216351-000 rev1

INSTALLATION & OPERATION MANUAL

OIL CIRCULATING HEATING SYSTEM
FOR HAZARDOUS LOCATIONS

MODEL

OSA

Hotstart®
THERMAL MANAGEMENT

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:

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

⚠ 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.

Electro-static discharge: Wipe all operators and hoses with damp cloth to reduce potential for electro-static discharge.

⚠ CAUTION

Read instructions carefully: The safety of any system incorporating this equipment is the responsibility of the assembler. The safe and proper use of this equipment 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 2014/34/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 heating system 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 heating system 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.
- **Flameproof joints:** Flameproof joints are not intended to be repaired in the field. Do not attempt to repair any flameproof joints that become damaged.
- **Bend radius:** Do not adjust cable bend radius in the field. Cables are pre-wired to meet the minimum requirements for bend radius. If a cable is moved from factory positioning, adjust cable to ensure minimum bend radius is 4 × (Ø) outer diameter of the cable.
- **Enclosure yield strength:** The enclosures utilize metric bolts that are Class 8.8 minimum and Class A4-70 with a minimum yield strength of 600 MPa.

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.)

The following additional previous editions of Standards noted under the "Standards" section of the Certificate were applied to integral Components as itemized below. There are no significant safety related changes between these previous editions and the editions noted under the "Standards" section.	
Weg Induction Motors of Frame Size 90 to 132	IEC 60079-1 Edition 2007
Siemens Motors	IEC 60079-0 Edition 2009
Siemens Motors	IEC 60079-1 Edition 2007
ABB M3JP Motors	IEC 60079-0 Edition 2009
ABB M3JP Motors	IEC 60079-1 Edition 2007
CMP Products Limited TMC2X Range of Cable Glands	IEC 60079-1 Edition 2007
CMP Products Limited Cable Gland Types PX**	IEC 60079-1 Edition 2007
Adalet/Scott Fetzer Co. XCEX Series Enclosures	IEC 60079-0 Edition 2009
Adalet/Scott Fetzer Co. XCEX Series Enclosures	IEC 60079-1 Edition 2007

CERTIFICATIONS

Certifications:
IECEx UL 18.0106X
Ex db IIA T3 Gb
DEMKO 18 ATEX 2107X
CE 0539 Ex II 2 G Ex db IIA T3 Gb

Standards used for certifications:

- IEC 60079-0:2011 and Corr. 1:2012 and Corr. 2:2013
- IEC 60079-1:2014
- EN 60079-0:2012 and A11:2013
- EN 60079-1:2014
- IEC TS 60079-46

Max/ Min. process fluid temp.	0 °C to 80 °C
Ambient temp.	-20 °C to 40 °C
Voltages	120 to 575 V AC, 50/60 Hz,1/3 phase

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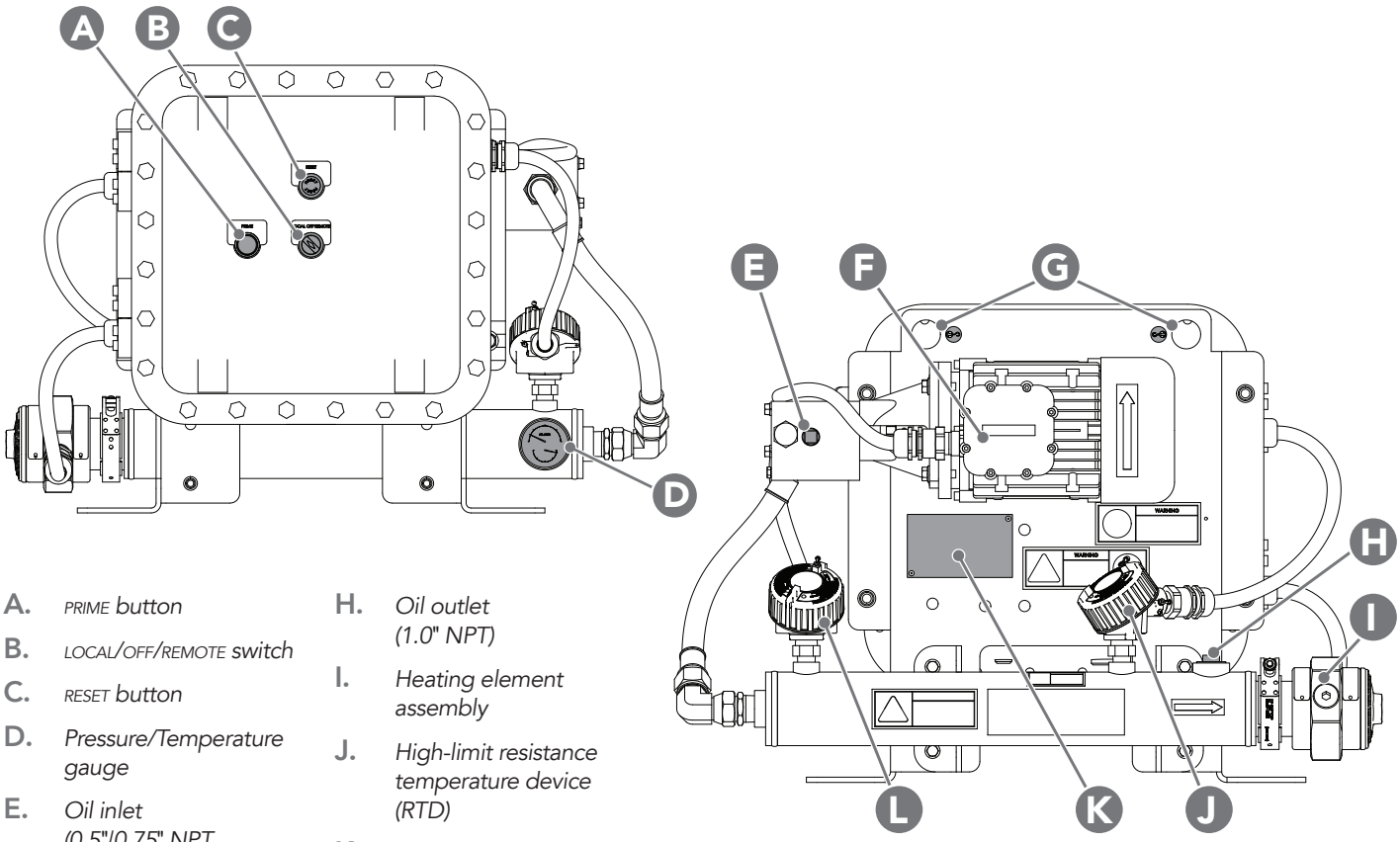
1 OVERVIEW

