216330-000 rev2

INSTALLATION & OPERATION MANUAL

MODULAR COOLANT CIRCULATING HEATING SYSTEM

MODEL

MODULAR CLV

Hotstart
THERMAL MANAGEMENT

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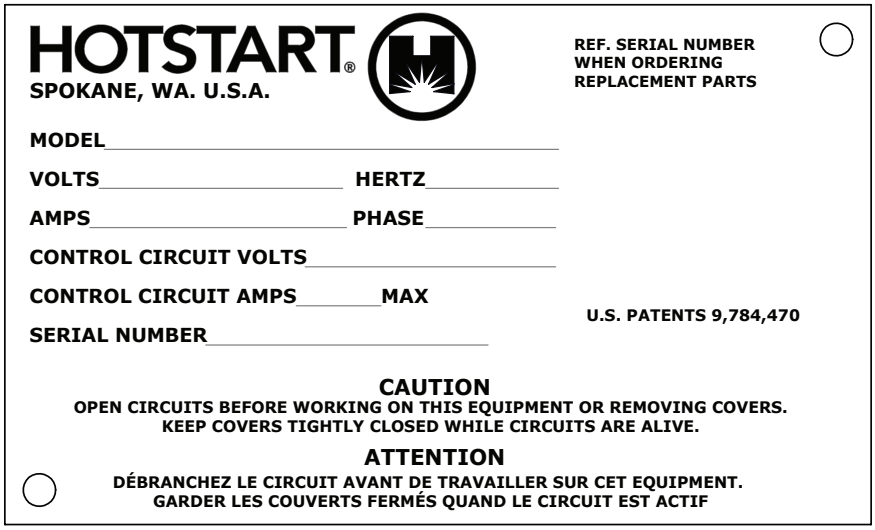
IDENTIFYING YOUR SYSTEM

The Hotstart heating system is designed to heat fluids for use in marine propulsion, diesel-powered generator sets, locomotives, gas compression or any large-engine applications. Each heating system has an identification plate which includes the part number and serial number.

This operation manual describes the installation, operation and maintenance of the heating system. Model specifics, capabilities and features may vary. See part drawings for dimensions and specifications.

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

⚠ WARNING 

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

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

⚠ CAUTION

Read instructions carefully: The safety of any system incorporating this heater is the responsibility of the assembler. The safe and proper use of this heater is dependent upon the installer following sound engineering practices. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. All applicable electrical safety standards defined by local jurisdictions must be followed. (Reference EU directive 2006/95/EC in EU countries.)

- **Read carefully:** Installers and operators of this equipment must be thoroughly familiar with the instructions in this manual before commencing work.
- **Hot surfaces:** Avoid contact with the system while it is in service. Some surfaces may remain hot even if the system is not energized.
- **Proper lifting:** Proper rigging and safety equipment must be used to move this equipment. Do not lift the heating system by any cords, electrical conduit or cabling. Create a plan before attempting to move. Proper lifting locations are identified on each system; use these locations when lifting and mounting the system.
- **Rotating equipment:** The heating system can start automatically and without warning. Avoid contact unless a lockout at the service panel has been installed.
- **Grounding:** The heater must be connected to a suitable ground (protective earthing conductor).
- **Overcurrent limiting:** The power supply must be protected by a suitable overcurrent limiting device.
- **Power disconnection:** A means to disconnect the heater from the power supply is required. Hotstart recommends that a power switch or circuit breaker be located near the heater for safety and ease of use.

NOTICE

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

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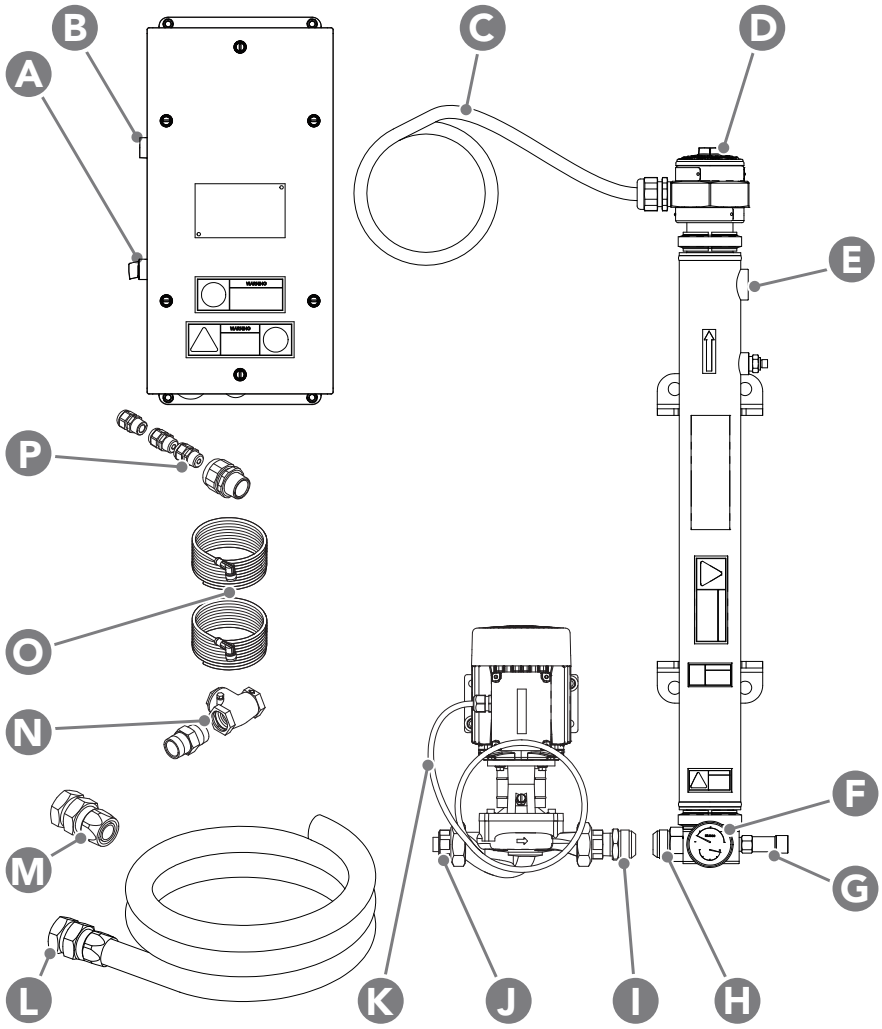
1 OVERVIEW

1.1 HEATING SYSTEM COMPONENTS

The 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. Modular CLV heating system components.



