216383-000 rev0

INSTALLATION & OPERATION MANUAL

COOLANT CIRCULATING HEATING SYSTEM

MODEL

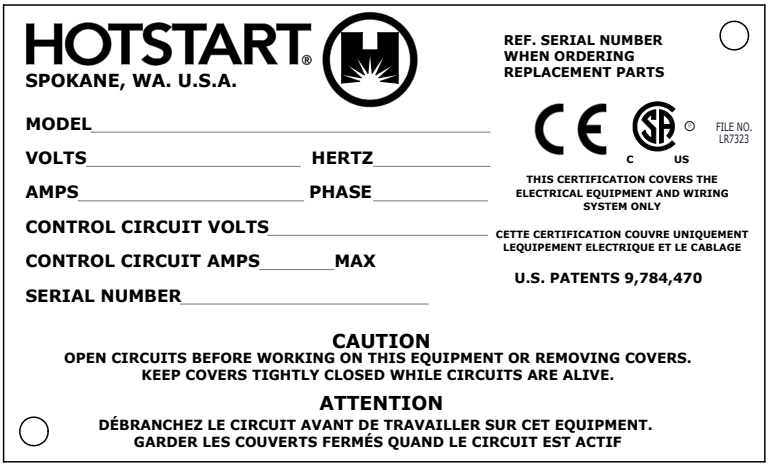
CMM
CLM

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, heavy equipment or other large-engine applications. 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.

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IMPORTANT SAFETY INFORMATION

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

Read instructions carefully: The safety of any system incorporating this 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. Heating systems with flanges have marked lift points. When lifting, use soft straps and avoid placing side-loads on heating system plumbing components, including fluid pumps.
- **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.

NOTICE

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

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1 OVERVIEW

1.1 HEATING SYSTEM COMPONENTS

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

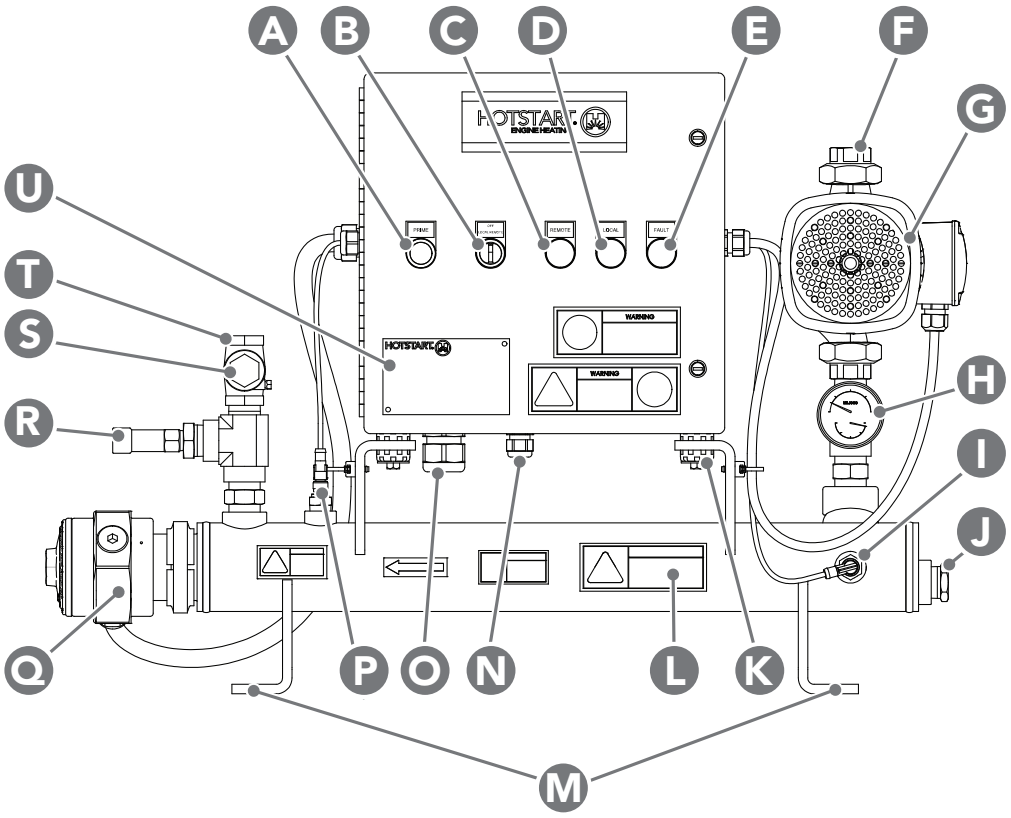


Figure 1. Typical CMM/CLM system components. Model style and configuration may vary. See part drawings for dimensions and specifications.

- **A.** *PRIME button*
- **B.** *LOCAL/OFF/REMOTE switch*
- **C.** *REMOTE light*
- **D.** *LOCAL light*
- **E.** *FAULT light*
- **F.** *Coolant inlet (1.0" NPT standard)*
- **G.** *Coolant pump/motor*
- **H.** *Coolant pressure/ temperature gauge*
- **I.** *Coolant control resistance temperature device (RTD)*
- **J.** *Tank drain plug*
- **K.** *Vibration isolators × 4*
- **L.** *Heating tank*
- **M.** *Mounting feet*
- **N.** *User interface wiring entrance*
- **O.** *Power in wiring entrance*
- **P.** *Coolant high-limit resistance temperature device (RTD)*
- **Q.** *Element assembly*
- **R.** *Coolant pressure relief valve (0.5" NPT)*
- **S.** *Coolant check (non-return) valve*
- **T.** *Coolant outlet (1.0" NPT standard)*
- **U.** *Identification plate*

1.2 OPERATION OVERVIEW

The CMM/CLM 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 2.4.2**). The CMM/CLM 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. The coolant 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 CMM/CLM unit and installed at the coolant outlet) prevents 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.