⚠ WARNING

System location classification: Before installing the OSA 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

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



- **A.** *PRIME button*
- **B.** *LOCAL/OFF/REMOTE switch*
- **C.** *RESET button*
- **D.** *Pressure/Temperature gauge*
- **E.** *Oil inlet (0.5"/0.75" NPT see part drawings)*
- **F.** *Oil pump motor*
- **G.** *Lift points*
- **H.** *Oil outlet (1.0" NPT)*
- **I.** *Heating element assembly*
- **J.** *High-limit resistance temperature device (RTD)*
- **K.** *Identification plate*
- **L.** *Control resistance temperature device (RTD)*

Figure 1. Typical OSA system components. Model style and configuration may vary. See part drawings for dimensions and specifications.

1.2 OPERATION OVERVIEW

The OSA heating system is intended to maintain optimal oil temperature while the engine or compressor is shut down. The heating system may be activated locally or by optional remote control (*see* **SECTION 2.5.2**). The OSA heating system must be deactivated upon engine or compressor 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 throughout the engine or compressor. To maintain consistent fluid temperature, the heating element will cycle on and off at the user-selected temperature control point.

An oil check valve (user-supplied and installed near the oil suction port) prevents backflow while the engine or compressor is operating. When the engine or compressor is shut down, the heating system should be activated locally or remotely to resume maintaining the optimal oil temperature.