- **A.** *ON/OFF/PRIME switch*
- **B.** *FAULT light*
- **C.** *Element cable (40 ft. / 12.2 m)*
- **D.** *Element assembly*
- **E.** *Outlet (1.0" NPT)*
- **F.** *Pressure/temperature gauge*
- **G.** *Pressure relief valve (0.5" NPT)*
- **H.** *Tank inlet (#20 JIC)*
- **I.** *Pump outlet (#20 JIC)*
- **J.** *Pump inlet (1.0" NPT)*
- **K.** *Pump motor cable (40 ft. / 12.2 m)*
- **L.** *Pump to tank hose (#20 JIC, 9 ft. / 2.7 m)*
- **M.** *Adapter #20 JIC*
- **N.** *Check valve nipple and check valve (1.0" NPT)*
- **O.** *RTD assembly × 2 (resistance temperature device) & cable (50 ft. / 15.2 m)*
- **P.** *Strain relief*
  1 × 1 NPT
  (grip range .590 – 1.00)
  1 × 1/2 NPT
  (grip range .170 – .450)
  2 × 1/2 NPT
  (grip range .095 – .290)

1.2 OPERATION OVERVIEW

The Modular CLV 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 3.4**). The Modular CLV 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 element will cycle on and off at the user-selected temperature control point.

A return line check valve (included with the Modular CLV) 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.

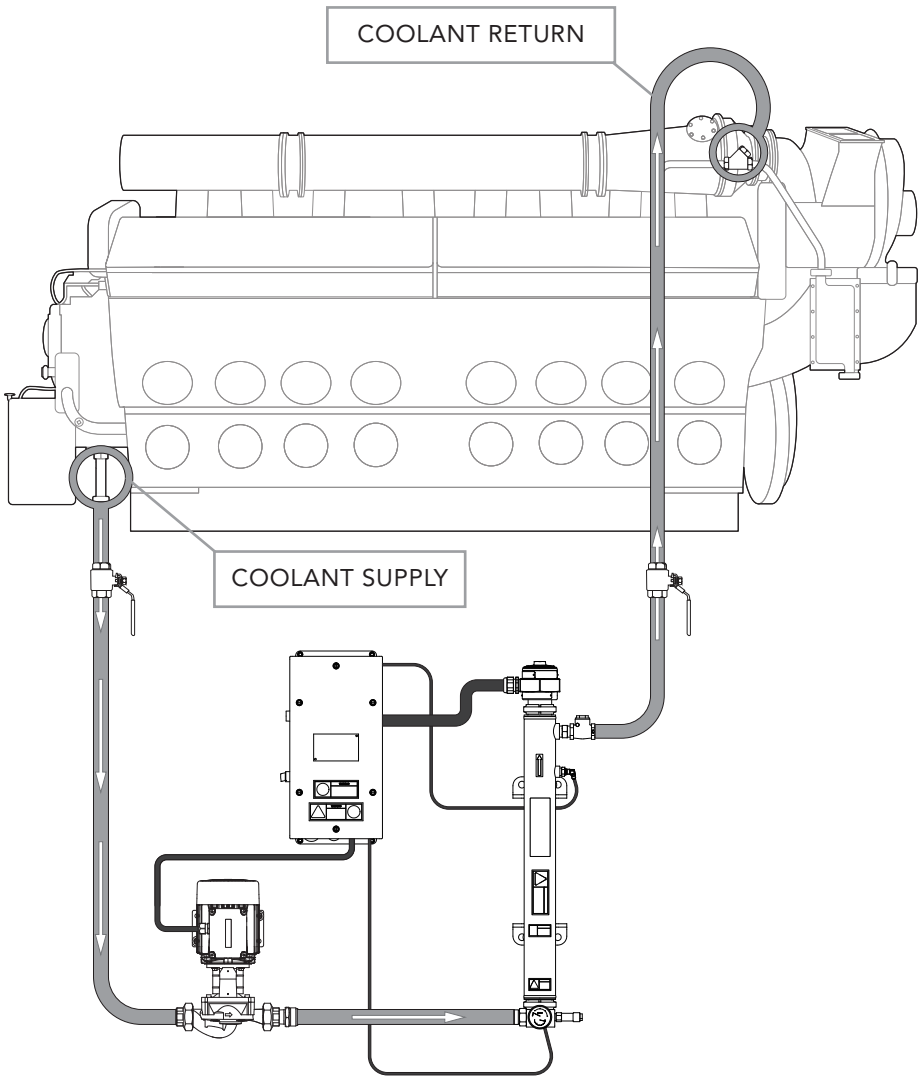


Figure 2. Modular CLV operation overview. While the heating element cycles on and off to maintain the preset temperature, the pump circulates fluid continuously during operation.

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

2 COMPONENT INSTALLATION

Before installing the Modular CLV components, plan connections and routing for coolant plumbing. For coolant plumbing requirements, *see* **SECTION 3.1.**

2.1 HEATING TANK ASSEMBLY INSTALLATION

NOTICE

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

Heating tank orientation: Heating tank assembly may be mounted in a vertical orientation or horizontal orientation with the tank outlet positioned at the top of the tank or pointing directly upward. *(See Fig. 3).* Do not mount the tank assembly at an angle.

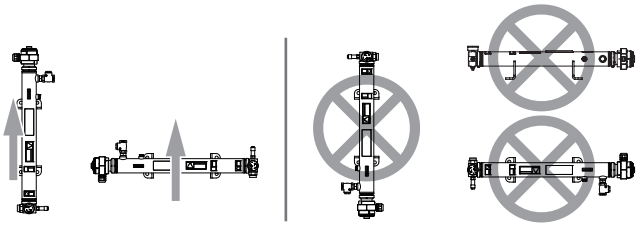


Figure 3. Correct heating tank assembly mounting orientations (left) and incorrect orientation (right). Incorrect positions show tank outlet positioned at bottom of tank, pointing downward or pointing horizontally.

When installing the heating system, note that the tank requires a minimum of 30 inches (63.5 cm) of clearance to remove the element for maintenance. *See* **SECTION 6.2.11**.

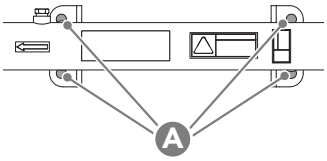


Figure 4. Modular CLV tank assembly .375 inch (9.5 mm) diameter mounting holes × 4 **(A)**.

2.1.1 CHECK VALVE ASSEMBLY

NOTICE

Check valve assembly: Check valve must be installed prior to heating system activation. If check valve is absent during heating system activation or engine activation, damage may occur to coolant heating system.

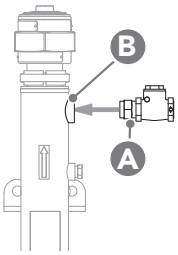


Figure 5. Modular CLV check valve and nipple assembly **(A)** *and coolant tank outlet* **(B)**.

