.com
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 IP54. (Special conditions for specific applications may apply.)
# TABLE OF CONTENTS

**IDENTIFYING YOUR SYSTEM** | I

**WARRANTY INFORMATION** | I

**IMPORTANT SAFETY INFORMATION** | II

## 1 INSTALLATION | 1

1.1 HEATING SYSTEM COMPONENTS | 1

1.2 OIL PLUMBING ILLUSTRATION (ENGINE) | 2

1.3 OIL PLUMBING ILLUSTRATION (COMPRESSOR WITH PRELUBE) | 3

1.4 OIL PLUMBING INSTALLATION | 4

1.4.1 Oil Supply | 4

1.4.2 Oil Return | 4

1.5 MOUNTING | 5

1.5.1 Tank and Pump | 5

1.6 MAIN POWER SUPPLY | 6

1.7 CUSTOMER INTERFACE CONNECTIONS | 7

## 2 SYSTEM COMPONENTS AND OPERATION | 8

2.1 PRIME BUTTON | 8

2.2 LOCAL/OFF/REMOTE SWITCH | 8

2.3 RESET BUTTON/MOTOR PROTECTION SWITCH (MPS) | 9

2.4 PRESSURE GAUGE | 9

2.5 PRESSURE RELIEF VALVE | 9

2.6 CONTROL TCR (TEMPERATURE CONTROL RELAY) | 9
# TABLE OF CONTENTS

2.7  HIGH-LIMIT TCR (TEMPERATURE CONTROL RELAY) | 9

3   HEATING SYSTEM START-UP | 10

4   OVERVIEW OF OPERATIONS | 11

4.1   OIL FAULTS | 11

5   MAINTENANCE, REPAIR AND TROUBLESHOOTING | 11

## 5.1  SYSTEM MAINTENANCE | 11

5.1.1  Plumbing Connections | 12

5.1.2  Electrical Connections | 12

5.1.3  System Mounting | 12

5.1.4  Magnetic Contactors | 12

5.1.5  Pump Seal | 12

5.1.6  Pressure Relief Valve | 12

5.1.7  Pressure Gauge | 12

5.1.8  Volatile Corrosion Inhibitor (VCI) | 12

5.1.9  Control Resistance Temperature Device (RTD) | 13

5.1.10  Heating Tank/Elements | 14

5.1.11  Reassembly of Heating Element and Tank | 14

5.2  RECOMMENDED MAINTENANCE | 16

5.3  STORAGE REQUIREMENTS | 16

5.4  TROUBLESHOOTING | 17
1 INSTALLATION

WARNING

System location classification: Before installing the OSE or OSX heating system, ensure all system components are suitable for the intended installation location by referring to the location classification labeling attached to the individual system components.

1.1 HEATING SYSTEM COMPONENTS

The OSE/OSX oil circulating heating system consists of the following main components: See Fig. 1 and Fig. 2.

NOTE: Component illustrations are for reference only and are not to scale. See part drawings for dimensions and specifications.
1.2 OIL PLUMBING ILLUSTRATION (ENGINE)

CHECK VALVE
SECTION 1.4.1

OIL SUCTION PORT
SECTION 1.4.1

OIL RETURN
SECTION 1.4.2

ISOLATION VALVES
1.4 OIL 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 oil.

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

**Pump priming:** Fill the supply line with oil. 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.

**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:** To minimize flow restriction along the oil supply line, HOTSTART recommends installing a customer-supplied swing-type or full-flow check 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.

**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 the oil.

1.4.1 OIL SUPPLY

To ensure that oil does not flow back into the sump, the oil suction port must be at or below the oil level. Keep the oil suction port away from the bottom of the oil pan. The oil supply line must be as short and as straight as possible. If installing a check valve is necessary, HOTSTART recommends installing a swing-type or full-flow check valve to minimize flow restriction along the oil supply line. Install the check valve as close to the oil supply port as possible.

1.4.2 OIL RETURN

Size the oil return line per the outlet of the heating system. Depending on your application or compressor size, there may be configuration options or requirements for locating the oil discharge port of the HOTSTART oil heating system.

**NOTE:** The OSE/OSX heating system is designed and sized for **continuous** prelube. Continuous prelube will heat the oil and compressor frame itself. HOTSTART specifies flow rates based on compressor manufacturer’s recommendations.

- For diesel engine applications, the oil return line **must** be routed to the oil discharge port located at opposite end of the oil sump. See **SECTION 1.2**.