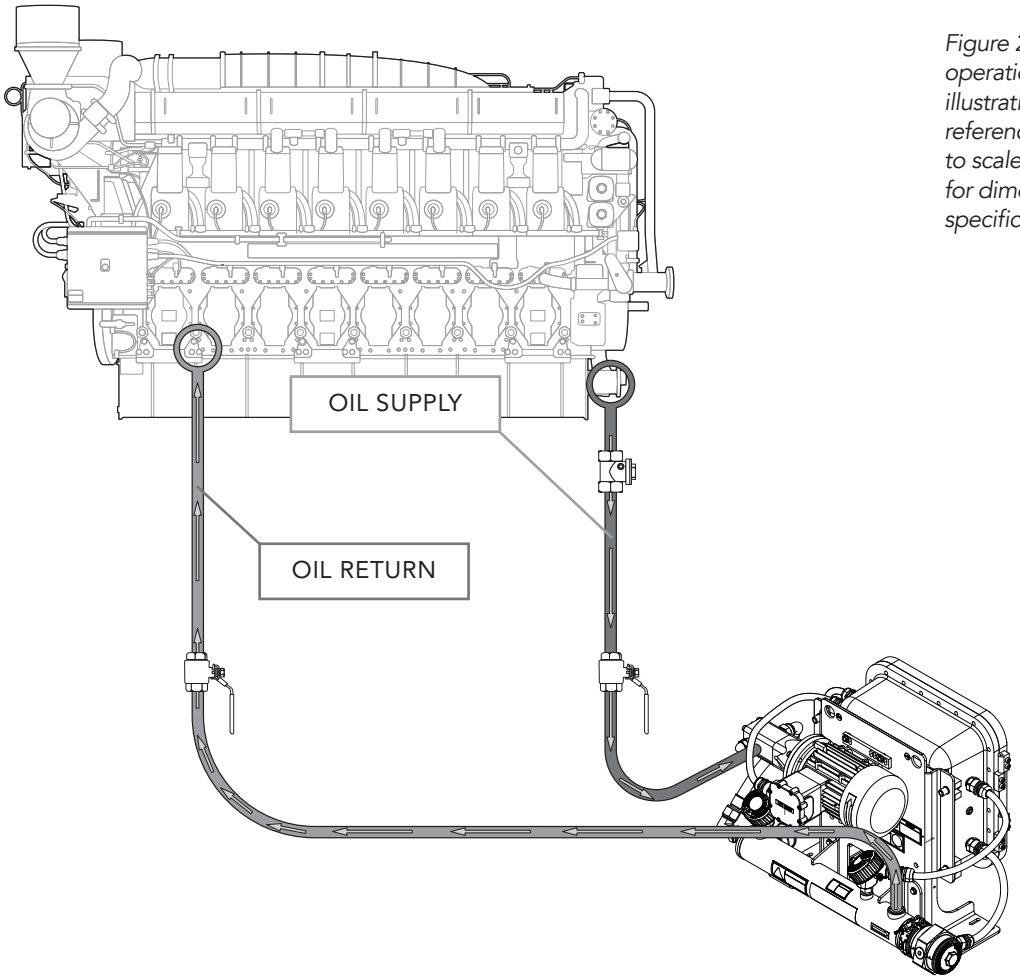


Figure 2. OSA system operation. Component illustrations are for reference only and are not to scale. See part drawings for dimensions and specifications.

2 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, leaks and unexpected release of heated oil.

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.

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.

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 OSA oil supply line, refer to the following Hotstart guidelines:

- 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 OSA oil supply recommendations:

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

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

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 customer-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.
- To ensure consistent oil heating, it is acceptable to select a suction port on the opposite side of the sump.

2.1.2 OIL RETURN

When installing the OSA oil return line, refer to the following Hotstart guidelines:

- At a minimum, size the oil return line per the pump outlet. **NOTICE!** Do not reduce the return line inner diameter.

Depending on your application, there may be additional requirements for locating the oil discharge port of the hotstart oil heating system:

- 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 2.3**.
- For large-sized (four- or six-throw reciprocating) compressor applications, the return line may be routed to the opposite end of the oil sump **or** the oil return line may be routed to a prelube location. *See* **SECTION 2.2**.
- 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 2.2**. 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.

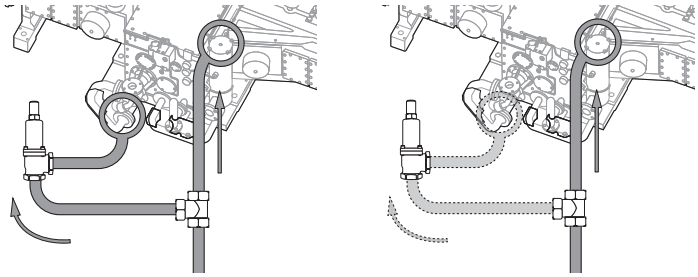
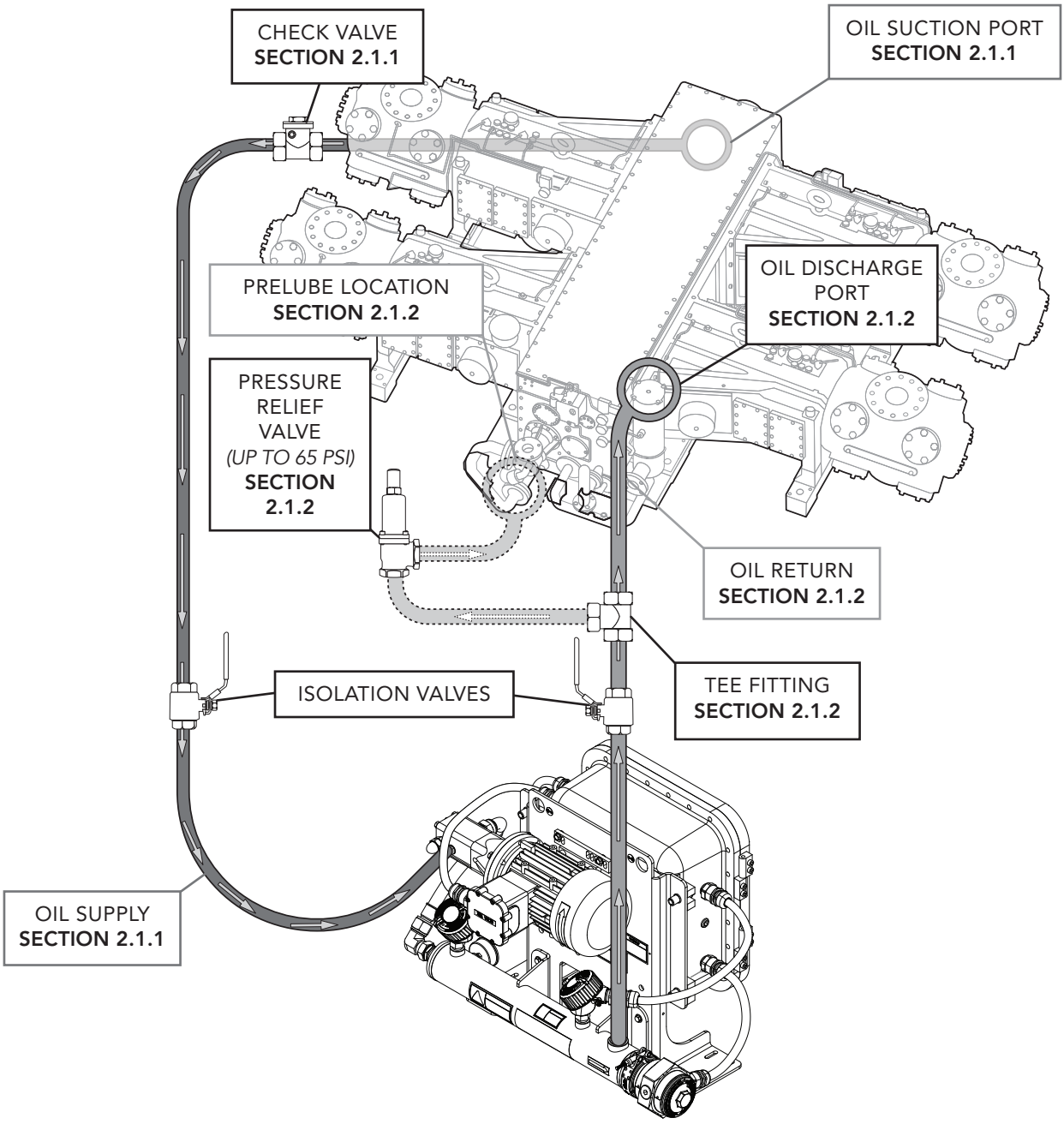