1. Attach supplied check valve nipple to check valve.
2. Attach check valve and nipple assembly **(A)** to coolant tank outlet **(B)**. *See Fig. 5.*

2.1.2 RTD ASSEMBLY

1. Note positions of coolant RTD locations. *See Fig. 6.*
2. 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.

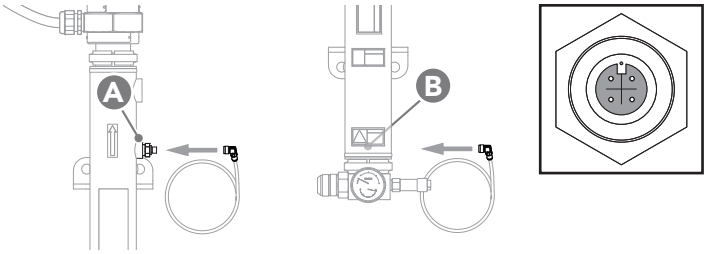


Figure 6. Tank assembly showing high-limit RTD **(A)** *and control RTD behind heating tank assembly* **(B)**. *Note RTD notch position (inset).*

3. Mark each RTD cable end with the RTD location. *See Fig. 9 on following page.*

2.2 PUMP INSTALLATION

NOTICE

Pump/motor assembly damage: Engine vibration will damage the heating system; isolate the heating system from vibration. Never mount the heating system

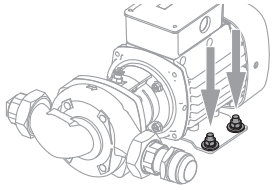


Figure 7. Coolant pump assembly showing .40 inch (10 mm) × 4 diameter mounting holes.

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.

2.3 CONTROL BOX INSTALLATION

NOTICE

Water ingress: Control box must be mounted in a vertical orientation. Do not mount control box on back or in any other orientation.

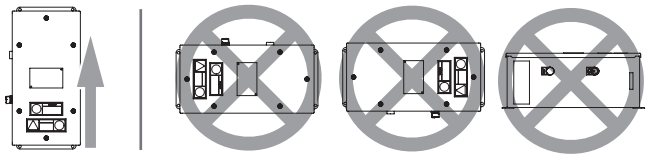


Figure 8. Correct control box orientation (left) and incorrect control box mounting orientations (right).

2.3.1 CONTROL BOX CONNECTIONS

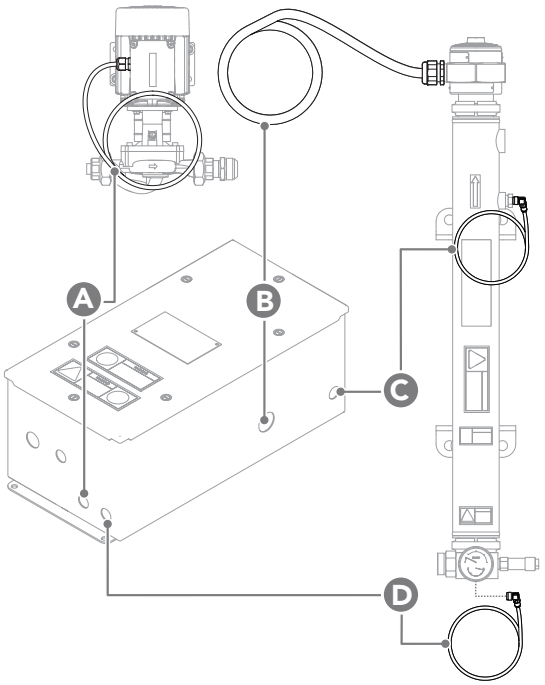


Figure 9. Pump, element and RTD connections as shown connected to the Modular CLV control box. See Table 1.

1. Route pump motor cable and heating tank assembly cable to control box. Using supplied strain relief, connect all cables to control box. *See Table 1 and Fig. 9.*
2. Using supplied wire markers, label each wire before connecting wire. *(See Fig. 10 on following page).*
3. Connect **coolant element** cable wires to temperature contactor **K1**:
   1. Connect #1 wire L1 to K1:T1
   2. Connect #2 wire L2 to K1:T2
   3. Connect #3 wire L3 to K1:T3
   4. Connect ground wire to ground terminal

   NOTE: For single-phase systems, connect single element cable wire L1 to K1:T1, and two element cable wires L2 to K1:T3.
4. Connect **coolant high-limit RTD** cable wires to temperature control relay **TCR2**:
   1. Connect blue wire to TCR2:T1
   2. Connect brown wire to TCR2:T2
   3. Connect black wire to TCR2:T3
5. Connect **coolant control RTD** cable wires to temperature control relay **TCR1**:
   1. Connect blue wire to TCR1:T1
   2. Connect brown wire to TCR1:T2
   3. Connect black wire to TCR1:T3
6. Connect **coolant pump motor** cable wires to contactor **K2**.
   1. Connect #1 wire U to K2:T1
   2. Connect #2 wire V to K2:T2
   3. Connect #3 wire W to K2:T3
   4. Connect ground wire to ground terminal

   NOTE: For single-phase systems, connect motor cable wires to K2:T1 and K2:T3.

	CABLE		BOX SIDE
	COMPONENT	LENGTH	
A	Coolant Pump Motor	40 ft. (12.2 m)	Bottom
B	Coolant Element	40 ft. (12.2 m)	Right
C	Coolant High-Limit RTD	50 ft. (15.2 m)	Right
D	Coolant Control RTD	50 ft. (15.2 m)	Bottom

Table 1. Modular CLV pump, element and RTD connections.

