216306-000 rev0

INSTALLATION & OPERATION MANUAL

DUAL FLUID CIRCULATING HEATING SYSTEM

MODEL

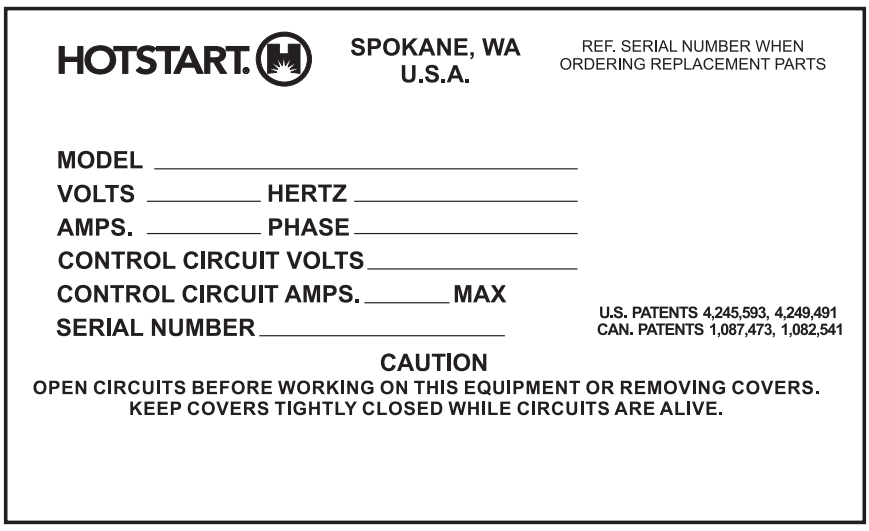
DLV

HOTSTART®
ENGINE HEATING

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 Seigburg, 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.

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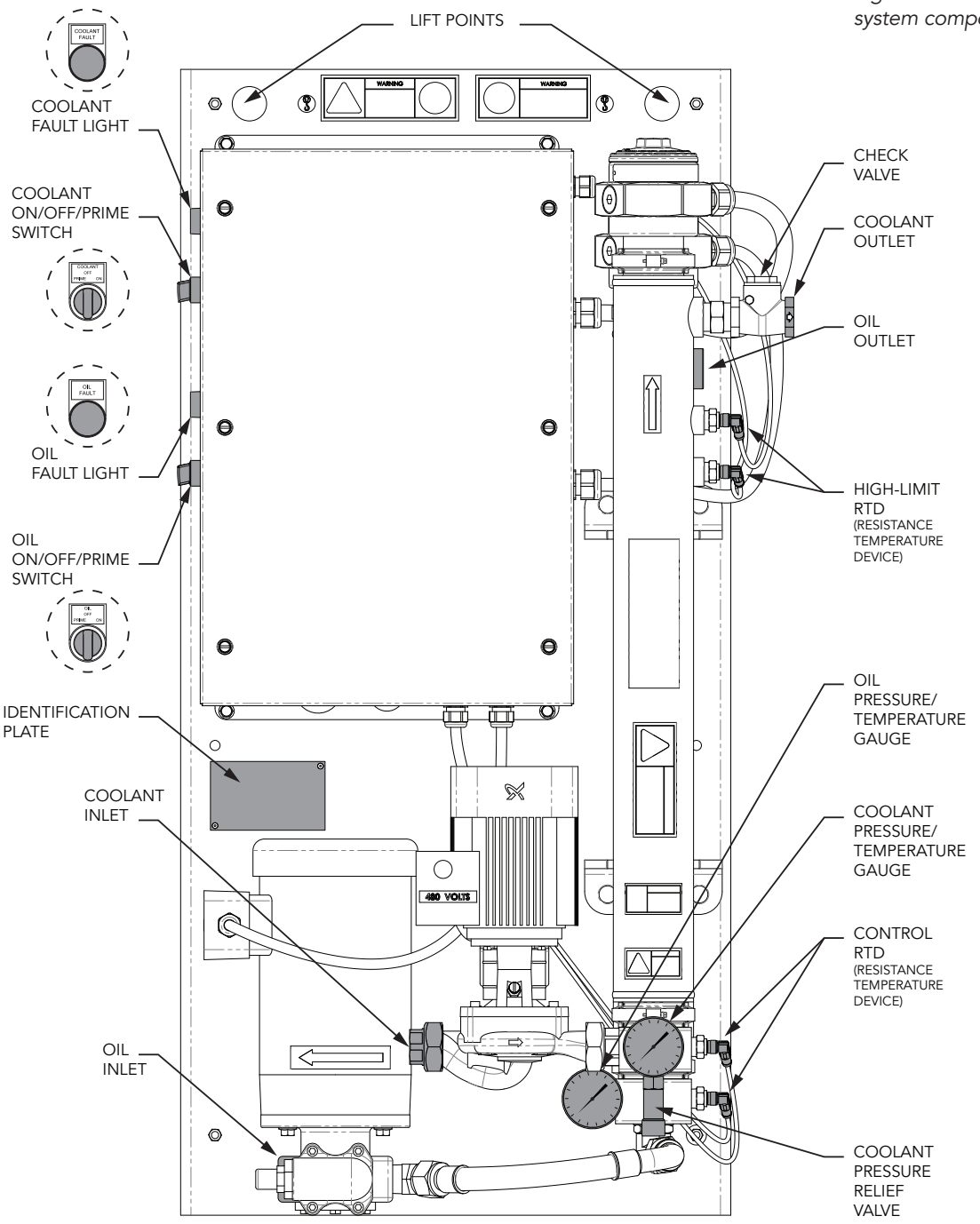
1 OVERVIEW

1.1 HEATING SYSTEM COMPONENTS

The DLV 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.

Figure 1. DLV heating system components.



1.2 OPERATION OVERVIEW

The DLV heating system is intended to maintain an engine's optimal starting temperature while the engine is shut down. The heating system may be activated locally or by optional remote control (*see* **SECTION 2.7**). The DLV heating system should be deactivated upon engine start-up.

During heating system operation, a centrifugal pump takes coolant from the drain area low on the engine water jacket and forces it through the heating tank and into the coolant return line. Simultaneously, a rotary gear pump takes oil from the sump and forces it through the heating tank to the oil return line. The coolant pump and oil pump will continuously circulate fluid throughout the engine. To maintain consistent fluid temperature, the heating elements will cycle on and off at the user-selected temperature control point.

A coolant check valve (included with the DLV unit and installed at the coolant outlet) and an oil check valve (user-supplied and 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 engine's optimal starting temperature.