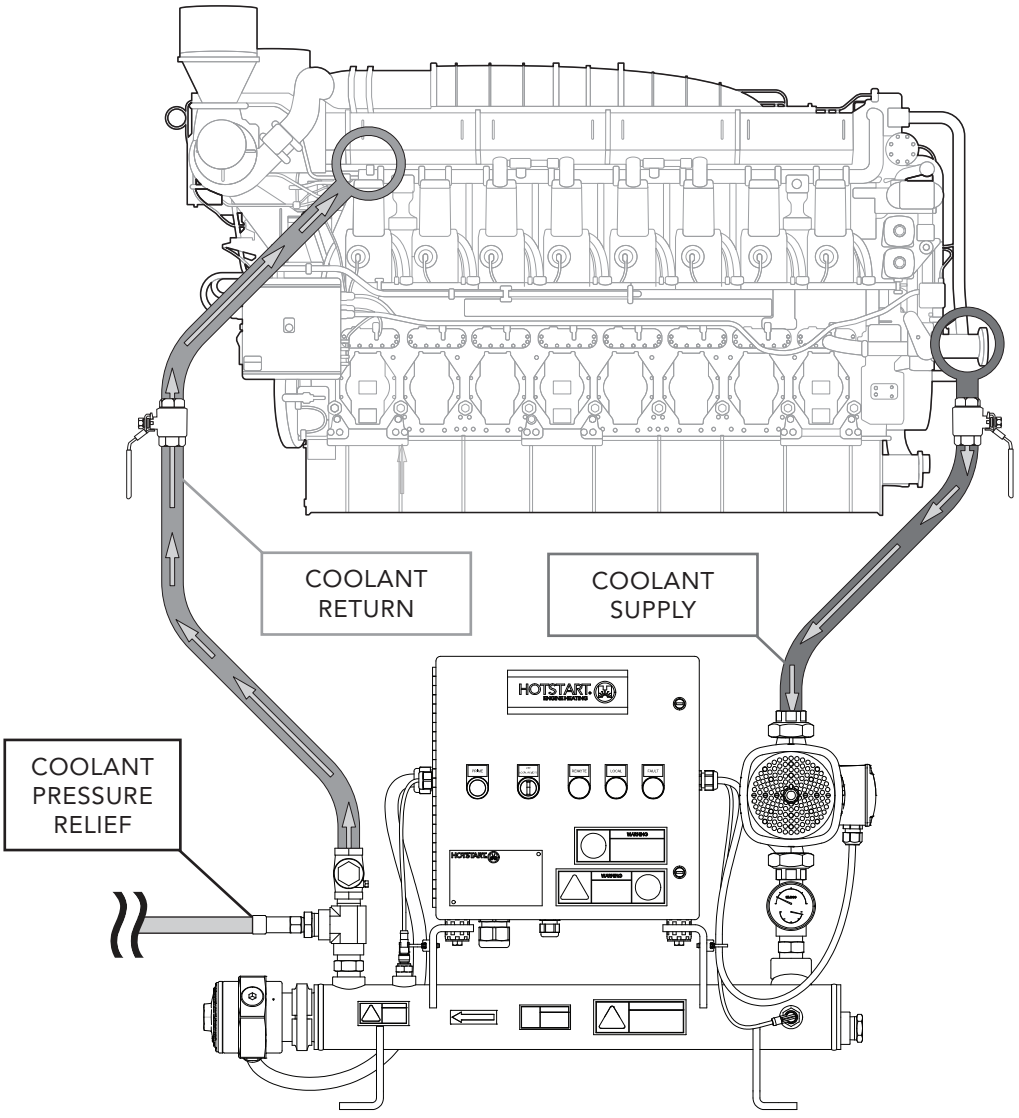


Figure 2. CMM/CLM system operation. Component illustrations are for reference only and are not to scale. See part drawings for dimensions and specifications.

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, 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 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 to an inner diameter smaller than the pump inlet; pump seal damage will occur.

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 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.

Proper lifting: Use proper lifting equipment and rigging to move this equipment. Create a plan before attempting to move. Heating systems with flanges have marked lift points. When lifting, use soft straps and avoid placing side-loads on heating system plumbing components, including fluid pumps.

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 in the supply and return lines 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.

2.1 COOLANT PLUMBING INSTALLATION

NOTICE

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

Air lock: Avoid high points in supply and return lines that could trap air and restrict flow. Where high points are unavoidable, install bleed fittings to allow removal of trapped air.

2.1.1 COOLANT SUPPLY

When installing the CMM/CLM coolant supply line, refer to the following Hotstart guidelines *(See* **SECTION 2.2***)*:

- 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. Where applicable, HOTSTART recommends a connection point at the suction side of the engine water pump. **NOTICE!** At a minimum, suction port must be sized per the pump inlet (1" NPT).

- The coolant pump is a centrifugal-type that is not self-priming. It must be situated below the minimum liquid level of the engine cooling jacket to ensure it remains flooded and has a positive pressure at the inlet.

- 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.

  NOTE: For optimal pump performance, Hotstart recommends a minimum of 6 inches (152 mm) of straight pipe installed into pump inlet.

2.1.2 COOLANT RETURN

When installing the CMM/CLM coolant return line, refer to the following Hotstart guidelines *(See* **SECTION 2.2***)*:

- Size the coolant return line per the coolant outlet. **NOTICE!** Do not reduce the return line inner diameter.

- Install the coolant discharge port as high as possible on the engine's water jacket at the end of the engine opposite the suction port. To minimize heat loss and warm-up time, Hotstart recommends running the coolant return directly the engine water jacket and critical accessories, if applicable.

- If the coolant return must be connected to the engine's external plumbing, it should be in a location that readily allows flow directly into the engine's cooling jacket and does not allow warm coolant to bypass the engine.

- To minimize heat loss, avoid connecting the coolant return to any location that will allow warm coolant to pass through radiators or heat exchangers.

COMPONENT	DESCRIPTION
V-1	USER SUPPLIED FULL FLOW ISOLATION VALVE
E-1	COOLANT PUMP
E-2	COOLANT HEATING ELEMENT
V-2	PRESSURE RELIEF VALVE
V-3	CHECK (NON-RETURN) VALVE
V-4	USER SUPPLIED FULL FLOW ISOLATION VALVE