Figure 3. Small compressor oil heating in lower ambient temperatures (left). High oil viscosity restricts oil flow and increases oil pressure. The pressure relief valve opens and allows oil to flow directly to the sump in addition to the prelube location. In higher temperatures, the bypass pressure relief valve is closed and oil is routed directly to the prelube location (right).

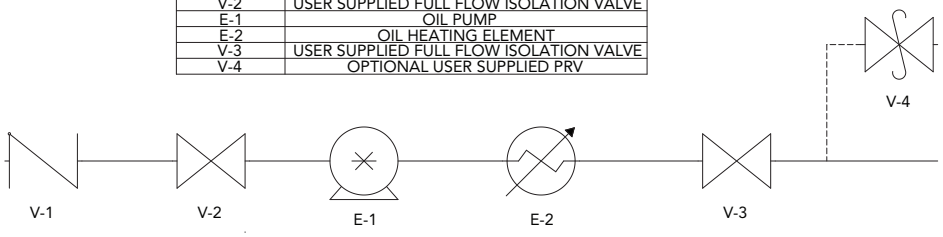
Should flow become restricted due to low ambient temperatures, the pressure relief valve along the bypass line will open and allow heated oil to route to the compressor's oil sump. This alternate routing will allow the heating system to maintain optimal oil temperature while still providing the necessary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

NOTE: The pressure relief valve must be designated as full-flow bypass and must be set for a maximum of 65 psi. Hotstart does not recommend non-code safety valves for this application.