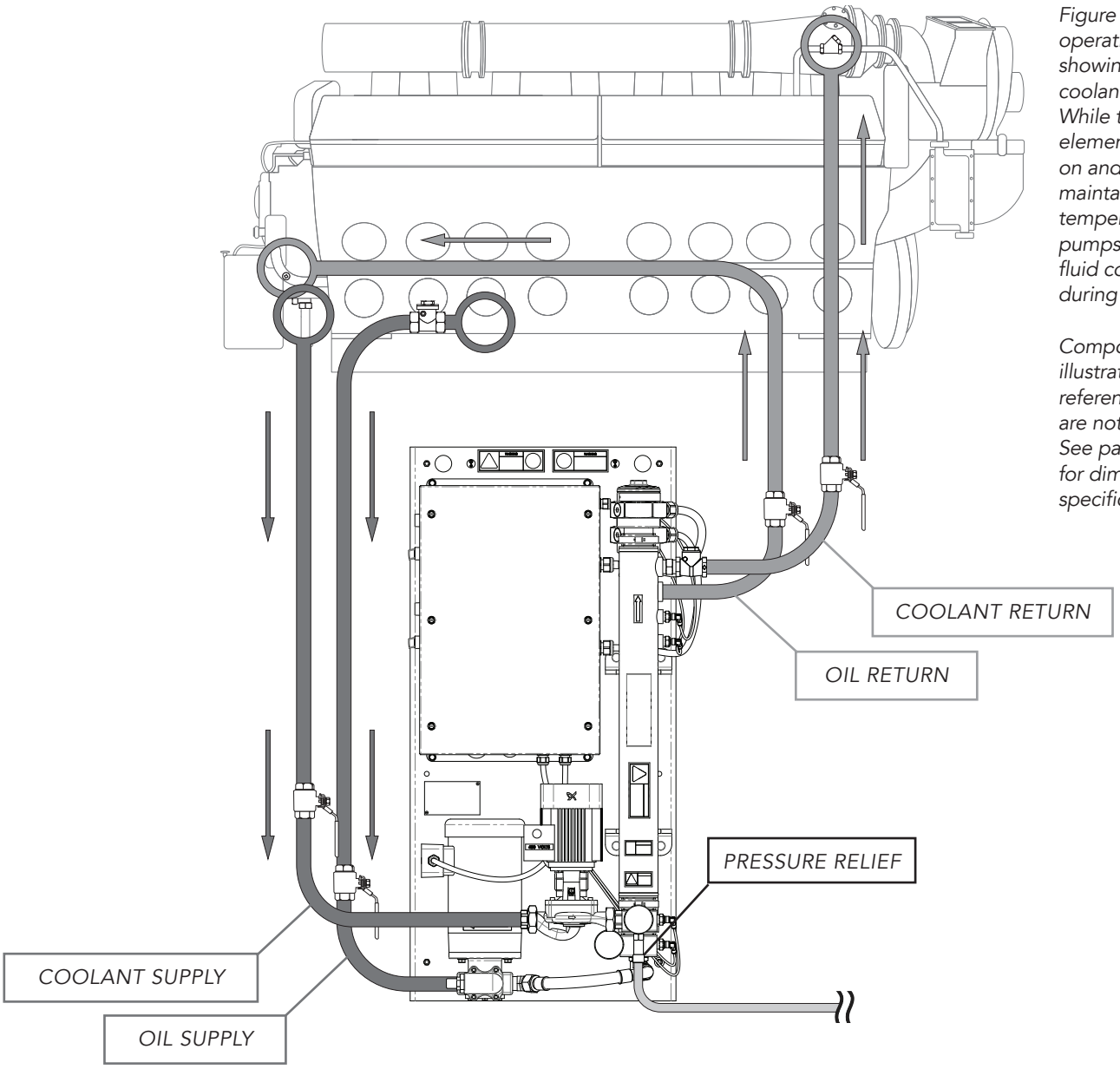


Figure 1. DLV operation overview, showing oil and coolant circulation. While the heating elements cycle on and off to maintain the preset temperature, the pumps circulate fluid continuously during operation.

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 coolant.

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 each 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 coolant supply line or oil supply line to an inner diameter smaller than the pump inlet; pump seal damage will occur.

Check valve: 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 oil or coolant.

Pressurized steam hazard: Coolant pressure relief valve outlet must be vented to the atmosphere in case an over-pressure release of heated coolant occurs. Do not connect pressure relief plumbing to coolant system.

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 DLV 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 DLV oil supply recommendations:

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

Table 1. HOTSTART recommended hose inner diameters, line lengths and elbow counts for DLV 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, typically near or on the third inspection cover. **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 valve to prevent oil flowing into the sump. Install the check valve as close to the oil supply port as possible.