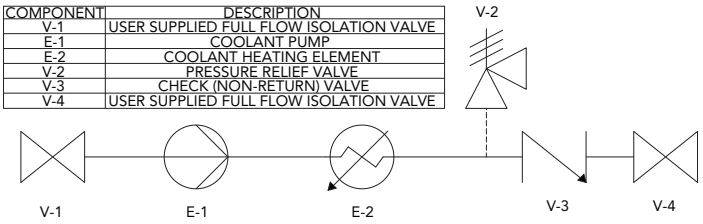
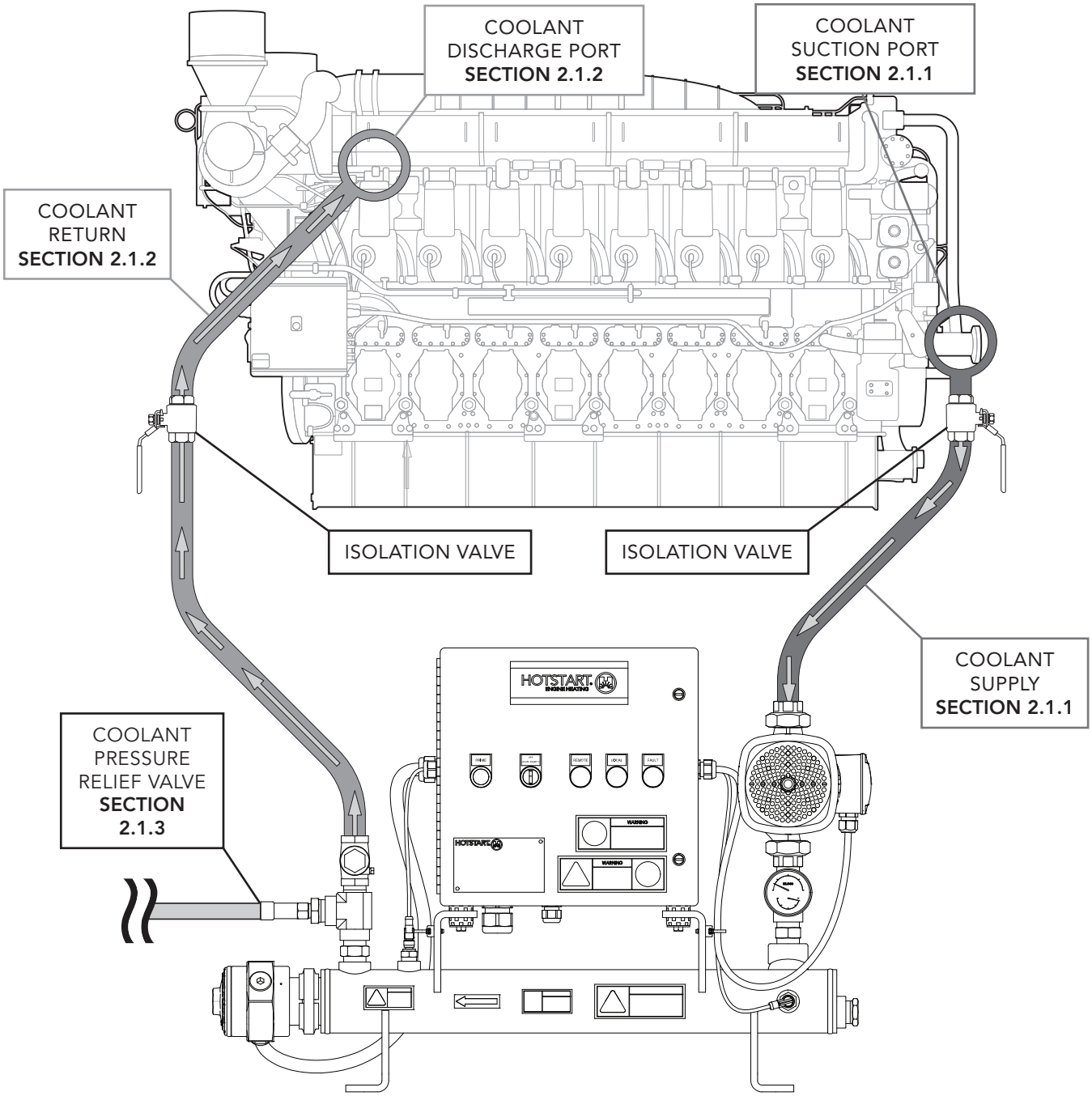


Figure 3. CMM/CLM system operation. Component illustrations are for reference only and are not to scale. See part drawings for dimensions and specifications.

2.1.3 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 heating system or engine coolant system.

2.2 COOLANT PLUMBING ILLUSTRATION



2.3 MOUNTING

⚠ CAUTION

Lifting hazard: Use proper lifting equipment and rigging to move this equipment. Create a plan before attempting to move. Heating systems with flanges have marked lift points. When lifting, use soft straps and avoid placing side-loads on heating system plumbing components, including fluid pumps.

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

NOTICE

Heating system damage: Engine vibration will damage the heating system; isolate the heating system from vibration. Never mount the heating system or components directly to the engine.

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

2.3.1 TANK AND PUMP

Mount the heater below the fluid level in the engine on a level surface in a vertical orientation with pump motor assembly directly above tank. Reference drawings for mounting position.

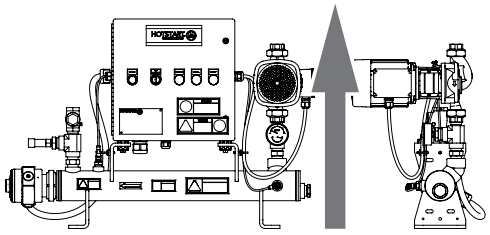


Figure 4. Mount unit in orientation shown. Do not mount at an angle or in any other orientation.

When installing the heating system, ensure sufficient clearance for the following components:

- **Control box**
  Ensure the control box is accessible and the lid may be opened.
- **Pump motor cooling fan**
  Ensure the cooling fan is not obstructed.
- **Heating element**
  Note the tank may require up to 30 inches (762 mm) of clearance to remove element for maintenance. The clearance required for specific part numbers will be shown on system drawings.

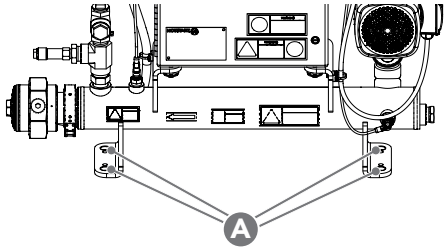


Figure 5. CMM/CLM 0.75 inch (19.05 mm) and .38 inch (9.65 mm) diameter mounting holes × 4 **(A)**.

2.4 ELECTRICAL CONNECTIONS

⚠ WARNING

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

2.4.1 MAIN POWER SUPPLY

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

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.