- For large-sized (four- or six-throw reciprocating) compressor prelube applications, the oil return line may be routed to a prelube location **or** the return line may be routed to the opposite end of the oil sump. See **SECTION 1.3**.
1.4 OIL PLUMBING INSTALLATION CONTINUED

For small- and medium-sized compressors, the oil return line may be routed to the opposite end of the oil sump or the return line may be routed to a prelube location. See SECTION 1.3. If the return line is routed to a prelube location, HOTSTART requires installing a bypass to the compressor oil sump, including a customer-supplied tee fitting and pressure relief valve.

Should flow become restricted due to low ambient temperatures, the pressure relief valve along the bypass line will open and allow heated oil to route to the compressor’s oil sump. This alternate routing will allow the heating system to maintain optimal oil temperature while still providing the necessary pressure to the prelube system. See Fig. 3 and Fig. 4.

NOTE: The pressure relief valve must be designated as full-flow bypass and must be rated for up to 65 psi. HOTSTART does not recommend non-code safety valves for this application.

Figure 3. Small compressor oil heating in low ambient temperatures. The bypass pressure relief valve is closed and oil is routed directly to the prelube location.

Figure 4. Small compressor oil heating in low ambient temperatures. High oil viscosity restricts oil flow and increases oil pressure. The pressure relief valve opens and allows oil to flow directly to the sump in addition to the prelube location.

1.5 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 oil 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.
1.5.1 TANK AND PUMP

Mount the heater in a horizontal orientation with the pump and pump motor above the tank. To ensure that oil does not flow back into the sump, HOTSTART recommends mounting the heater at or below the minimum oil level. If the pump is installed above the minimum oil level, a check valve **must** be installed. Reference drawings for mounting position. When installing the heating tank, note that the tank requires a minimum of 12 inches (31 cm) of clearance to remove the element for maintenance. See **SECTION 5.1.10**.

1.6 MAIN POWER SUPPLY

**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.

1. Connect the specified power from the customer-supplied circuit breaker to the terminal blocks located in the main control box.

   **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.

   ▶ For **three-phase applications**, the terminal blocks are labeled L1, L2 and L3.

   ▶ For **single-phase applications**, use the terminal blocks labeled L1 and L2 or L and N. See Fig. 5.

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

![Figure 5. The main power supply terminal blocks located in the OSE/OSX control box. The main power ground wire must be connected to the ground lug or ground block.](image-url)
### 1.7 CUSTOMER INTERFACE 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.

Reference electrical schematic drawing for proper wiring locations; the following illustrations are typical customer interface locations. See Fig. 6, Fig. 7 and Fig 8. (page 8).

The **switch location signal** will indicate the position of the **LOCAL/OFF/REMOTE** switch. 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) The **motor on when closed signal** indicates the pump is running. The **24 V dc relay connections** are for remote control for the heating system while the switch is in the **REMOTE** position.

**NOTE:** The **24 V dc remote control relay** is wired **NC (normally closed)** from the factory; see system wiring diagram for directions to switch to **NO (normally open)** operation.

---

**Figure 6. Remote control on/off, fault signal, motor on signal connections (TB2).**

**Switch location signal connections (X1).**

**Figure 7. 24 V dc remote control relay connections (K1).**
2 SYSTEM COMPONENTS AND OPERATION

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

- **PRIME** button
- **LOCAL/OFF/REMOTE** switch
- **RESET** button/motor protection switch
- Pressure gauge
- Pressure relief valve
- Control TCR (temperature control relay)
- High-limit TCR (temperature control relay)

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

2.1 PRIME BUTTON

The **PRIME** button is used to remove remaining air in the supply and return lines without energizing the heater element.

2.2 LOCAL/OFF/REMOTE SWITCH

- **LOCAL** – The system is **on**.
- **OFF** – The system is **off**.
- **REMOTE** – The system is turned **on** and **remotely controlled**.
2.3 RESET BUTTON/MOTOR PROTECTION SWITCH (MPS)

The motor protection switch (MPS) protects the 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 LOCAL/OFF/REMOTE switch must be switched to OFF and the operator must press the RESET button. See SECTION 4.1.

2.4 PRESSURE GAUGE

The oil pressure gauge will indicate a pressure increase when the pump motor is engaged by pressing the PRIME button or during normal operation.

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

2.5 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 external routing for discharge is required.

2.6 CONTROL TCR (TEMPERATURE CONTROL RELAY)

The control TCR is used to control the temperature of the oil. The TCR uses a resistance temperature device (RTD) to sense the oil temperature as the oil enters the heater. The standard setting for the control temperature relay (TCR1) is 104 °F (40 °C). See Fig. 9.