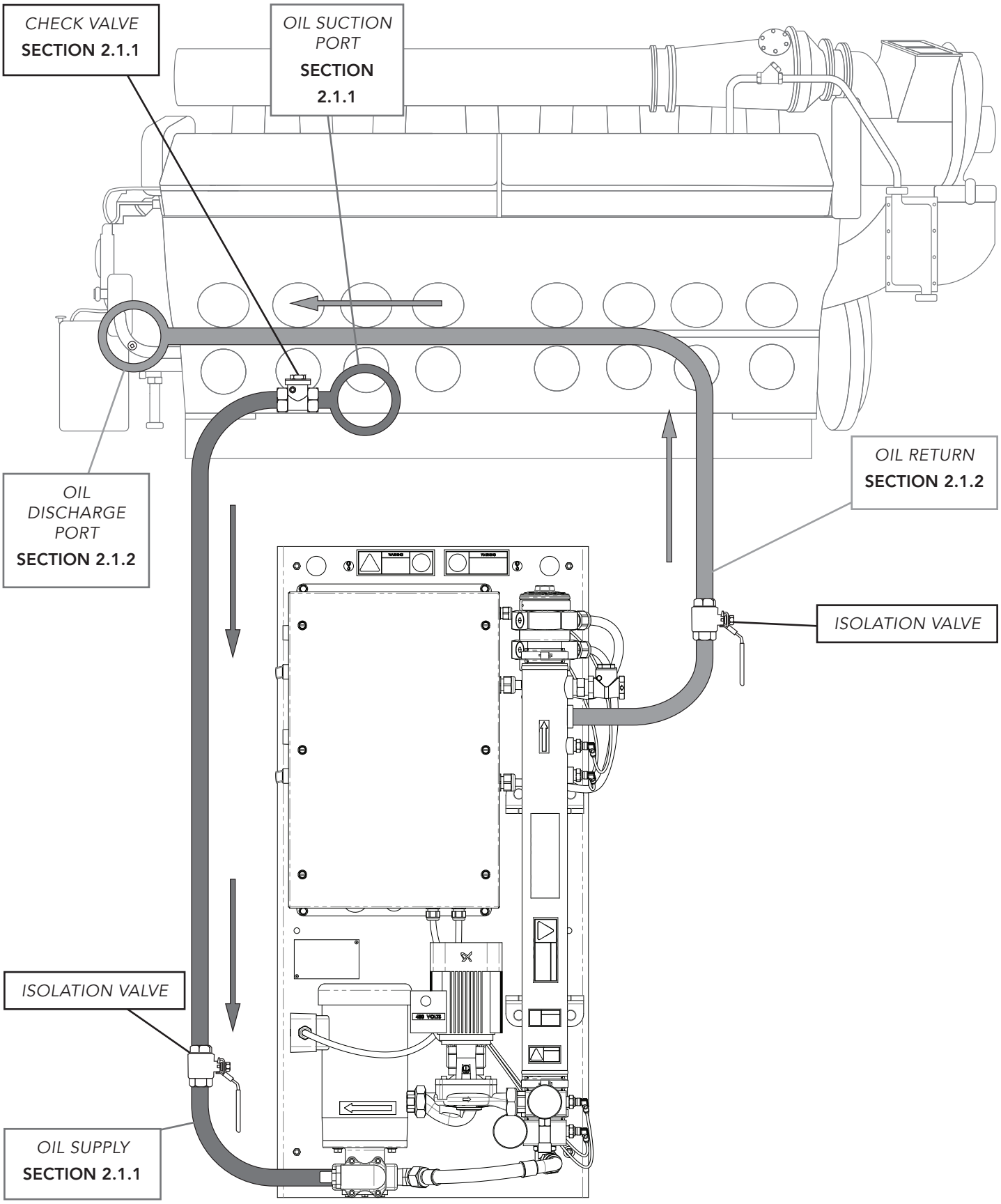
2.1.2 OIL RETURN

When installing the DLV 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.
- Install the oil discharge port near the engine oil pump (typically at the P-pipe before it enters the main engine block) or to the opposite end of the oil sump.

2.2 OIL PLUMBING ILLUSTRATION

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



2.3 COOLANT PLUMBING INSTALLATION

2.3.1 COOLANT SUPPLY

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

- At a minimum, size the coolant 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 coolant suction port as low as possible on the engine's water jacket, typically near the main water drain.
- To minimize flow restriction, the coolant supply line must be as short and as straight as possible. Use elbow fittings sparingly; HOTSTART recommends using sweeping bends or 45° fittings.

2.3.2 COOLANT RETURN

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

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

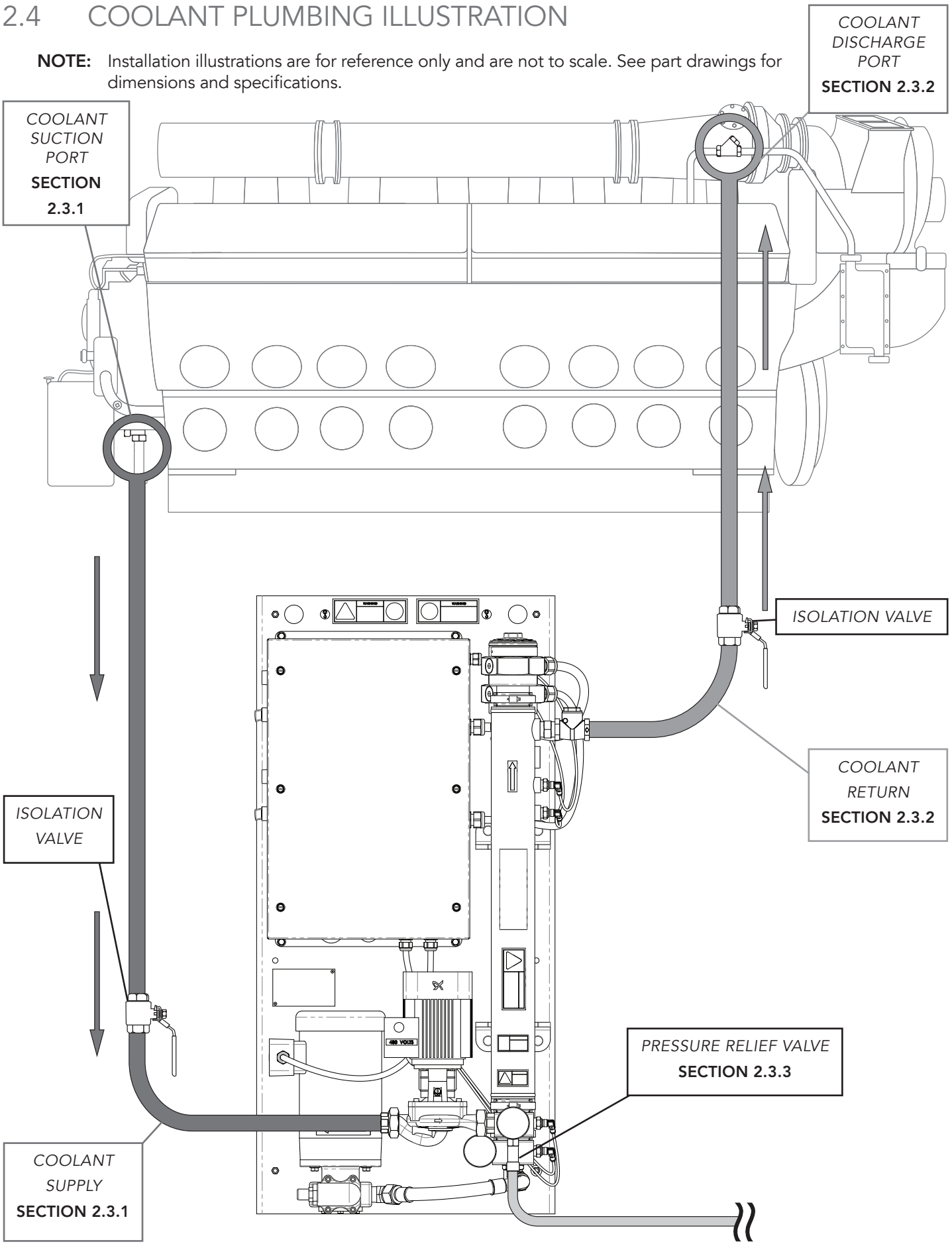
  NOTE: To ensure even heat distribution, the coolant return line may be split and routed to two return ports. Size both return lines per the outlet of the heating system. For engines without an aftercooler, typical installation points are along the water line from the radiator to the engine block.

2.3.3 COOLANT PRESSURE RELIEF

- To safeguard personnel and equipment, attach an appropriately sized pipe to the pressure relief valve and route to a safe area, bucket or catch-basin. **CAUTION!** Coolant pressure relief valve outlet must be plumbed to a safe area in case an over-pressure release of heated coolant occurs. Do not connect pressure relief plumbing to coolant system.