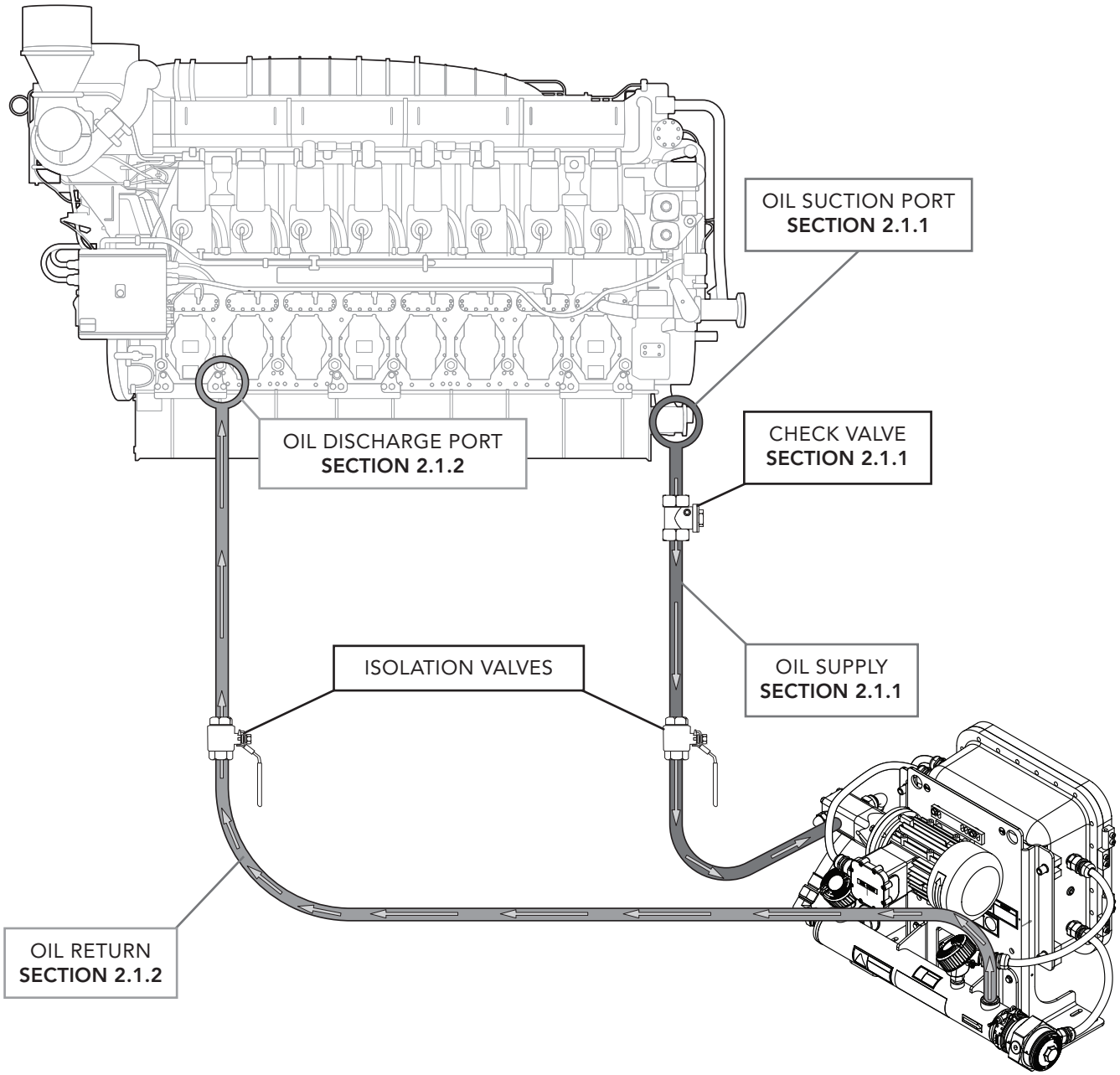
2.2 OIL PLUMBING ILLUSTRATION (COMPRESSOR)



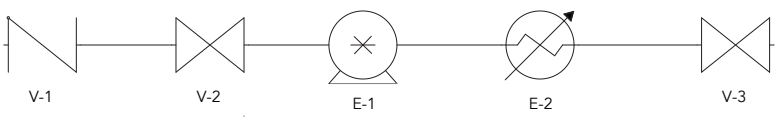
COMPONENT	DESCRIPTION
V-1	USER SUPPLIED CHECK VALVE
V-2	USER SUPPLIED FULL FLOW ISOLATION VALVE
E-1	OIL PUMP
E-2	OIL HEATING ELEMENT
V-3	USER SUPPLIED FULL FLOW ISOLATION VALVE
V-4	OPTIONAL USER SUPPLIED PRV



2.3 OIL PLUMBING ILLUSTRATION (ENGINE)



COMPONENT	DESCRIPTION
V-1	USER SUPPLIED CHECK VALVE
V-2	USER SUPPLIED FULL FLOW ISOLATION VALVE
E-1	OIL PUMP
E-2	OIL HEATING ELEMENT
V-3	USER SUPPLIED FULL FLOW ISOLATION VALVE



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 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.

2.4.1 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 system, note that the tank requires a minimum of 18 inches (46 cm) of clearance to remove element for maintenance.

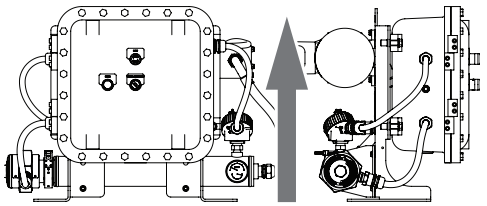


Figure 4. Mount OSA unit in orientation shown. Do not mount at an angle or in any other orientation.

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. Install in accordance with the National Electrical Code (NEC) or Canadian Electrical Code (CEC), and any applicable local codes (such as NFPA 496), based on the installation location.

Electrical hazard: The heating system must be connected to a suitable protective earthing conductor. The heating system's power supply must be connected to a suitable overcurrent limiting device. A means of disconnection from 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. Reference markings on heating system for specific ratings.

Grounding conductor: Equipment grounding conductors shall be sized per NEC 2017 Table 250.122 for US installations. For international installations, use IEC 60079-0, Clause 16. Ground terminal block will accept 16–4 AWG conductors. External grounding connection not provided. Metallic conduit or armored cable must be used. Wiring systems shall comply with 15.1.2 b) of IEC 60079-0.