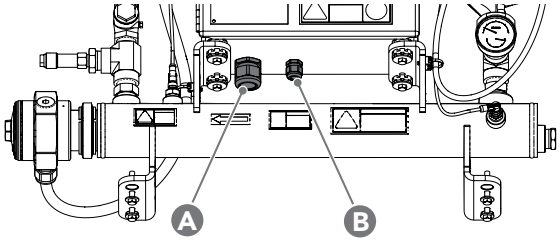
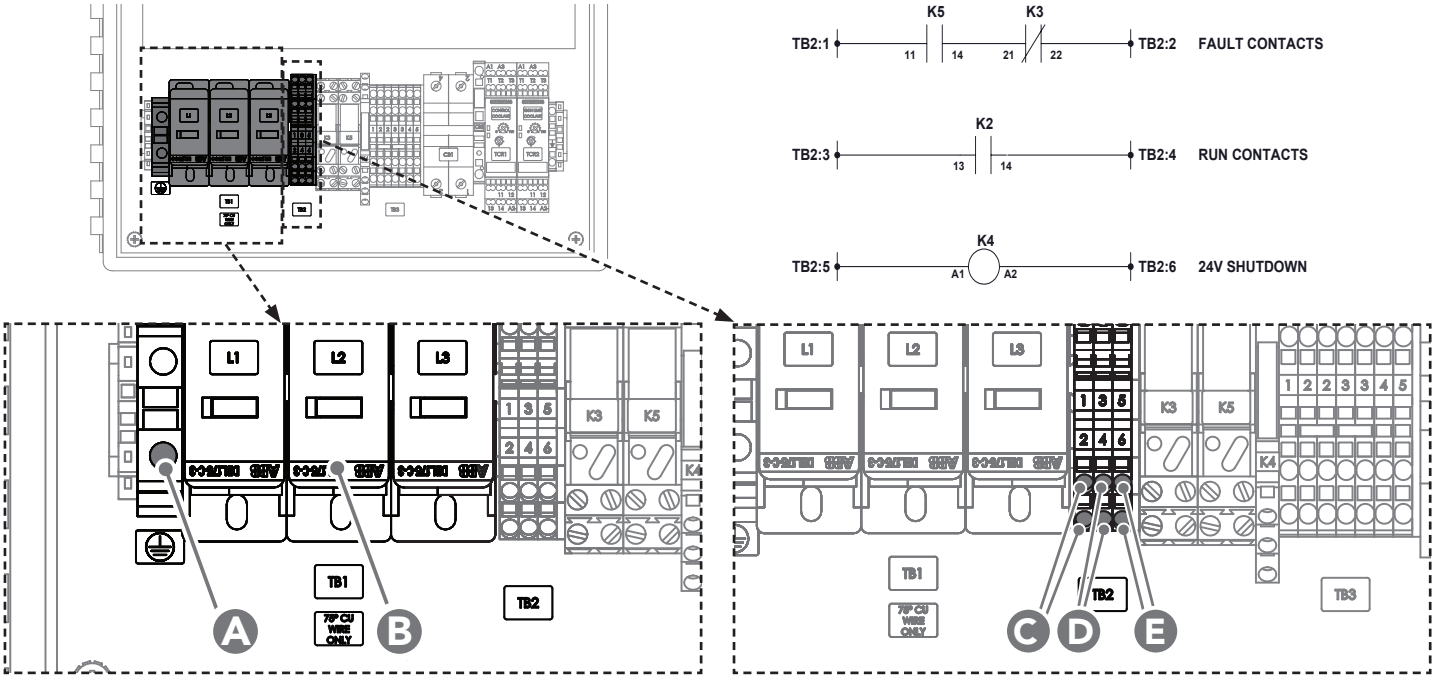


Figure 6. CMM/CLM underside, showing typical .590–1.00 (15–25 mm) main power entrance **(A)** *and .170–.450 (4.3–11.4 mm) customer interface wiring entrance* **(B)**. *Cord grip sizes, quantities, and styles may vary depending on system configuration.*



A. *Main power ground block*
B. *Main power terminal block*
C. *Coolant fault signal*
D. *Coolant motor run signal*
E. *Remote On/Off 24 V DC shutdown*

Figure 7. Main power supply and customer interface connections as shown in the CMM/CLM control box. Reference electrical schematic drawing for proper wiring locations; the following illustrations are typical customer interface locations but may not apply to all models.

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

- For **three-phase applications**, the terminal blocks are labeled **L1**, **L2** and **L3 (B)**.
- For **single-phase applications**, use the terminal blocks labeled **L1** and **L2 (B)**.

2. Connect the main power ground wire to the ground block **(A)**.

2.4.2 CUSTOMER INTERFACE CONNECTIONS

NOTICE

Wiring connections: Reference electrical schematic drawings for proper wiring locations; the following are typical interface locations.

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

- **TB2:1/TB2:2**
  Coolant Fault Signal (C)
  The fault signal will indicate a coolant heating system shutdown, triggered by either the high-limit temperature control relay or the motor protection switch.
- **TB2:3/TB2:4**
  Coolant Motor Run Signal (D)
  A motor run signal indicates the coolant pump motor is running. If no signal is present, the coolant pump motor is not running.
- **TB2:5/TB2:6**
  Remote On/Off 24 V DC shutdown (E)
  When energized, the remote on/off relay will activate the heating system. When de-energized, the remote on/off relay will deactivate the heating system. Use this connection for remote operation of the heating system when the **LOCAL/OFF/REMOTE** switch is turned to **REMOTE**.

NOTE: The **24 V DC shutdown** relay is wired **NO (normally open)** from the factory. To switch to NC (normally closed) operation, move the wire from the **K4:14** terminal to the **K4:12** terminal.

2.4.3 MOTOR ROTATION CHECK

NOTICE

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

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

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

1. With main power connected to the heating system motor *(see* **SECTION 2.4.1***)*, energize the pump while observing the rotation of the fan at the rear of the motor. Refer to markings on pump for correct rotation direction.
   - ➤ If the pump motor does not rotate in the correct direction, disconnect power and switch any two electrical leads at the main power terminal block (**L1, L2, L3**). Reconnect power. *Repeat step 1* to ensure motor rotates in the correct direction.

NOTE: For systems installed on mobile equipment that may connect to power at multiple locations, ensure all shore power connection points have consistent phase sequences.

3 COMPONENTS AND OPERATION

The following is an operational description for each of the CMM/CLM interface and system components.