2.4 COOLANT PLUMBING ILLUSTRATION

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



2.5 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 tanks so that they are 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.

2.5.1 TANK AND PUMP

Mount the heater in a vertical orientation with pumps directly below the control box. Reference drawings for mounting position. When installing the heating system, note that the tanks requires a minimum of 30 inches (63.5 cm) of clearance to remove each element for maintenance. *See* **SECTION 5.1.13**.

2.6 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 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.

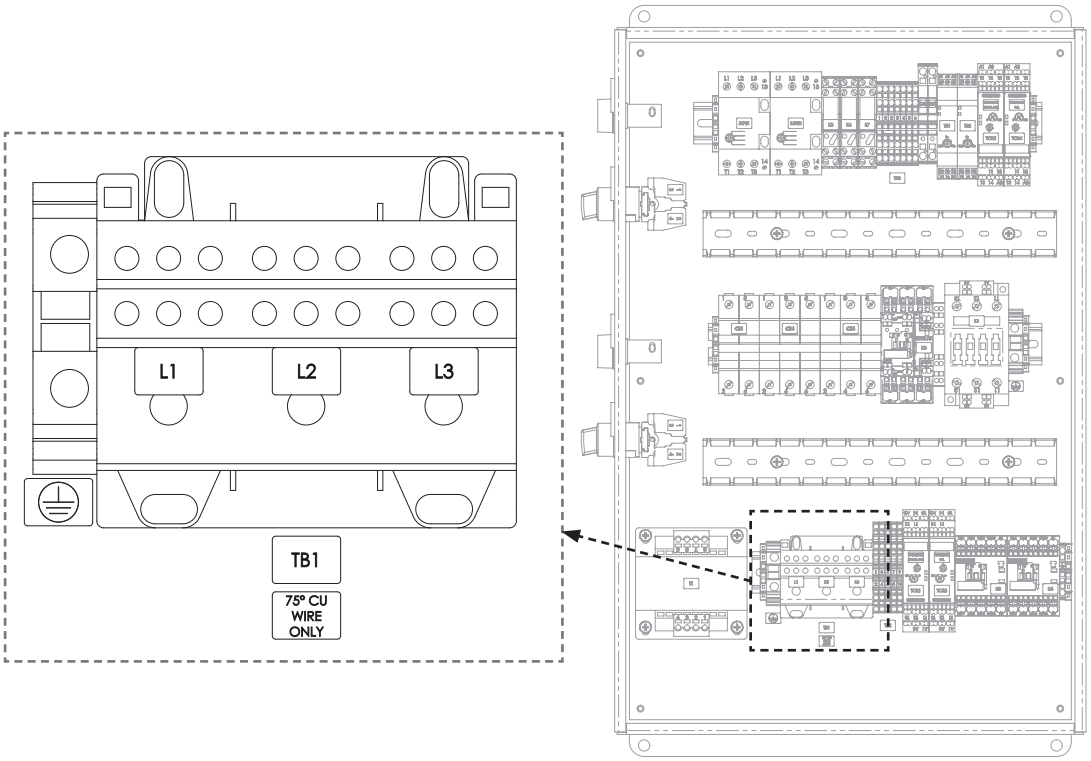
- For **three-phase applications**, the terminal blocks are labeled **L1**, **L2** and **L3**.
- For **single-phase applications**, use the terminal blocks labeled **L1** and **L2** or **L** and **N**. *See Fig. 2.*

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

Figure 2. The main power supply terminal blocks located in the DLV control box.

Example shown is a three-phase system. Single phase terminal blocks will be labeled L1 and L2 or L and N.

The main power ground wire must be connected to the ground lug or ground block.



2.7 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. 3 and Fig. 4.*

The **fault signal** (coolant or oil) will indicate a heating system shutdown, triggered by either the high-limit temperature control relay or the motor protection switch (*see* **SECTION 5.1**). The **coolant pump motor and oil pump motor** indicate the respective fluid system pump is running. When activated, the **24 V dc shutdown** connection shuts down the heating system. When deactivated, normal heating will resume. Use this connection for remote operation of the heater when the **ON/OFF/PRIME** switch is turned to **ON**.

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.

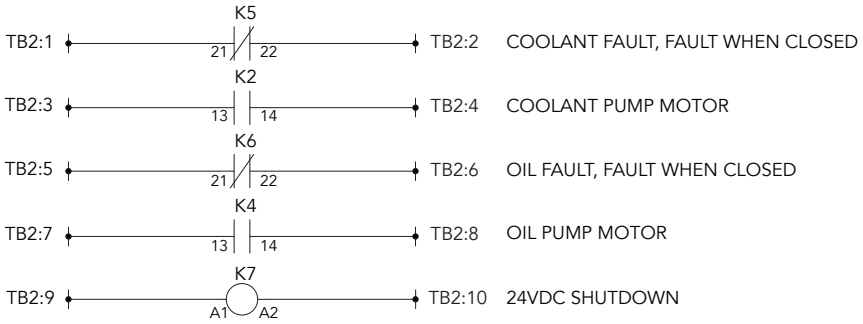


Figure 3. Customer interface connection wiring schematic for the DLV heating system.