2.5.1 MAIN POWER SUPPLY

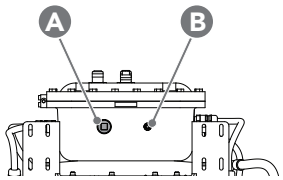


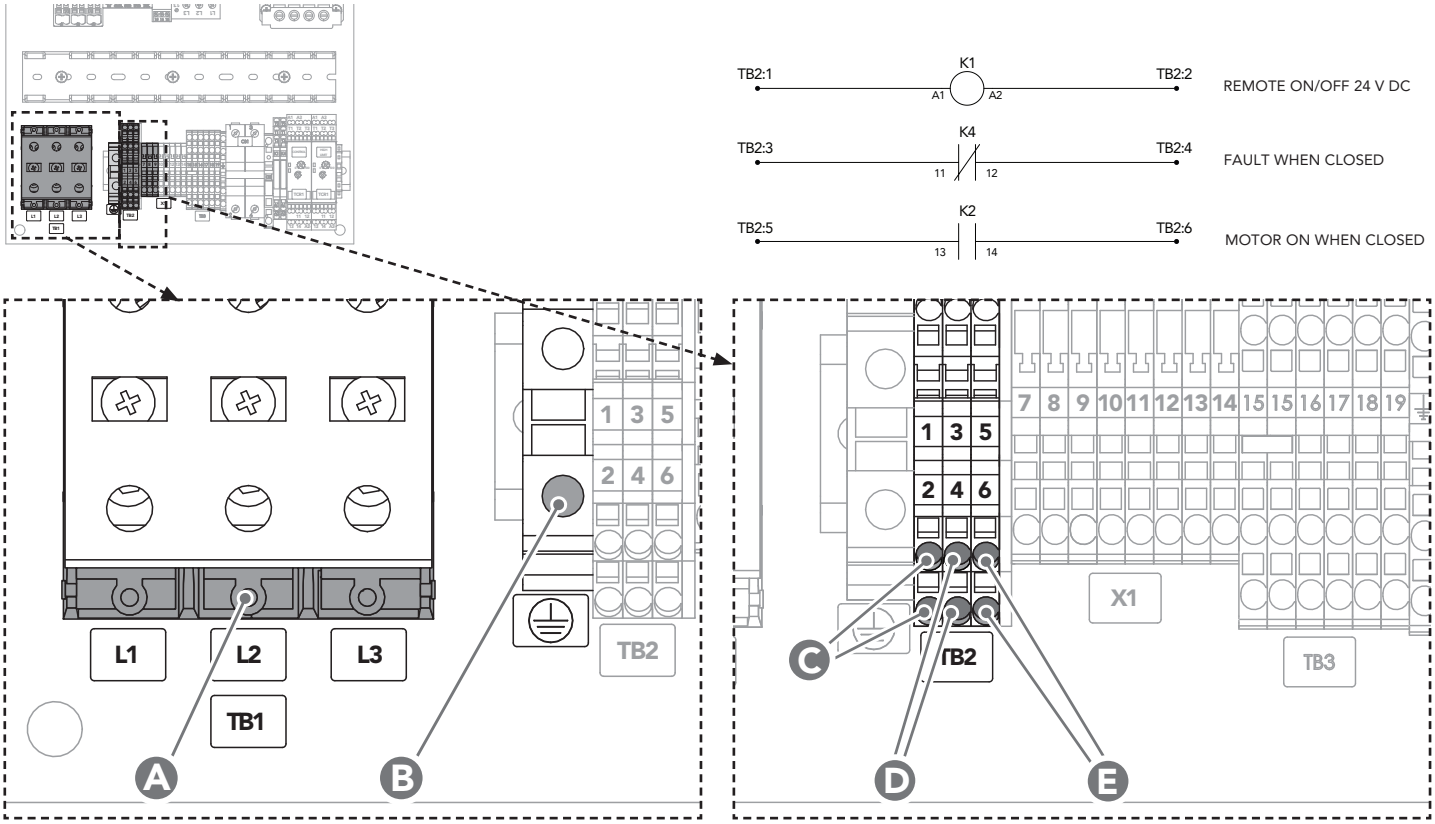
Figure 5. OSA control box underside, showing 1.25" NPT main power entrance **(A)** *and 0.5" NPT customer interface wiring entrance* **(B)**.

1. Connect the specified power from the customer-supplied circuit breaker to the terminal blocks located in the main control box. *See Table 2 and Fig. 6 on following page.*

   NOTE: The specified power source must be within plus or minus 10% of the rated voltage.

		Copper Wire Stranding Classes – Number of Strands						
Wire Size	Torque	Solid	Class B	Class C	Class G	Class H	Class I	Class K
2/0 AWG	120 in·lbs		19	37				
1/0	120 in·lbs		19	37				
1	120 in·lbs		19	37	~133	~259	~210	~836
2	120 in·lbs		7	19	~49	~133	~161	~665
4	120 in·lbs		7	19	~49	~133	~105	~420
6	120 in·lbs		7	19	~49	~133	~63	~266
8	40 in·lbs		7	19	~49	~133	~41	~168
10	35 in·lbs	1	7	19			~27	~104
12	35 in·lbs	1	7	19			~19	~65
14	35 in·lbs	1	7	19			~19	~41

Table 2. Line Side Wire Approvals. ~Qantity of strands for Classes G, H, I, K may vary by manufacturer. Aluminum stranded wire range: 2/0 – #6 AWG. Minimum 90 °C wire for all electrical connections.