2.7 HIGH-LIMIT TCR (TEMPERATURE CONTROL RELAY)

The high-limit TCR (TCR2) is a protection device to prevent overheating of oil in the system. The high-limit TCR uses an RTD located inside the element enclosure. The default setting is 194 °F (90 °C) 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. 9.
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 oil 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. Press and hold the PRIME button to check the pump for proper rotation. NOTICE! Do not run the motor/pump assembly dry for more than a few seconds. If you are operating a three-phase heating system, check for proper rotation of the pump motor when the system is energized. If the pump motor is not rotating in the correct direction, switch any two electrical leads at the main power terminal block.

   NOTE: 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 or compressor.

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

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 122 °F (50 °C). The high-limit temperature setting on TCR2 should be set at 194 °F (90 °C). See SECTION 2.6.

7. To verify that the 24 V dc customer controls operate properly, turn the LOCAL/OFF/REMOTE switch to REMOTE.
4 OVERVIEW OF OPERATIONS

**NOTICE**

Compressor damage: Incorrectly configured continual prelubing can cause permanent compressor damage. Consult the compressor manufacturer for proper prelube techniques.

When the system is energized, a positive displacement rotary gear pump takes oil from the oil sump and forces it through the heating tank and into the oil return line. Diesel engines must have the oil return line routed to the opposite end of the sump. Compressors may have the oil return line routed to the opposite end of the sump or to a prelubing location.

**NOTE:** The OSE/OSX heating system is designed and sized for continuous prelube. Continuous prelube will heat the oil and compressor frame itself. HOTSTART specifies flow rates based on compressor manufacturer’s recommendations.

4.1 OIL FAULTS

If there is a failure in the system that causes a high temperature to occur, the high-limit temperature controller (TCR2) will shut down the entire heating system, including the pump motor. The fault light will illuminate. To restart the system, the LOCAL/OFF/REMOTE switch must be switched to OFF and then back to either LOCAL or REMOTE to resume operation.

A failure in the pump motor that causes the motor protection switch to trip will shut down the entire system. A fault signal will be transmitted. If this failure occurs, the LOCAL/OFF/REMOTE switch must be switched to OFF and the operator must press the RESET button to reset the fault. For additional troubleshooting, see SECTION 5.4.

5 MAINTENANCE, REPAIR AND TROUBLESHOOTING

5.1 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 heater.

- Plumbing connections
- Electrical connections
- System mounting
- Magnetic contactors
- Pump seal
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 cause terminals to loosen. At start-up, tighten electrical connections. Check connections again in a week. Tighten all electrical connections every three 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 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.

5.1.5 PUMP SEAL

Pump mechanical seals are controlled leakage devices and are not intended to create a zero leak seal. Some leaking from seal is expected during normal operation. If seal becomes worn, replacement pump seals are available.

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

5.1.6 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.

5.1.7 PRESSURE GAUGE

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

5.1.8 VOLATILE CORROSION INHIBITOR (VCI)

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

To replace the control RTD, use the following procedures. See Fig. 10.

1. De-energize the heating system. Follow your organization's lockout and tagout procedures.
2. Close isolation valves. Drain the fluid from the heating tank.
3. Remove the control RTD service entrance cap (A).
4. Disconnect the wires from the control RTD (C).
5. Disconnect the wiring conduit from the control RTD enclosure (B).
6. Remove control RTD enclosure (B). Remove and replace control RTD (C).
7. Reattach control RTD enclosure (B). Reattach wiring conduit to control RTD enclosure. Reattach thermostat wires to control RTD (C). Reattach control thermostat service entrance cap (A).
8. To ensure proper installation and temperature regulation, re-energize and operate heating system. Refer to SECTION 3 for system start-up procedures.

*Figure 10. Removing and replacing the control thermostat resistance temperature device (RTD).*
5.1.10 HEATING TANK/ELEMENTS

**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.

To replace the heating element or perform routine maintenance, use the following procedures. See Fig. 11. The wattage and phase of the heating element are listed on the identification plate on the outside of the element (B). Reference this label for the replacement part number.

1. De-energize the heating system. Follow your organization’s lockout and tagout procedures.
2. Close isolation valves.
3. Drain the fluid from the heating tank (F).
4. Remove the cap (A) from the heating element service entrance enclosure.
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. 13.

**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. Disconnect the wires from the high-limit RTD (H). See Fig. 12.
7. Remove the conduit connector (C) and electrical wires from the heating element.
8. Loosen V-clamp screw to remove V-clamp (D) Detach the heating element from the tank as shown.
9. Replace the heating element (G) or perform the necessary cleaning procedure. Ensure the O-ring (E) is in place.