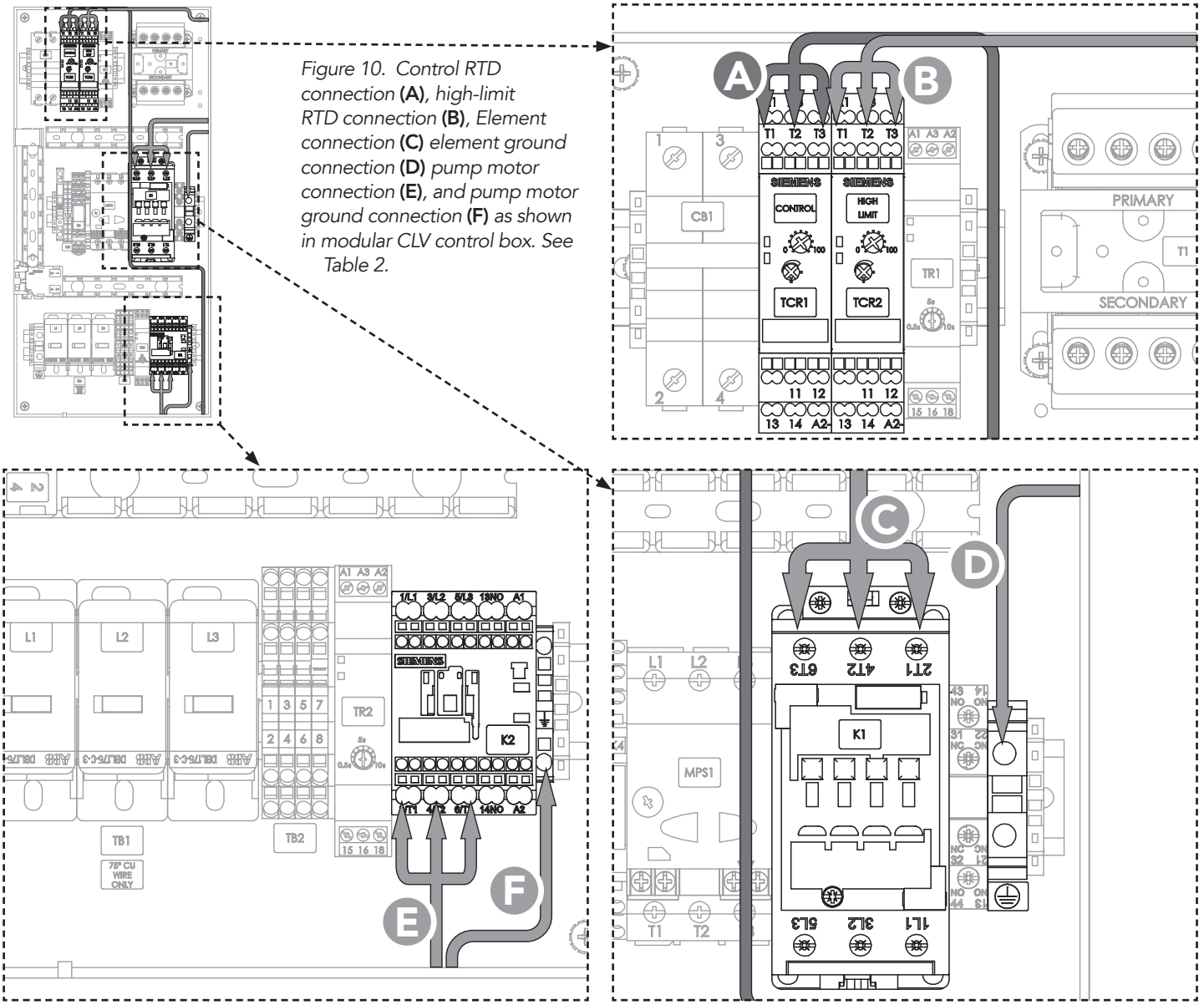


Figure 10. Control RTD connection **(A)**, *high-limit RTD connection* **(B)**, *Element connection* **(C)** *element ground connection* **(D)** *pump motor connection* **(E)**, *and pump motor ground connection* **(F)** *as shown in modular CLV control box. See Table 2.*

	FROM		TO		TIGHTENING TORQUE
	COMPONENT	WIRES	LOCATION	TERMINAL	
A	Coolant Control RTD	blue, brown, black	TCR1	T1, T2, T3	–
B	Coolant High-Limit RTD	blue, brown, black	TCR2	T1, T2, T3	–
C	Coolant Element	L1, L2, L3	K1	T1, T2, T3	35 in · lbs
D	Coolant Element Ground	–	ground	–	25 in · lbs
E	Coolant Pump Motor	U, V, W	K2	T1, T2, T3	–
F	Coolant Pump Motor Ground		ground	–	–

3 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, 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.

⚠ CAUTION

Pump seal damage: Do not reduce the coolant supply line to an inner diameter smaller than the pump inlet; pump seal damage may 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.

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.

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.

3.1 COOLANT PLUMBING

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.

The following illustrations are intended for a locomotive installation. For non-locomotive engine applications, general installation principles still apply.

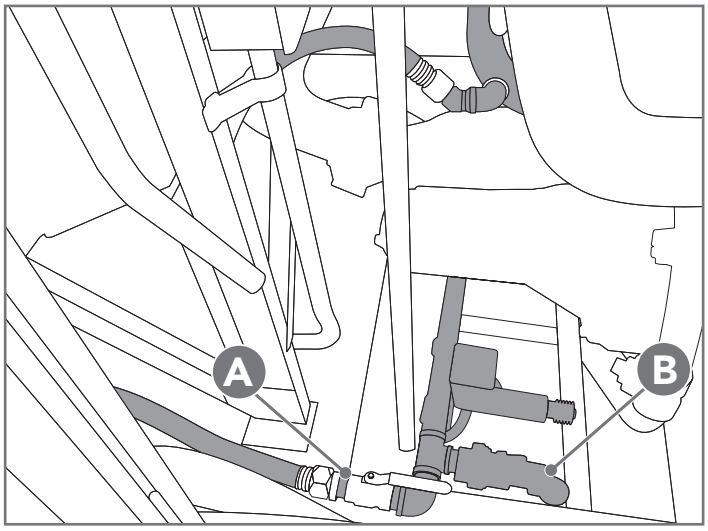


Figure 11. Coolant suction port installed at main locomotive engine drain. Note suction port **(A)** *has been installed at the same level as the drain* **(B)***, ensuring CLV pump will draw water from the cooling system's lowest point.*

3.1.1 COOLANT SUPPLY

When installing the Modular CLV 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. *See Fig. 11.*
- 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.

3.1.2 COOLANT RETURN

When installing the CLV 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.
- To minimize heat loss, avoid connecting the coolant return to any location that will allow warm coolant to bypass the engine or pass through radiators or heat exchangers.
- 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. *See Figure 15.*

Install coolant return line as follows:

1. Using appropriate fittings, install a 1 inch full-flow ball valve at the water discharge outlet before installing any T-fittings.
2. Place a 1/2 inch T-fitting after the shutoff valve to supply a 1/2 inch line for heating the locomotive's accessories. The line may be installed at either of the following locations:
   - the locomotive's compressor *(preferred)*
   - the locomotive's expansion tank *(if a compressor connection is not available)*
3. Install fittings at the compressor or expansion tank to accept 1/2 inch hose. *See Figure 12 and Figure 13.*

   NOTE: If the locomotive has wet cab heaters, install another 1 inch T-fitting after the shutoff valve to supply a 1/2 inch branch line to the cab heater drain valve line.
4. Use appropriate fittings after the shutoff valve and T-fittings to route a 1 inch inside diameter hose up to the ceiling inside the car body to allow trapped air to be purged from system.

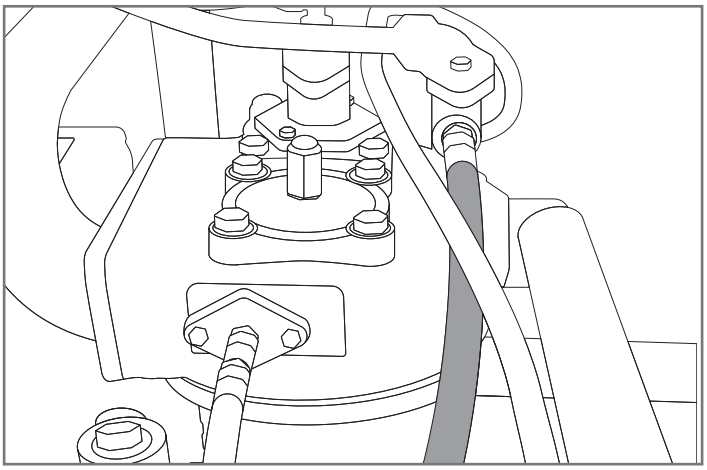


Figure 12. Coolant return hose (1/2 inch inner diameter) as installed on locomotive compressor. If a connection to the compressor cannot be made, utilize an alternative connection to the expansion tank.