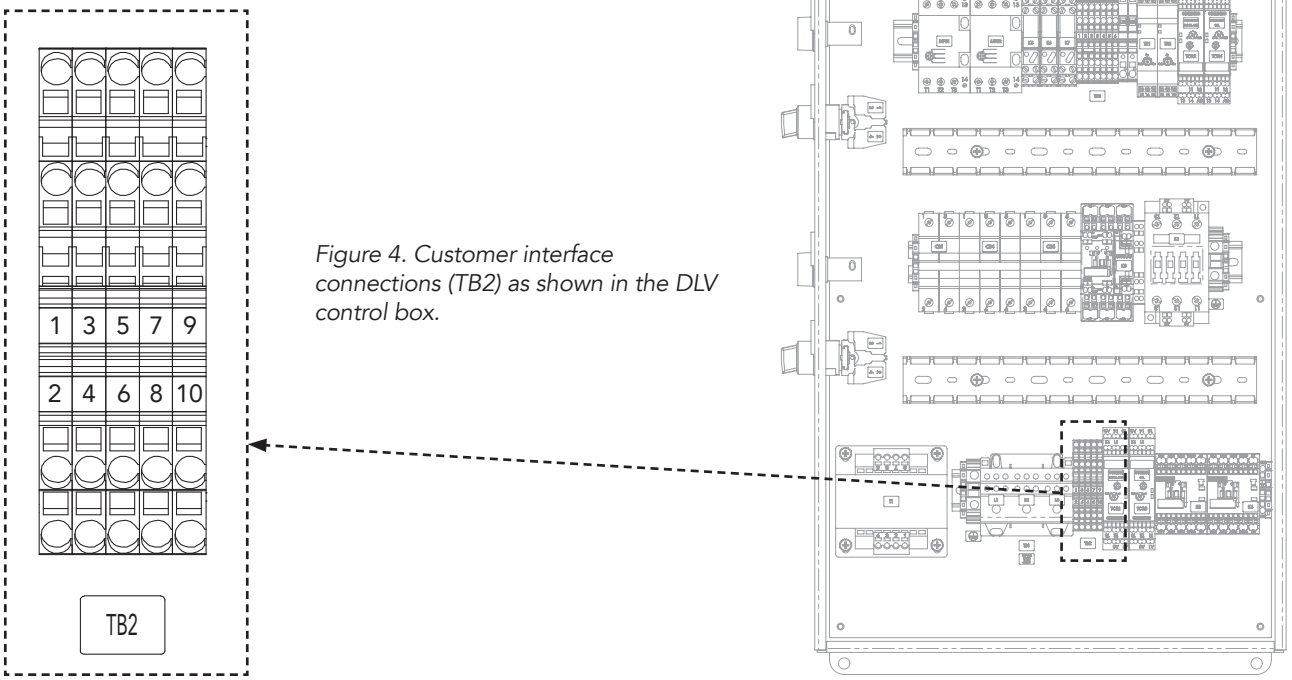


Figure 4. Customer interface connections (TB2) as shown in the DLV control box.

3 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:

- **ON/OFF/PRIME** switch
- Motor protection switch (MPS)
- 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.

3.1 ON/OFF/PRIME SWITCH

- **ON** – The system is **on**.
- **OFF** – The system is shut **off**.
- **PRIME** – Turn and hold the switch to **PRIME** to energize the pump motor in order to remove any air in the respective fluid system without energizing the elements.

3.2 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 **ON/OFF/PRIME** switch must be switched to **OFF** and the operator must press the MPS reset/on button. *See* **SECTION 5.1**.

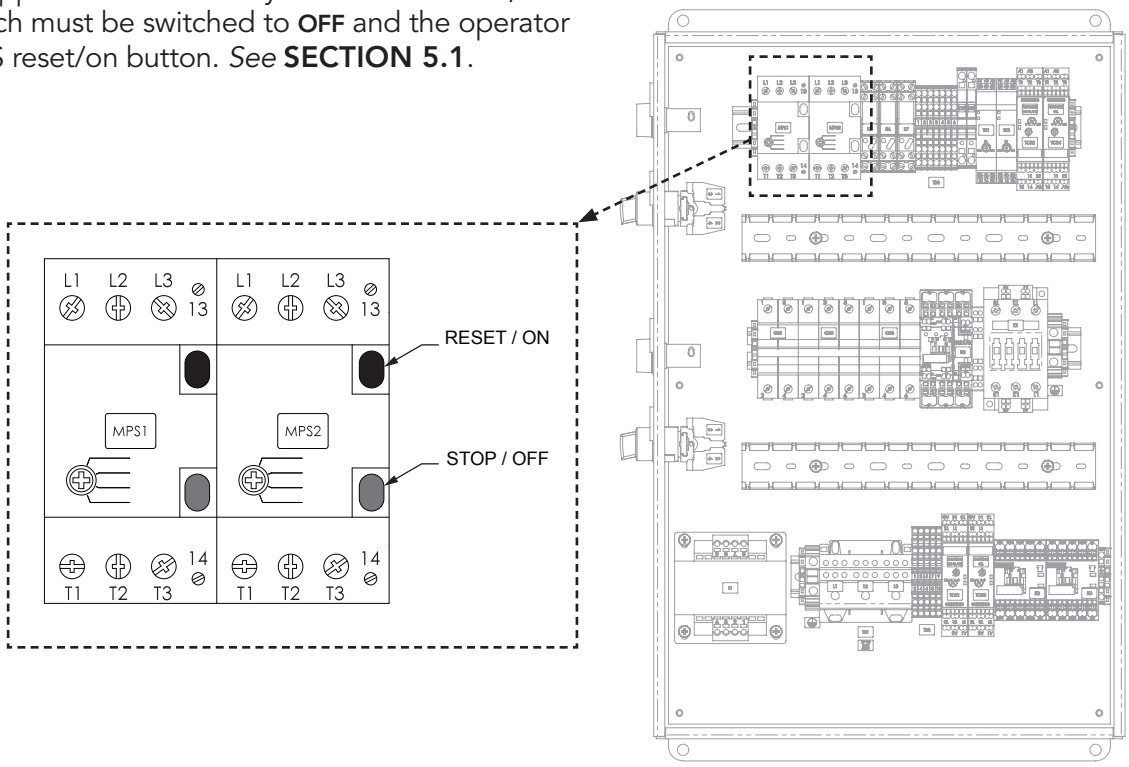


Figure 5. Motor protection switches MPS1 (coolant) and MPS2 (oil). To reset the MPS, the heating system must be switched off and the reset/on button must be pressed.

3.3 PRESSURE/TEMPERATURE GAUGES

The DLV model features a temperature/pressure gauge mounted at the inlet of each heating tank. The gauges will indicate a pressure increase when the pump motor is engaged by holding the **ON/OFF/PRIME** switch to **PRIME** or during normal operation. The gauges will also indicate the current temperature of the respective fluid.

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

3.4 PRESSURE RELIEF VALVE

⚠ CAUTION

Pressurized steam hazard: Coolant pressure relief valve outlet must be plumbed to a safe area in case an over-pressure release of heated coolant occurs.

The coolant pressure relief valve is mounted at the coolant heating tank outlet and is set to relieve at 100 psi (690 kPa). During normal operation, pressure release events are rare. To safeguard personnel and equipment, attach an appropriately sized pipe to the pressure relief valve outlet and direct flow to a safe area, bucket or other catch-basin.

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.