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

3.1 INTERFACE COMPONENTS

3.1.1 LOCAL/OFF/REMOTE SWITCH

- **LOCAL** – The system is **on** and will run continuously until manually shut off.
- **OFF** – The system is shut **off**.
- **REMOTE** – The system is **on** and will run based on an input signal. In this state, the 24 V DC shutdown may be used to activate and deactivate the system.

3.1.2 PRIME BUTTON

When the system is not running, press and hold the **PRIME** button to energize the pump motor in order to remove any air in the heating system without energizing the elements.

3.1.3 PRESSURE/TEMPERATURE GAUGE

The CMM/CLM system features a temperature/pressure gauge mounted at the heating tank inlet. The gauge will indicate a pressure increase when the pump motor is engaged by pressing and holding the **PRIME** button or during normal operation. The gauge will also indicate the fluid's current temperature.

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

3.1.4 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.

3.2 SYSTEM COMPONENTS

3.2.1 MOTOR PROTECTION SWITCH

The motor protection switch (MPS1) 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 MPS **RESET/ON** button. *See Figure 8.* For additional troubleshooting, *see* **SECTION 4.5**.

3.2.2 CONTROL TCR (TEMPERATURE CONTROL RELAY)

The control TCR (TCR1) is used to control the heating element and maintain the temperature of the fluid. 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 control relay (TCR1) is 50 °C (122 °F) and 10% (5 °C/9 °F) hysteresis. The TCR will turn the heating element off at 50 °C (122 °F) and turn the element back on at 45 °C (113 °F) with these set points. **NOTICE!** Decreasing the hysteresis below 10% may increase the cycles of the contactor, shortening its expected life and potentially overheating it. *See Figure 8.*

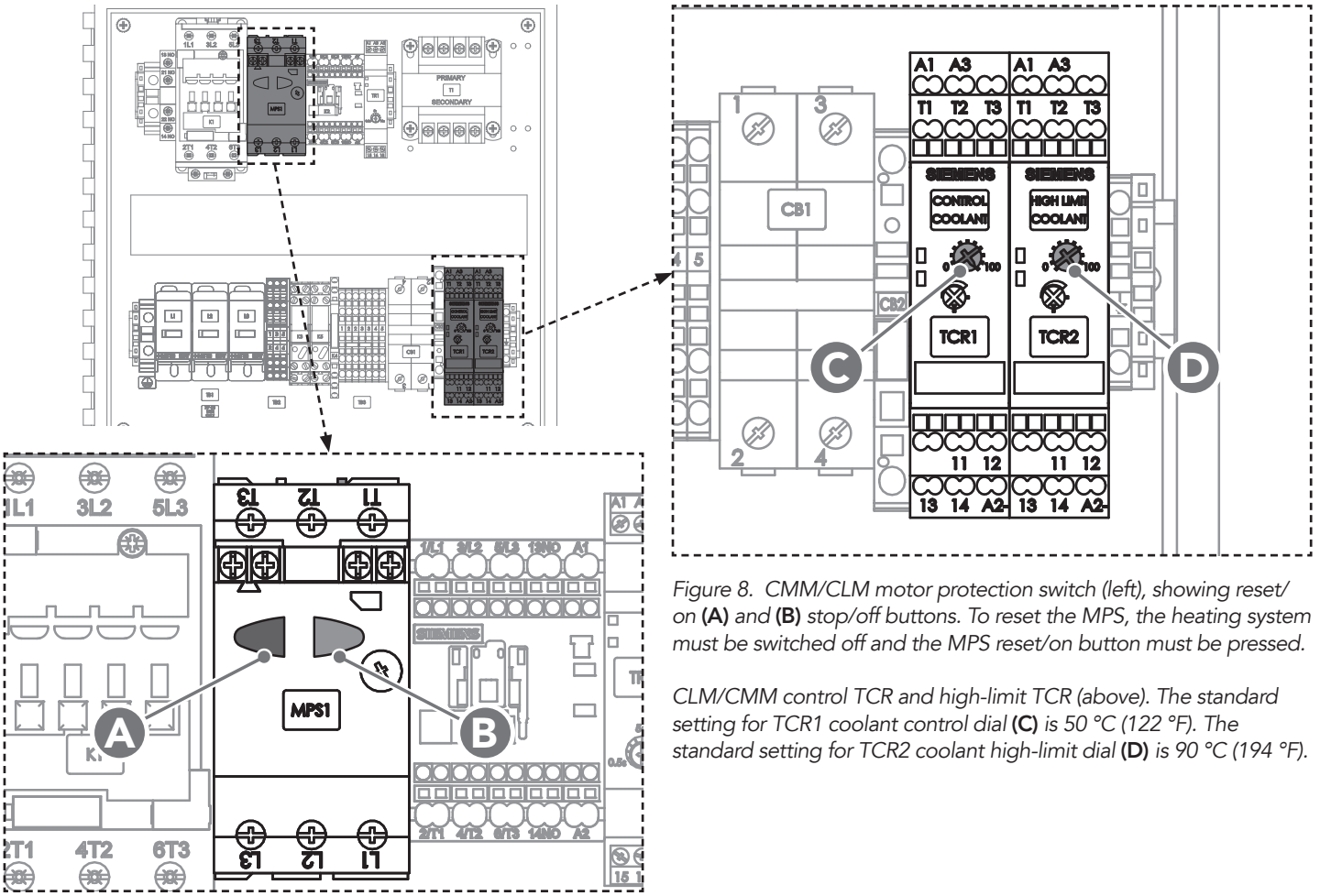


Figure 8. CMM/CLM motor protection switch (left), showing reset/on **(A)** *and* **(B)** *stop/off buttons. To reset the MPS, the heating system must be switched off and the MPS reset/on button must be pressed.*

CLM/CMM control TCR and high-limit TCR (above). The standard setting for TCR1 coolant control dial **(C)** *is 50 °C (122 °F). The standard setting for TCR2 coolant high-limit dial* **(D)** *is 90 °C (194 °F).*

3.2.3 HIGH-LIMIT TCR (TEMPERATURE CONTROL RELAY)

The high-limit TCR (TCR2) is a protection device to prevent fluid overheating. The high-limit TCR connects to a second resistance temperature device (RTD) located near the tank outlet. The default setting for the coolant high-limit TCR is 90 °C (194 °F) and should always be at least 10 °C (18 °F) higher than the control TCR set point. The high-limit TCR hysteresis is not used in the high-limit control. *See Figure 8.*

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 five seconds at a time. Running a pump that is not completely filled with fluid will cause damage to the pump seal.