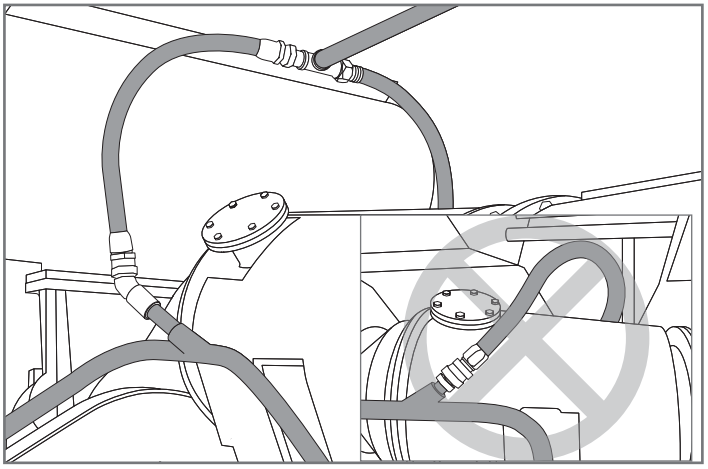


Figure 14. Typical coolant discharge ports installed on a turbocharged engine. The return line is split into two ports, installed at a welded 45° fitting to ensure majority of heated coolant is transferred to engine. Note incorrectly oriented fitting (inset). This fitting must be angled in the opposite direction to allow proper flow.

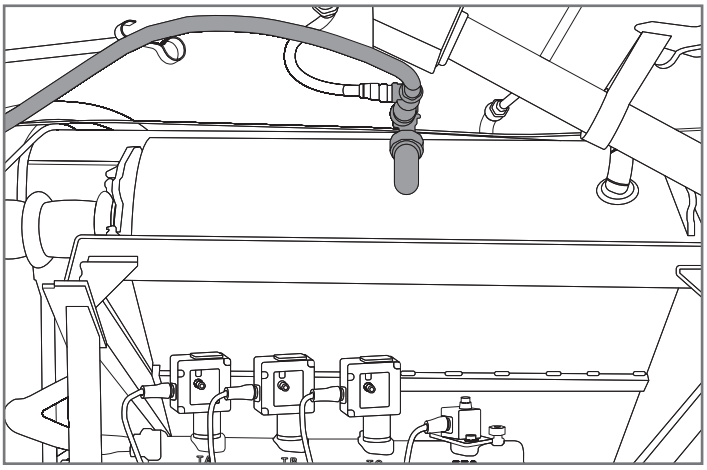


Figure 13. Coolant return hose (1/2 inch inner diameter) as installed at the locomotive's expansion tank.

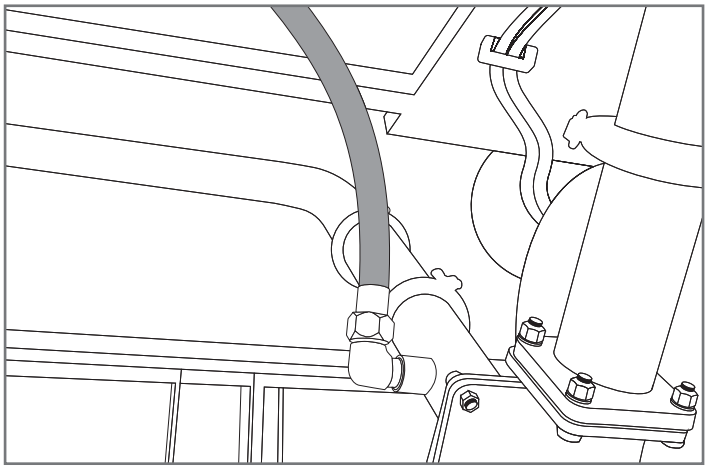


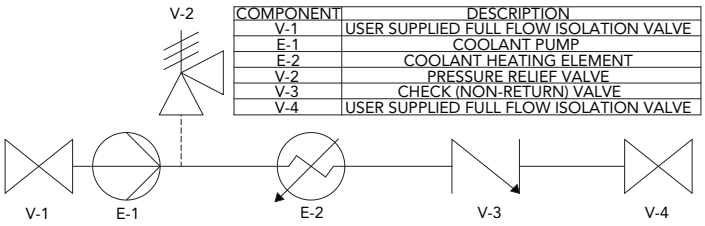
Figure 15. Coolant discharge port installed in non-turbocharged (supercharged) engine. Discharge port is located at radiator Y-pipe.

- If locomotive engine is turbocharged, the coolant return line may be split and routed to two return ports. Size both return lines per the outlet of the heating system. The water discharge flow must be directed to the upper after-cooler tubes on both sides. Fittings must be welded to the tubes at 45° angles to force most coolant toward the locomotive engine and allow some coolant to flow to the turbochargers. *See Figure 14.*

- If engine is supercharged, install a single return port at the radiator Y-pipe. *See Figure 15.*

3.1.3 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 coolant system.