3.5 HIGH-LIMIT TCR (TEMPERATURE CONTROL RELAY)

The high-limit TCR for each fluid system (TCR2 and TCR4) is a protection device to prevent fluid overheating. The high-limit TCR uses a resistance temperature device (RTD) located near the tank outlet. The default setting for both high-limit TCRs 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. 6.*

3.6 CONTROL TCR (TEMPERATURE CONTROL RELAY)

The control TCRs are used to control the temperature of the fluid in each system. The control TCR uses a resistance temperature device (RTD) to sense the temperature of the fluid as it enters the heater. The standard setting for the coolant control temperature relay (TCR1) is 122 °F (50 °C). The standard setting for the oil control temperature relay (TCR3) is 104 °F (40 °C). *See Fig. 6.*

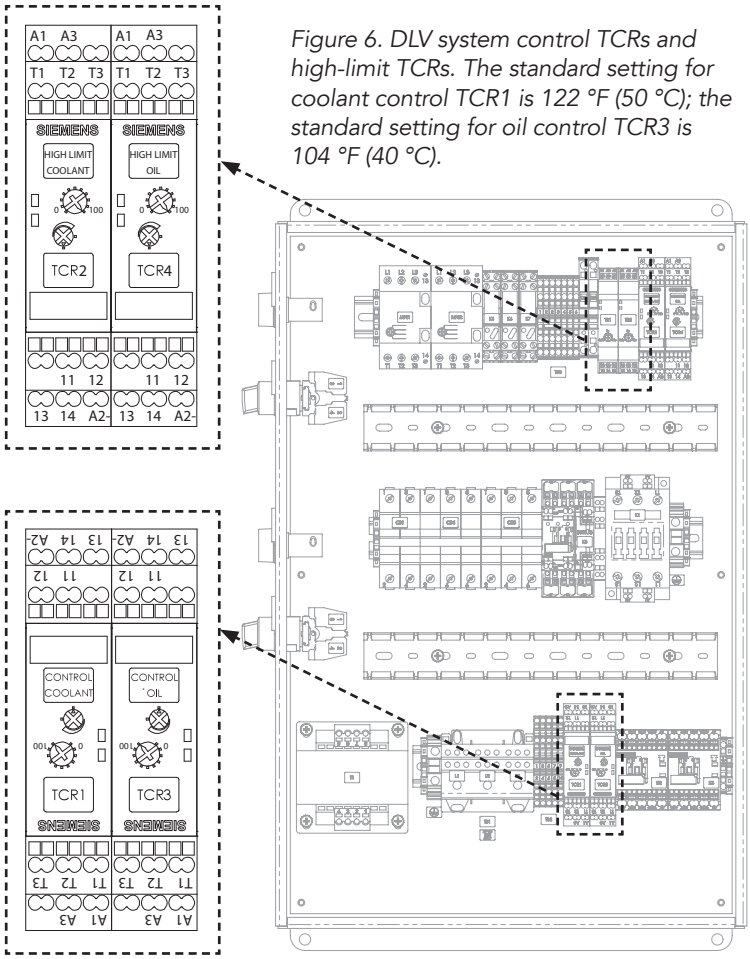


Figure 6. DLV system control TCRs and high-limit TCRs. The standard setting for coolant control TCR1 is 122 °F (50 °C); the standard setting for oil control TCR3 is 104 °F (40 °C).

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 and TCR4) must be set at least 18 °F (10 °C) higher than the corresponding control temperature control relay (TCR1 and TCR3) 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. If you are operating a three-phase heating system, **check for proper rotation of the pump motor**. Turn and hold the **ON/OFF/PRIME** switch to **PRIME** to check the pump for proper rotation. **NOTICE!** Do not run the motor/pump assembly dry for more than a few seconds. 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. Turn and hold the **ON/OFF/PRIME** switch to **PRIME** 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 **ON/OFF/PRIME** switch to **ON** 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 for engine coolant. 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 3.5** *and* **SECTION 3.6**.

7. Turn the control dials on the temperature control relay TCR3 to the desired temperature setting for engine oil. HOTSTART recommends a control temperature on TCR3 of 104 °F (40 °C). The high-limit temperature setting on TCR4 should be set at 194 °F (90 °C). *See* **SECTION 3.5** *and* **SECTION 3.6**.

5 MAINTENANCE, REPAIR AND TROUBLESHOOTING

5.1 COOLANT/OIL FAULTS

The coolant fault light will display if:

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

The oil fault light will display if:

- The oil pump motor protection switch is tripped (MPS2).
- The oil high-limit temperature is exceeded (TCR4).

A failure in the pump motor that causes the motor protection switch (MPS1 or MPS2) to trip will shut down the respective heating system. A fault signal will be transmitted and the coolant or oil fault light will illuminate. If this failure occurs, the **ON/OFF/PRIME** switch must be switched to **OFF** and the operator must press the MPS reset/on button to reset the fault. (*See* **SECTION 3.2.**)

If there is a failure that causes a high temperature to occur, the high-limit temperature controller (TCR2 or TCR4) will shut down the coolant or oil heating system, including the pump motor. A fault signal will be transmitted and the coolant or oil fault light will illuminate. To restart the system, the **ON/OFF/PRIME** switch must be switched to **OFF** and then back to **ON** to resume operation once the fluid temperature drops below the high-limit preset (*See* **SECTION 3.5**.)

NOTE: A high-limit fault can only occur when the respective heating element is energized. A fault in one fluid system will not cause the other fluid system to shut down.

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 both oil and coolant pumps. To ensure pump seal longevity, ensure the supply lines do not restrict flow excessively (*see* **SECTION 2.1.1** *and* **SECTION 2.3.1**) 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 pump relubrication. *See* **SECTION 5.4**.

5.2.7 COOLANT PRESSURE RELIEF VALVE

The pressure relief valve on coolant systems must be periodically checked and replaced when appropriate. At a minimum, the valve should be removed from the system, checked for deposits and corrosion, and tested to ensure that it relieves the proper pressure.

5.2.8 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.

5.2.9 COOLANT & OIL PRESSURE/TEMPERATURE GAUGES

The coolant and oil pressure/temperature gauges will indicate a pressure increase when the pump motor is engaged by toggling the **PRIME** switch or during normal heater operation. The gauges will also indicate the current temperature of the respective fluid. No maintenance for this part is required.

5.2.10 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**.

5.2.11 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 DLV heating system does not maintain the desired preset control temperature or consistently signals a high-limit temperature fault, 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. Check the temperature gauge to ensure the liquid in the tank is below 122 °F (50 °C).

2. Using the ohmmeter, measure the resistance between TCR terminals **T1** and **T2**. *See Fig. 7*.

➤ If the measured resistance is **between 80 and 120 ohms** continue troubleshooting. *Proceed to step 3*.

➤ If the resistance is **lower than 80 ohms** or **higher than 120 ohms**, contact HOTSTART for further assistance.

3. Use the ohmmeter to test for continuity between TCR terminals **T2** and **T3**.

➤ If there **is continuity** between TCR terminals **T2** and **T3** and the DLV does not maintain temperature or consistently signals a high limit fault, the TCR requires replacement. Contact HOTSTART for further assistance.

➤ If there **is no continuity** between TCR terminals **T2** and **T3**, locate the connected RTD on the heating tank. Unscrew the RTD plug from the RTD. *See Fig. 9 and Fig. 10 on following page*.