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

Seal damage: Pump seal faces may adhere while in storage. Before energizing the pump motor for the first time, remove the pump shaft guards and rotate the shaft by hand to ensure the seal faces move freely.

3.3.1 FIRST RUN PROCEDURE

1. For three-phase applications, ensure a motor rotation check has been performed prior to introducing fluid to the pumps (*see* **SECTION 2.4.3**).

   NOTE: Single-phase motors are prewired at the factory to ensure rotation in the correct direction. If a single-phase pump motor rotates in the incorrect direction, contact Hotstart for re-wiring instructions.

2. Check and tighten all electrical and plumbing connections.

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

4. Bleed all trapped air from the heating system and connecting plumbing by opening plugs or pipe fittings as needed. 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.

   NOTE: Remaining air may be evacuated from the pump using the pump air bleed screw. Unscrew the pump air bleed screw to vent trapped air. Tighten screw once coolant begins venting. See *Figure 9*.

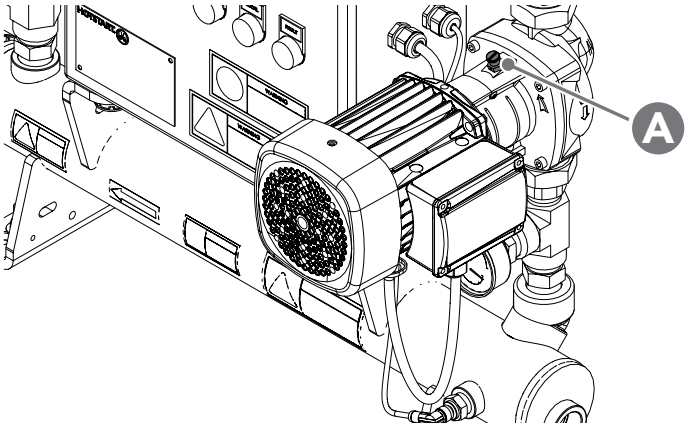


Figure 9. CMM/CLM pump bleed screw (A). Unscrew bleed screw to vent trapped air. Tighten screw once coolant begins to vent.

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

6. Turn the control dial on the temperature control relay TCR1 to the desired temperature setting for engine coolant. TCR1 is set to a control temperature setting of 50 °C (122 °F) and TCR2 is set to a high-limit setting of 90 °C (194 °F) at the factory. *See* **SECTION 3.2.2** *and* **SECTION 3.2.3**.

7. Turn the **LOCAL/OFF/REMOTE** switch to **REMOTE** to verify the 24 V DC remote on/off connection (if used).

8. Disconnect power to the heating system and tighten all electrical connections. *See* **SECTION 4.2.2**.

4 MAINTENANCE AND TROUBLESHOOTING

4.1 SYSTEM FAULTS

A failure in the pump motor that causes the motor protection switch (MPS1) to trip will shut down the heating system. The **FAULT** light will illuminate and 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 MPS **RESET/ON** button to reset the fault. (*See* **SECTION 3.2.1.**)

If there is a failure that causes a high fluid temperature to occur, the high-limit temperature controller (TCR2) will shut down the heating system, including the pump motor. The **FAULT** light will illuminate and a fault signal will be transmitted. To restart the system, the **LOCAL/OFF/REMOTE** switch must be switched to **OFF** and then back to **LOCAL** or **REMOTE** to resume operation once the system has cooled back down. (*See* **SECTION 3.2.3**.) For additional troubleshooting, *see* **SECTION 4.5**.

4.1.1 FAULT SIGNALS

A fault signal will be transmitted if:

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

4.2 SYSTEM MAINTENANCE

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 and thermal cycling may cause terminals to loosen. After initial first run, disconnect power and tighten electrical connections (*see* **SECTION 4.3**). 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 SYSTEM DRAINING

Use the following points for draining purposes (*see* **SECTION 4.2.11** *and* **SECTION 4.2.12**):

- Coolant tank plug **(A)**

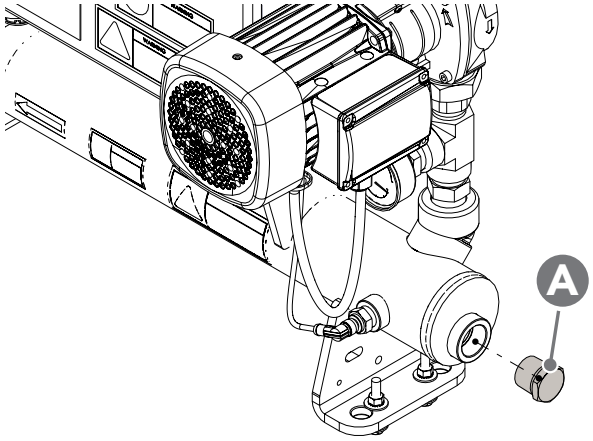


Figure 10. CMM/CLM, showing drain plug **(A)** *at coolant tank.*

4.2.5 MAGNETIC CONTACTORS

Magnetic contactors are used to control motors and heating elements in Hotstart heating systems. The contactor coils operate at the system's nameplate control voltage. To test for failure, check for continuity across the coil connections (A1 and A2); an open or direct-short reading indicates a failed contactor coil.

With power disconnected, verify that the mechanism of the contactor moves freely and is not stuck in an open or closed position. With the contacts held closed, check for unusually high resistance across the main poles. For contactors with screw terminals, verify that all wire connections are properly tightened.

Magnetic contactors have finite life cycles, as they contain moving parts and electrical contacts that will wear out with use. Replace contactors that develop functional problems or show obvious external signs of heat damage. Hotstart recommends that element contactors be replaced at least every five years as a preventative maintenance measure.

NOTE: Higher-current systems or systems operating in high ambient temperatures may require more frequent contactor replacement.

4.2.6 PUMP SEAL

If seal becomes worn, replacement pump seals are available. To improve pump seal longevity, ensure the supply line does not restrict flow excessively (*see* **SECTION 2.1.1).**

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

4.2.7 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.

4.2.8 PRESSURE/ TEMPERATURE GAUGE

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

4.2.9 VOLATILE CORROSION INHIBITOR

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 the VCI to be replaced at six month intervals. *See* **SECTION 4.4**.

4.2.10 TEMPERATURE CONTROL RELAY (TCR)

⚠ WARNING

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

If the CMM/CLM 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 50 °C (122 °F).