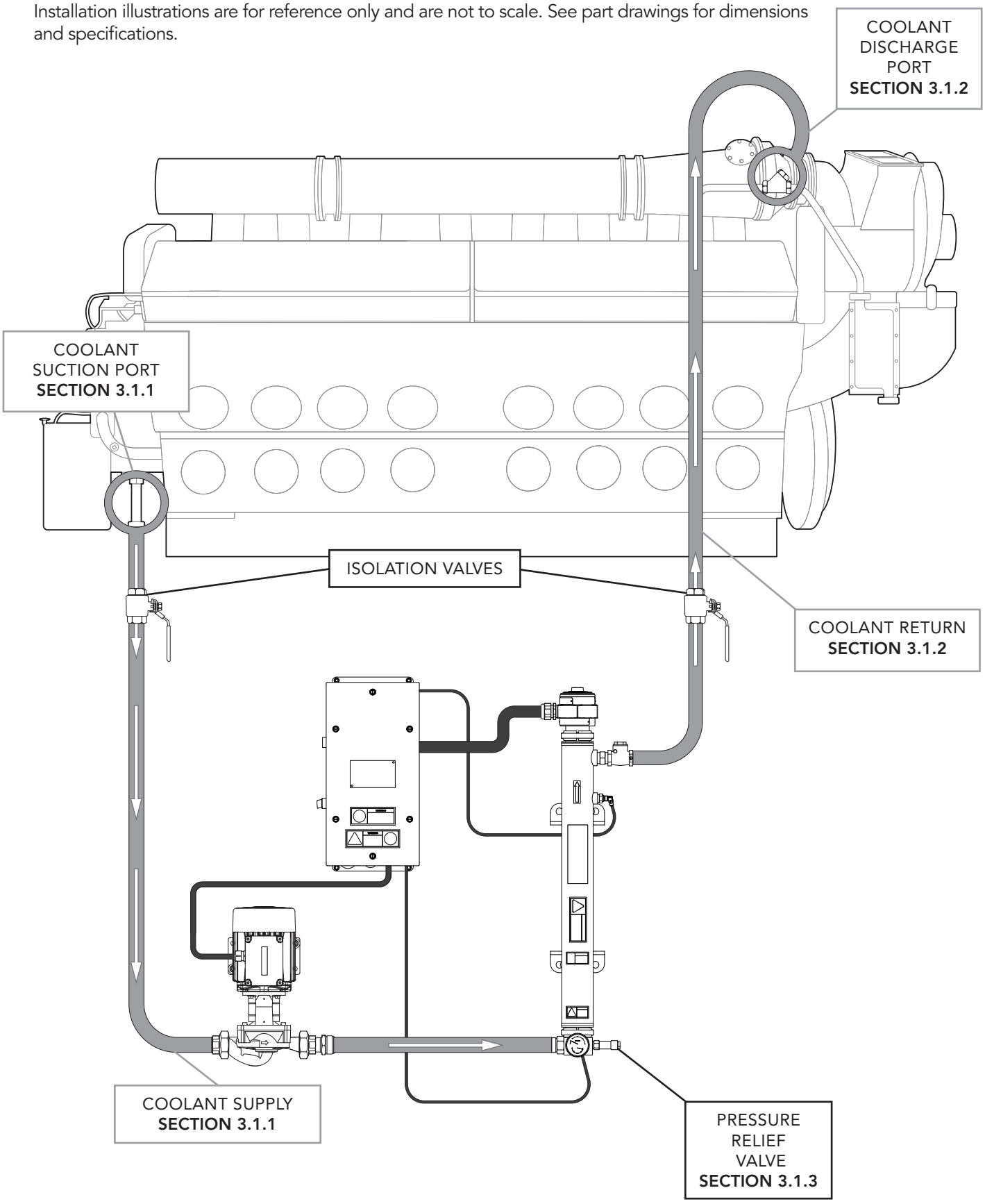


COMPONENT	DESCRIPTION
V-1	USER SUPPLIED FULL FLOW ISOLATION VALVE
E-1	COOLANT PUMP
E-2	COOLANT HEATING ELEMENT
V-2	PRESSURE RELIEF VALVE
V-3	CHECK (NON-RETURN) VALVE
V-4	USER SUPPLIED FULL FLOW ISOLATION VALVE

Figure 16. CLV system operation. Component illustrations are for reference only and are not to scale. See part drawings for dimensions and specifications.

3.2 COOLANT PLUMBING ILLUSTRATION

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



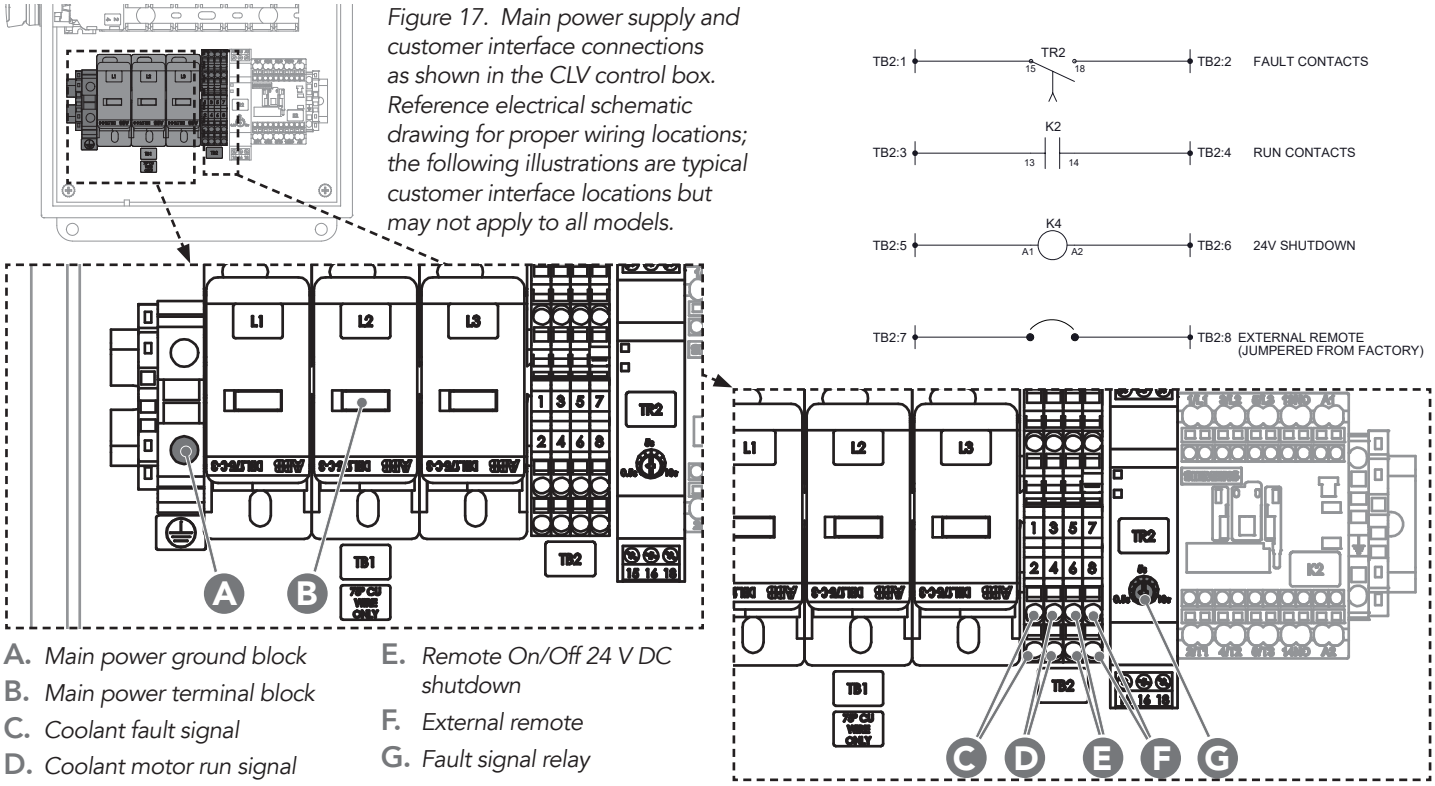


Figure 17. Main power supply and customer interface connections as shown in the CLV control box. Reference electrical schematic drawing for proper wiring locations; the following illustrations are typical customer interface locations but may not apply to all models.

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*
F. *External remote*
G. *Fault signal relay*

3.3 ELECTRICAL CONNECTIONS

⚠ WARNING

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

Electrical hazard: All wiring shall be done by qualified personnel in accordance with national, state and local codes. Each system shall be grounded in accordance with the National Electrical Code. Failure to properly ground the system may result in electrical shock.

3.3.1 MAIN POWER SUPPLY

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

   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 may be 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**. *See Figure 17.*

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

3.3.2 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 cause pump seal failure.