4. 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. *See* **SECTION 5.2.12**.

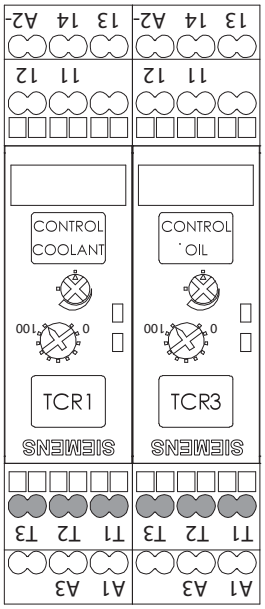


Figure 7. Coolant (TCR1) and oil (TCR3) control TCR showing terminals T1 (blue wire), T2 (brown wire) and T3 (black wire).

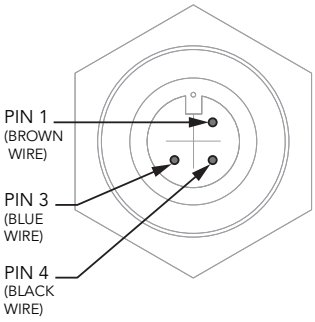


Figure 8. RTD pins 1, 3 and 4. The resistance between pin 1 and pin 3 should measure between 80 and 120 ohms. There should be continuity between pin 1 and pin 4.

5.2.12 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 5.2.11**.

1. De-energize the heating system. Allow fluid to cool.
2. Close isolation valves. Drain the fluid from the oil or coolant heating tank. Locate the RTD that requires replacement. *See Fig. 9.*
3. Unscrew RTD plug. Remove plug. *See Fig. 10.*
4. Unscrew RTD from tank. *See Fig. 11.*
5. Screw replacement RTD to tank. When tightening, ensure plug is aligned with notch toward top of tank. *See Fig. 12.*
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.*

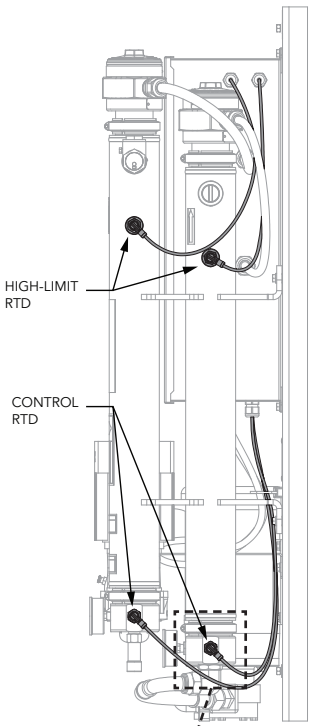


Figure 9. High-limit and control RTDs for coolant and oil heating systems. High-limit RTDs are located near the tank outlets; control RTDs are located near the tank inlets.

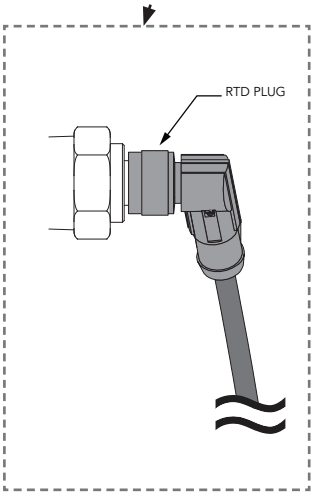


Figure 10. RTD plug. Unscrew plug and remove to disconnect RTD prior to removal.

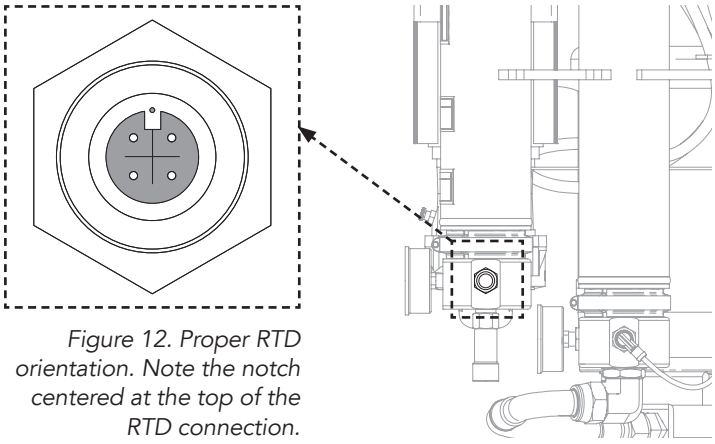


Figure 12. Proper RTD orientation. Note the notch centered at the top of the RTD connection.

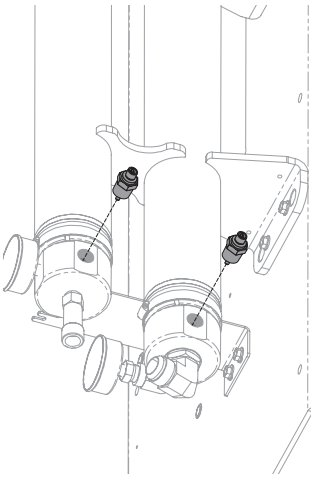


Figure 11. RTDs shown removed from tank assemblies.

5.2.13 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. 12*. 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. Allow fluid to cool.
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. 14*.