5.1.11 REASSEMBLY OF HEATING ELEMENT AND TANK

To reassemble the heating element and tank, follow the steps listed in SECTION 5.1.10 in reverse order. Make sure the ground and power electrical wires are properly reconnected using the provided washers, cup washers and nuts.
Figure 11. Removing and replacing the heating tank element. The heating system should be drained, cleaned and flushed annually.

See SECTION 5.2.

Figure 12. Detail of element assembly interior, showing element posts and high-limit RTD.

Figure 13. Heating tank element phase configurations. Replacement elements may be a different phase configuration.
5.2 RECOMMENDED MAINTENANCE

<table>
<thead>
<tr>
<th>INTERVAL</th>
<th>MAINTENANCE TASK</th>
</tr>
</thead>
<tbody>
<tr>
<td>At initial start-up</td>
<td>Tighten electrical connections. See SECTION 3.</td>
</tr>
<tr>
<td>One week after initial start-up</td>
<td>Check and tighten electrical connections. See SECTION 5.1.2.</td>
</tr>
<tr>
<td>Every three months</td>
<td>Tighten electrical connections.</td>
</tr>
<tr>
<td>Annually</td>
<td>Drain, clean and flush heating system.</td>
</tr>
<tr>
<td></td>
<td>Check for cracked or weakened hoses and replace if necessary.</td>
</tr>
<tr>
<td></td>
<td>Check electrical wiring and connections for wear and excessive heat.</td>
</tr>
<tr>
<td></td>
<td>Check mounting bolts and tighten if necessary.</td>
</tr>
<tr>
<td></td>
<td>Remove element and clean element and tank. See SECTION 5.1.10.</td>
</tr>
<tr>
<td>Every five years</td>
<td>Replace magnetic contactors. See SECTION 5.1.4.</td>
</tr>
</tbody>
</table>

5.3 STORAGE REQUIREMENTS

If long-term storage is necessary, precautions must be taken to ensure that the heating system is operational for start-up. If possible, store the system in its original packaging. If storing the heating system in the original packaging is not possible, 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.
<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>POSSIBLE CAUSES</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil temperature too high</td>
<td>Pump not primed properly</td>
<td>Bleed all trapped air from lines. Restart system.</td>
</tr>
<tr>
<td></td>
<td>Isolation valves may be closed</td>
<td>Open valves. Restart system.</td>
</tr>
<tr>
<td></td>
<td>Hose kinked or crushed</td>
<td>Remove obstruction. Restart system.</td>
</tr>
<tr>
<td></td>
<td>Leak in suction line</td>
<td>Repair leak. Restart system.</td>
</tr>
<tr>
<td></td>
<td>Pump motor turning backwards</td>
<td>Reverse any two leads on power (in three-phase system). Restart system.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>See SECTION 3.</td>
</tr>
<tr>
<td>Control TCR failure: closed</td>
<td></td>
<td>Check and replace if necessary. See SECTION 2.6.</td>
</tr>
<tr>
<td>Motor failure</td>
<td></td>
<td>Check and replace if necessary. Restart system.</td>
</tr>
<tr>
<td>Motor contactor failure</td>
<td></td>
<td>Check contacts and replace if needed. Restart system.</td>
</tr>
<tr>
<td>Motor protection switch tripped</td>
<td></td>
<td>Check and reset switch. If problem occurs again, check motor. Restart system.</td>
</tr>
<tr>
<td>Oil temperature too low</td>
<td>Motor failure</td>
<td>Check motor. Replace if necessary.</td>
</tr>
<tr>
<td></td>
<td>Heater has been turned off and fluid is cold</td>
<td>Allow time for the heating system to heat fluid.</td>
</tr>
<tr>
<td></td>
<td>Heating element failed</td>
<td>Check elements for continuity. Replace element if necessary.</td>
</tr>
<tr>
<td></td>
<td>Element fuses failed or element breaker tripped.</td>
<td>Check all element fuses for continuity and replace if necessary. Reset breaker.</td>
</tr>
<tr>
<td></td>
<td>Element contactor failed</td>
<td>Check contacts and coil. Replace if necessary.</td>
</tr>
<tr>
<td></td>
<td>Motor contactor failed</td>
<td>Check contacts and coil. Replace if necessary.</td>
</tr>
<tr>
<td>Control TCR failure: open</td>
<td></td>
<td>Check and replace if necessary. See SECTION 2.6.</td>
</tr>
</tbody>
</table>