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 3.3.1***)*, energize the pump

while observing the rotation of the pump motor fan at the rear of the motor. Refer to rotation decal on motor for correct rotation.

➤ 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.

3.3.3 CUSTOMER INTERFACE CONNECTIONS

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

- **Coolant Fault Signal**
  TB2:1/TB2:2 (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 (*see* **SECTION 5.1.1**).
- **Coolant Motor Run Signal**
  TB2:3/TB2:4 (D)
  A motor run signal indicates the coolant pump motor is running. If no signal is present, the pump motor is not running.
- **Remote On/Off 24 V DC shutdown (E)**
  TB2:5/TB2:6
  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 **ON/OFF/PRIME** switch is turned to **ON**.

NOTE: The **24 V DC shutdown** connection is wired **NC (normally closed)** from the factory; applying 24 V DC will shut down the heating system. See system wiring schematic for directions to switch to NO (normally open) operation.

- **External Remote**
  TB2:7/TB2:8 (F)
  The external remote connections allow a remote switch or relay to control the heating system when the **ON/OFF/PRIME** switch is in the **ON** position. The system will run when there is continuity between TB2:7 and TB2:8, and will shut down when continuity is broken. These connections are jumpered from the factory, and the jumper must be removed to use this feature. This can be used together with the 24V DC remote feature, but neither will override the other. Refer to system nameplate for control voltage/amperage when selecting and wiring an external switch or relay.
- **Fault Signal Relay**
  TR2 (G)
  The **Fault Signal Relay** introduces a small time delay to prevent a false fault signal when the system is switched off or starting up. This is set for a minimum delay from the factory, but the delay may be increased to up to 10 seconds if desired.

4 SYSTEM COMPONENTS AND OPERATION

4.1 INTERFACE COMPONENTS

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

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

4.1.1 ON/OFF/PRIME SWITCH

- **ON** – The system is **on**. The pump will run continuously while the heating element cycles on and off to maintain the coolant temperature. The 24V DC shutdown and/or external remote may be used to activate or deactivate the system.
- **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 heating system without energizing the elements.

4.1.2 PRESSURE/TEMPERATURE GAUGE

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

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

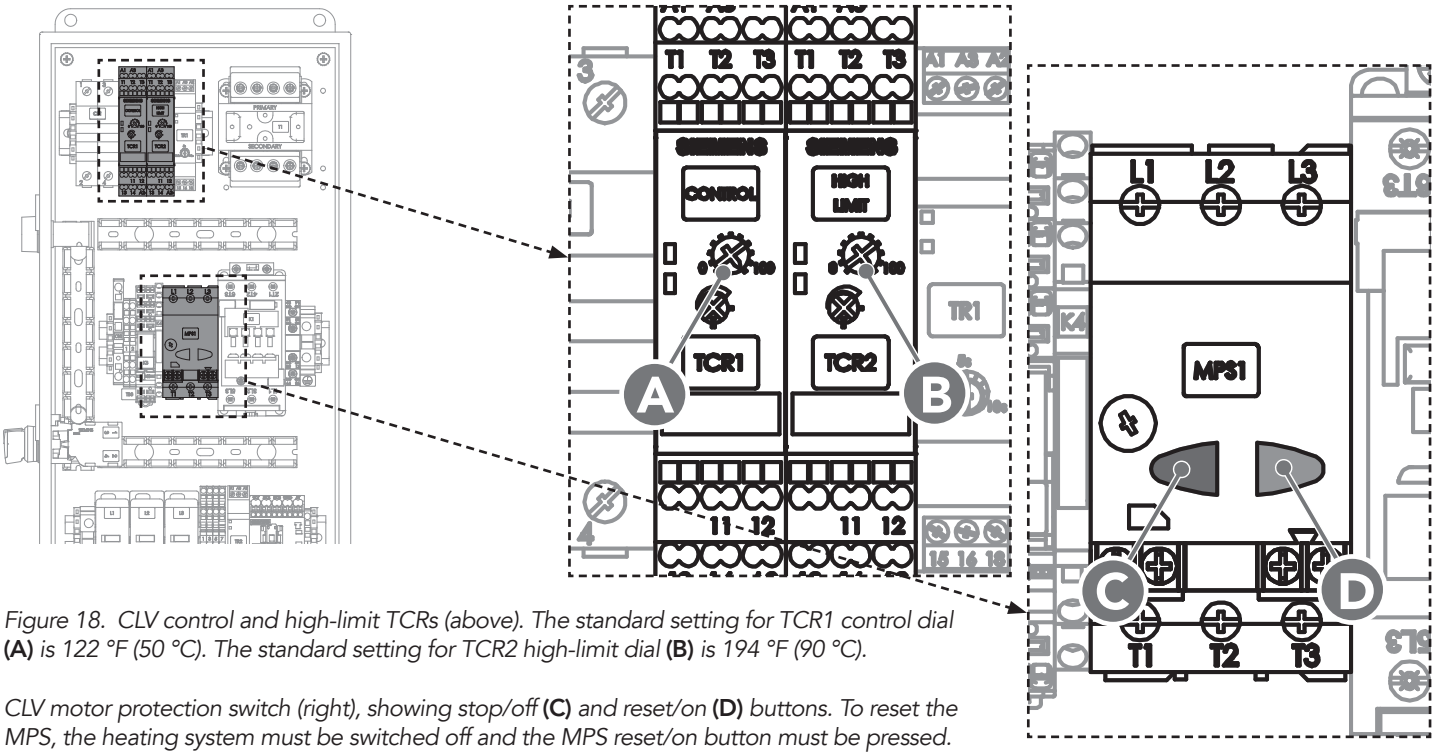


Figure 18. CLV control and high-limit TCRs (above). The standard setting for TCR1 control dial **(A)** *is 122 °F (50 °C). The standard setting for TCR2 high-limit dial* **(B)** *is 194 °F (90 °C).*

CLV motor protection switch (right), showing stop/off **(C)** *and reset/on* **(D)** *buttons. To reset the MPS, the heating system must be switched off and the MPS reset/on button must be pressed.*

4.1.3 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.

4.2 SYSTEM COMPONENTS

4.2.1 MOTOR PROTECTION SWITCH (MPS)

The motor protection switch (MPS) protects the pump motor from overloads. *See Figure 12.* 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 4.1.1**.

4.2.2 CONTROL TCR (TEMPERATURE CONTROL RELAY)

The control TCR (TCR1) is used to control 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 heating tank. The standard setting for the coolant control temperature relay (TCR1) is 122 °F (50 °C) at 10% hysteresis. *See Figure 18.*

The TCR will turn the heating element off at 122°F (50°C) and back on at 113°F (45°C) with these set points.

NOTICE! Decreasing the hysteresis below 10% may increase the cycle rate of the element contactor, shortening the contactor's expected life and potentially overheating the contactor.