A. *Main power terminal block*

B. *Main power ground terminal block*

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

D. *Fault signal*

E. *Motor run signal*

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

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 (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)**.

2.5.2 CUSTOMER INTERFACE CONNECTIONS

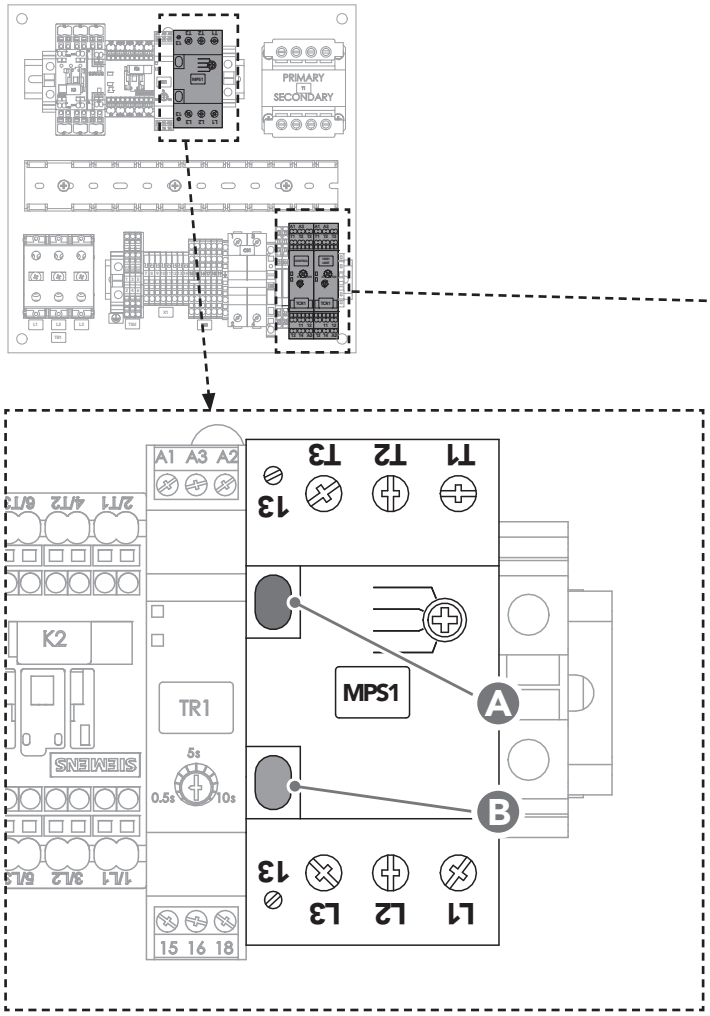
The following customer interface connections are available for remote control and monitoring:

- **TB2:1/TB2:2**
  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; see system wiring schematic for directions to switch to NO (normally open) operation.

- **TB2:3/TB2:4**
  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**).

- **TB2:5/TB2:6**
  Motor Run Signal (E)
  A motor run signal indicates the pump motor is running. If no signal is present, the pump motor is not running.



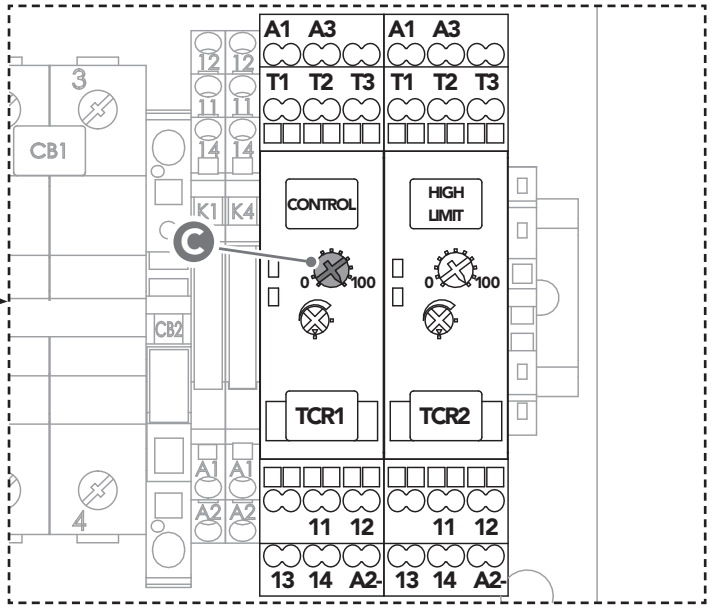


Figure 7. OSA motor protection switch (left), showing stop/off **(A)** *and reset/on* **(B)** *buttons. To reset the MPS, the heating system must be switched off and either the* **RESET** *button or the MPS reset/on button must be pressed.*

OSA control TCR and high-limit TCR (above). The standard setting for TCR1 control dial **(C)** *is 104 °F (40 °C).*

3 COMPONENTS AND OPERATION

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

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

3.1 SYSTEM COMPONENTS

3.1.1 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.