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

3. Using the ohmmeter, measure the resistance between TCR terminals **T1** and **T2** *(See Figure 11)*:
   - ➤ 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 3.3.1***)*. If fault or temperature problems persist after start-up, contact HOTSTART for further assistance.
   - ➤ If there **is no continuity** between TCR terminals **T2** and **T3**, locate connected RTD on the heating tank. Unscrew the RTD plug from RTD. *See Table 1 and Figure 11, Figure 12* on the following page.

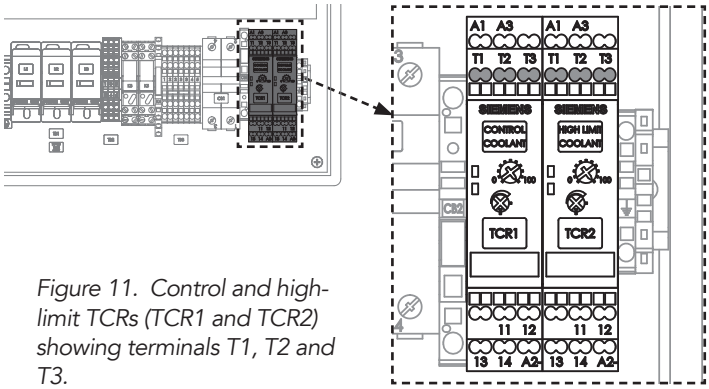


Figure 11. Control and high-limit TCRs (TCR1 and TCR2) showing terminals T1, T2 and T3.

TCR		TYPE		RTD Position
TCR1	Coolant	Control	50 °C	Tank Inlet
TCR2	Coolant	High-limit	90 °C	Tank Outlet

Table 1. TCR types, default temperature settings and corresponding RTD positions.

5. Using the ohmmeter, touch the probes to RTD **pin 1** and **pin 3**. *See Figure 12.* 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 4.2.11.**

4.2.11 RESISTANCE TEMPERATURE DEVICE (RTD)

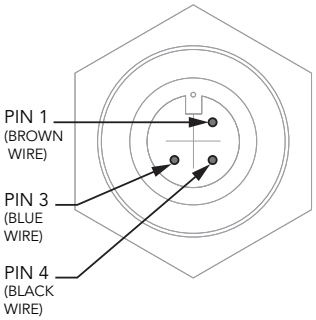


Figure 12. RTD pins 1, 3 and 4. The resistance between pin 1 and pin 3 should measure between 80 and 120 ohms. There should be continuity between pin 1 and pin 4.

⚠ 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 4.2.10**.

1. De-energize the heating system. Allow fluid to cool.

2. Close isolation valves. Drain fluid from the heating tank (*see* **SECTION 4.2.4**). Locate the RTD that requires replacem ent. *See Figure 13.*

3. Unscrew RTD plug. Remove plug. Unscrew RTD from tank. *See Figure 14.*

4. Screw replacement RTD to tank. When tightening, ensure plug is aligned with notch orientated as shown in *Figure 15*

5. 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.

6. To ensure proper installation and temperature regulation, re-energize and operate heating system. *Refer to* **SECTION 3.3.1** *for system start-up procedures.*

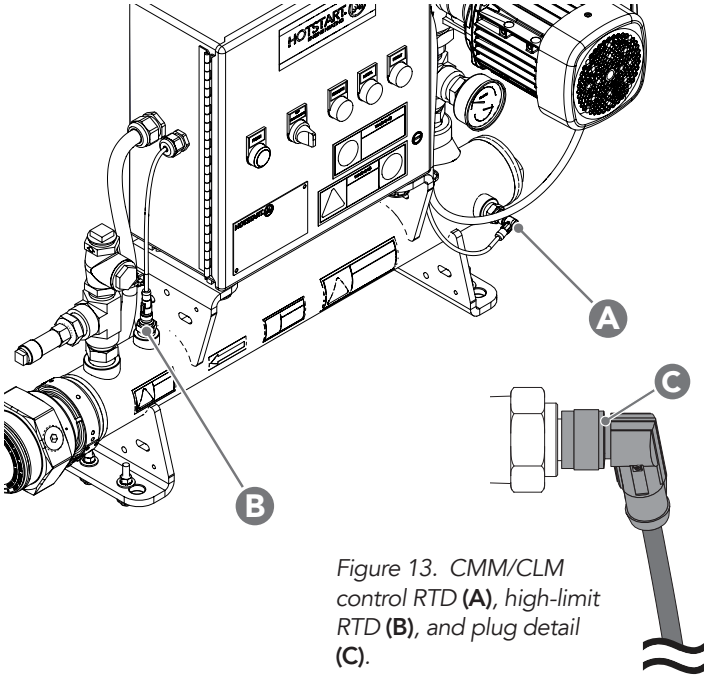


Figure 13. CMM/CLM control RTD **(A)**, *high-limit RTD* **(B)**, *and plug detail* **(C)**.

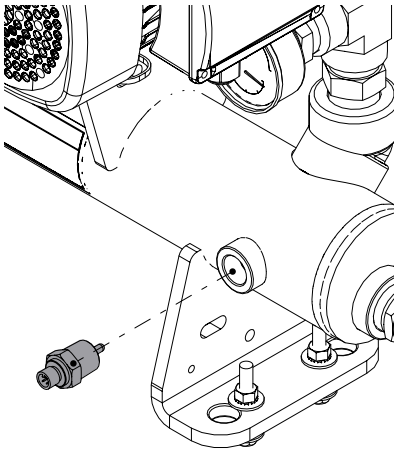


Figure 14. Control RTD shown removed from CMM/CLM heating tank.