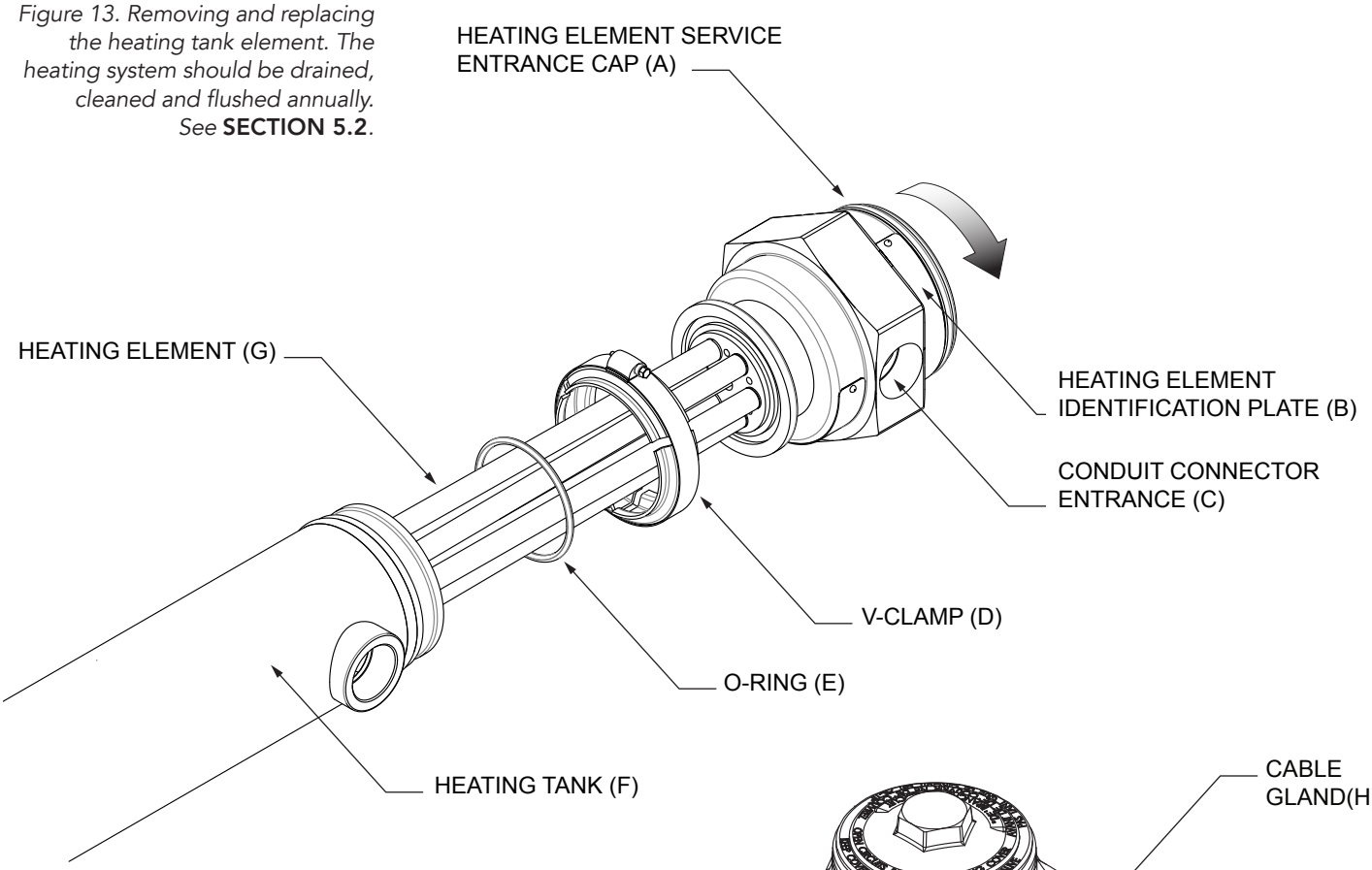
   NOTE: Replacement elements may be a different phase configuration.

6. Disconnect the ground (green/yellow) and power electrical wires from the posts inside the cap.
7. Unscrew cable gland **(H)** from conduit connector entrance **(C)**. Remove electrical cable and wires from the heating element. *See Fig. 13*.
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.

5.2.14 REASSEMBLY OF HEATING ELEMENT AND TANK

To reassemble the heating element and tank, follow the steps listed in **SECTION 5.2.13** in **reverse order**. Make sure the ground and power electrical wires are properly reconnected using the provided washers, cup washers and nuts.

Figure 13. Removing and replacing the heating tank element. The heating system should be drained, cleaned and flushed annually. See **SECTION 5.2**.



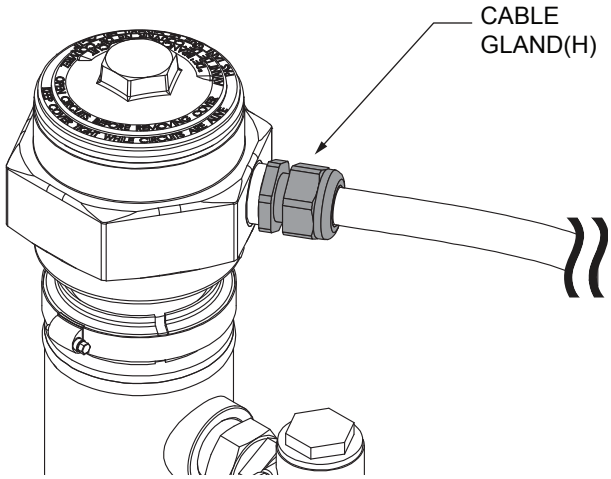


Figure 14. The cable gland as shown connected to the element assembly. Unscrew to remove element wiring.

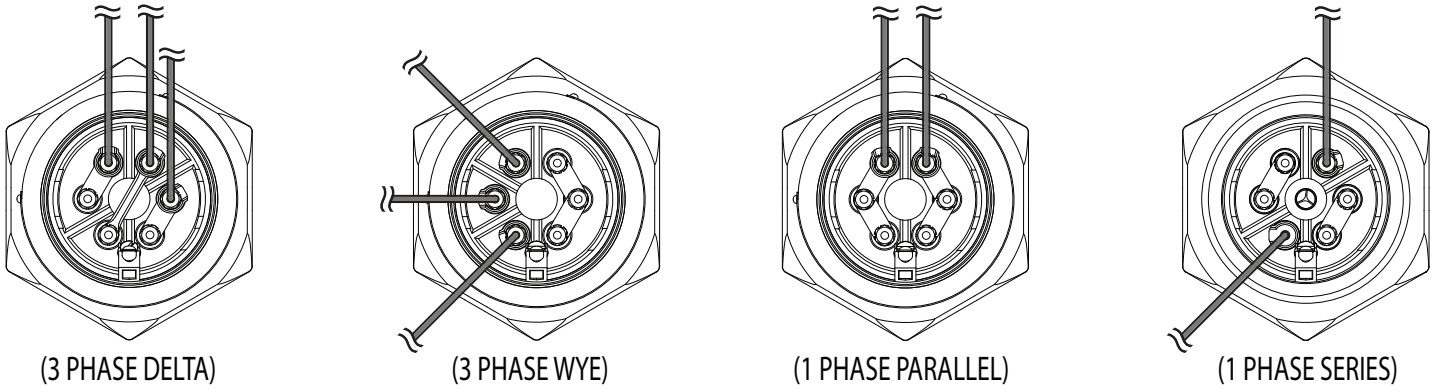


Figure 15. Heating tank element phase configurations. Replacement elements may be a different phase configuration.

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. 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.

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
Coolant/oil 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 5.2.11**.
	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 5.2.11**.
	RTD cable failure	Check TCR and RTD. See **SECTION 5.2.11**.
Coolant/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 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 5.2.11**.
	Control TCR set point too low	Adjust set point for control TCR. *See* **SECTION 3.6.**
	RTD failure	Check TCR and RTD. See **SECTION 5.2.11**
	RTD cable failure	Check TCR and RTD. See **SECTION 5.2.11**.