3.1.2 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. 7.*

3.1.3 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. 7.*

3.2 INTERFACE COMPONENTS

3.2.1 PRIME BUTTON

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

3.2.2 LOCAL/OFF/REMOTE SWITCH

- **LOCAL** – The system is **on**.
- **OFF** – The system is **off**.
- **REMOTE** – The system is turned **on** and **remotely controlled**.

3.2.3 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 4.1.1.**

3.2.4 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.

3.3 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.

3.3.1 FIRST RUN PROCEDURE

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 104 °F (40 °C). The high-limit temperature setting on TCR2 should be set at 194 °F (90 °C). *See* **SECTION 3.1.2** *and* **SECTION 3.1.3**.

7. To verify that the 24 V DC customer controls operate properly, turn the **LOCAL/OFF/REMOTE** switch to **REMOTE.**

4 MAINTENANCE AND TROUBLESHOOTING

4.1 SYSTEM FAULTS

4.1.1 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 4.5**.

4.2 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 heater.

NOTE: After maintenance is performed, *refer to* **SECTION 3.3** 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

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.

4.2.6 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.

4.2.7 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.

4.2.8 VOLATILE CORROSION INHIBITOR (VCI)

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

4.2.9 TEMPERATURE CONTROL RELAY

⚠ 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 OSA 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 (TCR1) is set correctly. Verify that high-limit TCR (TCR2) is set at least 18 °F (10 °C) higher than the control TCR set point. If the measured resistance is **between 80 and 120 ohms** continue troubleshooting. *Proceed to step 3.*

3. Using the ohmmeter, measure the resistance between TCR terminals **T1** and **T2** *(See Fig. 8)*:
   - ➤ 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 3.3***)*. 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.

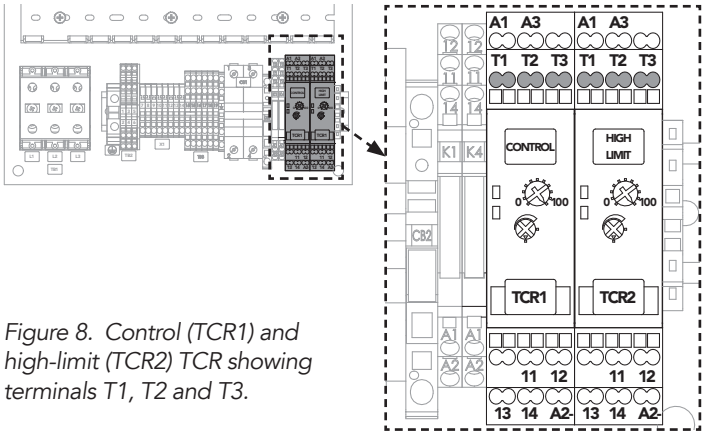


Figure 8. Control (TCR1) and high-limit (TCR2) TCR showing terminals T1, T2 and T3.

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

Table 3. 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. 8.* 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.

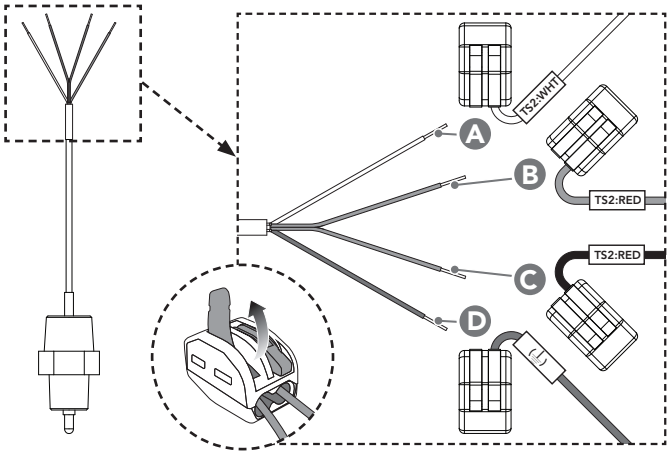


Figure 9. RTD leads and connectors shown on the RTD assembly, TSX:WHT **(A)**, *TSX:RED (red wire)* **(B)**, *TSX:RED (black wire)* **(C)**, *and Ground* **(D)**. *Disconnect wire from connector as shown.*

4.3 RECOMMENDED MAINTENANCE

INTERVAL	MAINTENANCE TASK
At initial start-up	Tighten electrical connections. *See* **SECTION 3.3.**
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 wear and excessive heat.
	Check mounting bolts and tighten if necessary.
	Remove element and clean element and tank.
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.

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.

4.5 TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSES	SOLUTION
Oil temperature too high	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 3.3.**
	Control TCR failure: closed	Check and replace if necessary. *See* **SECTION 4.2.9**.
	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.
Oil 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.
	Element fuses failed or element breaker tripped.	Check all element fuses for continuity and replace if necessary. 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 4.2.9**.