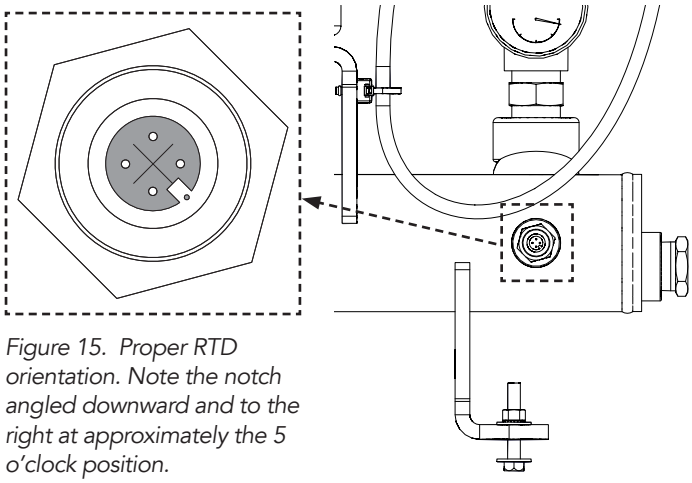
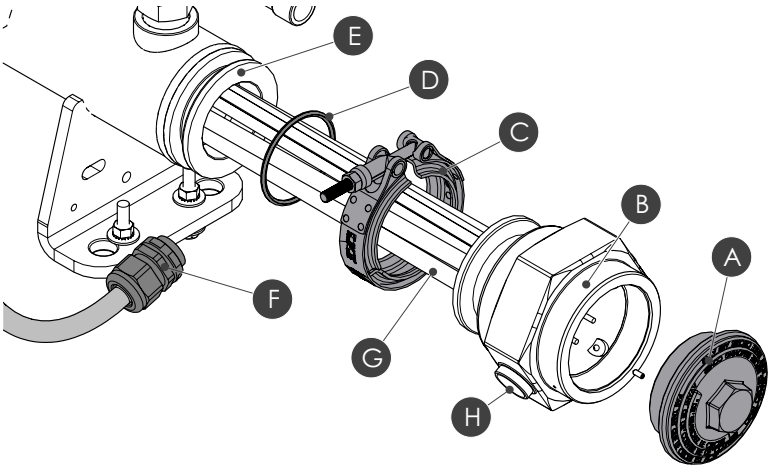


Figure 15. Proper RTD orientation. Note the notch angled downward and to the right at approximately the 5 o'clock position.

Figure 16. Removing and replacing the heating element. The heating system should be drained, cleaned and flushed annually. See **SECTION 4.3**



- **A.** *Element service entrance cap*
- **B.** *Element identification plate*
- **C.** *V-clamp*
- **D.** *O-ring*
- **E.** *Tank*
- **F.** *Element cable grip and element cable*
- **G.** *Element*
- **H.** *Cable connector entrance*

4.2.12 HEATING TANK/ELEMENT

⚠ WARNING

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

At least once per year, clean the interior of the heating tank and the heating element with a wire brush and/or damp cloth. Periodically check the sediment build-up around the element loops. Any scaling or build-up will shorten element life.

To replace the heating element or perform routine maintenance, use the following procedures. *See Figure 16*. 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. Drain the fluid from the heating tank **(E)**. *See* **SECTION 4.2.4**.
3. Remove the cap **(A)** from the heating element service entrance enclosure.
4. Note your unit's jumper configuration. *See Figure 17*. **NOTICE!** Elements are configured from the factory. Retain original jumper placement during element reassembly. Altering element configuration or jumper placement may cause heating system failure.

   NOTE: Replacement elements may be a different jumper configuration.
5. Disconnect the ground (green/yellow) and power electrical wires from the terminals inside the cap.
6. Unscrew cable gland **(F)** from conduit connector entrance **(H)**. Remove electrical cable and wires from the heating element. *See Figure 17*.
7. Loosen V-clamp nut to remove V-clamp **(C)**. Slide the heating element out of tank as shown.
8. Replace the heating element **(G)** or perform the necessary cleaning procedure. Ensure the O-ring **(D)** is intact and in place before securing V-Clamp.

4.2.13 REASSEMBLY OF HEATING ELEMENT AND TANK

To reassemble the heating element and tank, follow the steps listed in **SECTION 4.2.12** in **reverse order**. Make sure the ground and power electrical wires are properly reconnected using the provided nuts.

Tighten the following components:

- V-clamp nut **(C)** to 20 N m (180 lbf in)
- Element terminal nuts to 1.6 N m (14 lbf in)

NOTE: System wattage may be changed by replacing the element assembly. Prior to changing wattage, contact Hotstart with your system's part number and serial number to ensure it is safe to do so, or if other components need to be changed for proper operation.

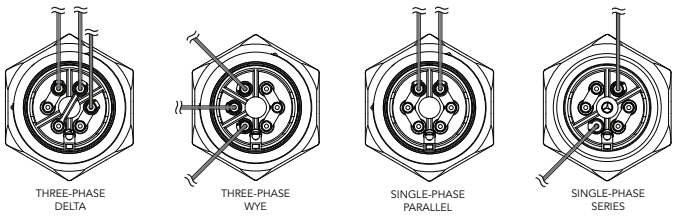


Figure 17. Heating element jumper configurations. Replacement elements may be a different jumper configuration.

4.3 RECOMMENDED MAINTENANCE

INTERVAL	MAINTENANCE TASK
At initial start-up	Tighten electrical connections. *See* **SECTION 4.2.2**.
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 4.2.5**.

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.

During storage, the faces of the pump seal may adhere to each other if there is no fluid in the pump. Applying power from the pump motor with stuck seal faces can damage or destroy the pump seal. For heating systems that are new or have been in storage, remove the pump shaft guards and rotate the shaft by and to ensure the seal faces move freely before energizing the motor.

4.5 TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSES	SOLUTION
System fault	Pump not primed properly	Bleed all trapped air from lines. Restart system.
	Isolation valves may be closed	Open valves. Restart system.
	Hose kinked or crushed	Remove obstruction. Restart system.
	Leak in suction line	Repair leak. Bleed and restart system.
	Pump motor turning backwards	Reverse any two power leads (in three-phase system). Restart system. *See* **SECTION 3.3.1**. For single-phase systems, contact Hotstart.
	Control TCR failure: closed	Check and replace if necessary. *See* **SECTION 4.2.10**.
	Motor failure	Check and replace if necessary. Restart system.
	Motor contactor failure	Disconnect system power and check contactor. Replace if needed. *See* **SECTION 4.2.5**.
	Motor protection switch tripped	Check and reset switch. If problem occurs again, check motor. Restart system. *See* **SECTION 4.1**.
	RTD failure	Check TCR and RTD. See **SECTION 4.2.10**.
	RTD cable failure	Check TCR and RTD. See **SECTION 4.2.10**.
Fluid temperature too low	Motor failure	Check motor. Replace if necessary.
	Heating system 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 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 4.2.10**.
	Control TCR set point too low	Adjust set point for control TCR. *See* **SECTION 3.2.3.**
	RTD failure	Check TCR and RTD. See **SECTION 4.2.10**
	RTD cable failure	Check TCR and RTD. See **SECTION 4.2.10**.