4.2.3 HIGH-LIMIT TCR (TEMPERATURE CONTROL RELAY)

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

4.3 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 fluid will cause damage to the pump seal.

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

4.3.1 FIRST RUN PROCEDURE

1. Check and tighten all electrical and plumbing connections.
2. Ensure isolation valves are **open** before energizing the system.
3. Check the pump for proper rotation. **NOTICE!** Do not run the motor/pump assembly dry for more than a few seconds.
   - ➤ For three-phase heating systems, briefly turn and hold the **ON/OFF/PRIME** switch to **PRIME** while observing the rotation of the pump motor fan at the rear of the motor. If the pump motor is not rotating in the correct direction, switch any two electrical leads at the main power terminal block. *See* **SECTION 3.3.1.**
   - ➤ Single-phase systems are prewired to ensure the pump motors rotate in the correct direction.
4. Bleed all trapped air from the heating system and connecting plumbing by opening plugs or pipe fittings as needed. 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.

   NOTE: Remaining air may be evacuated from the pump using the air bleed screw on the pump housing. Unscrew the pump air bleed screw to vent trapped air. Tighten screw once coolant begins venting.
5. Turn the **ON/OFF/PRIME** switch to **ON** to energize the heating system.
6. Once operation is satisfactory, turn the control dial on the temperature control relay TCR1 to the desired temperature setting for engine coolant. TCR1 is set to a control temperature setting of 122 °F (50 °C) and TCR2 is set to a high-limit setting of 194 °F (90 °C) at the factory. *See* **SECTION 4.2.2** *and* **SECTION 4.2.3**.

5 MAINTENANCE, REPAIR AND TROUBLESHOOTING

5.1 SYSTEM FAULTS

5.1.1 COOLANT 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).

A failure in the pump motor that causes the motor protection switch (MPS1) to trip will shut down the heating system. A fault signal will be transmitted and the coolant 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 4.2.1.**)

If there is a failure that causes a high temperature to occur, the high-limit temperature controller (TCR2) will shut down the heating system, including the pump motor. A fault signal will be transmitted and the coolant 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. Restarting the system remotely will also reset a high-limit fault. (*See* **SECTION 4.2.3**.)

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

For additional troubleshooting, *see* **SECTION 5.4**.

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 4.3.1** 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 and thermal cycling may cause terminals to loosen. After initial first run, disconnect power and tighten electrical connections (*see* **SECTION 5.4**). 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.

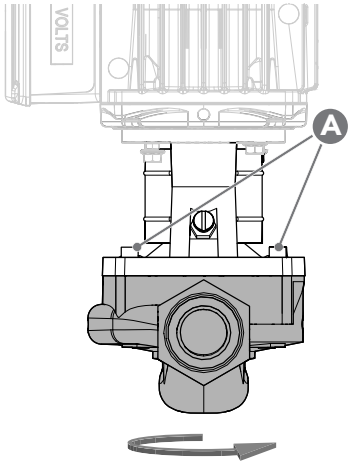


Figure 19. CLV pump, motor and pump volute, showing volute screws **(A)**. *Volute will need to be rotated 90 degrees as shown prior to installation on the CLV heating system.*

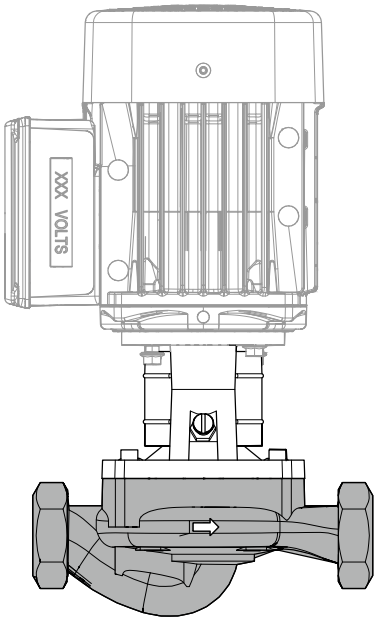


Figure 20. CLV pump, motor and pump volute, rotated in correct installation orientation. Note that pump and motor appearance may vary depending on CLV model. Orienation of motor terminal box and pump inlet/outlet are critical.

5.2.4 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.

5.2.5 COOLANT PUMP SEAL

Coolant 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. To ensure pump seal longevity, ensure the supply lines do not restrict flow excessively (*see* **SECTION 3.1.1** *and* **SECTION 3.1.2**) and run the heating system for 20 minutes monthly during offseason periods (*see* **SECTION 5.5**.)

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

5.2.6 COOLANT PUMP REPLACEMENT

Before installing a replacement pump, the replacement pump component will require volute adjustment for proper fit.

1. Unscrew four volute screws *See Figure 19.* Remove volute.
2. Rotate volute 90 degrees as shown.
3. Reattach volute and secure using volute screws.
4. Tighten volute screws.

5.2.7 MOTOR LUBRICATION

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

NOTE: New motors installed on heating systems placed in extended storage for a year or longer may require relubrication. *See* **SECTION 5.3**.

5.2.8 PRESSURE/TEMPERATURE GAUGE

The pressure/temperature gauge will indicate a pressure increase when the pump motor is engaged by turning and holding the **ON/OFF/PRIME** switch to **PRIME** or during normal heater operation. The gauge will also indicate the current temperature of the fluid. No maintenance for this part is required.

5.2.9 VOLATILE CORROSION INHIBITOR (VCI)

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

NOTE: Heating systems placed in extended storage will require that the VCI is replaced at six month intervals. *See* **SECTION 5.3**.

5.2.10 TEMPERATURE CONTROL RELAY (TCR)

⚠ WARNING

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

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

- Ohmmeter

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

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

3. Using the ohmmeter, measure the resistance between TCR terminals **T1** and **T2.** *(See Figure 21.)*
   - ➤ 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 3 and Figure 23, Figure 24.* on following page.

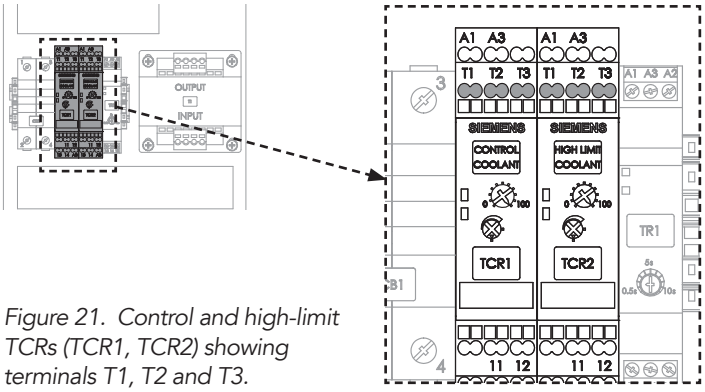


Figure 21. Control and high-limit TCRs (TCR1, TCR2) showing terminals T1, T2 and T3.

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

Table 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 Figure 22.* Note the resistance. Touch the probes to RTD **pin 1** and **pin 4** to check for continuity:
   - ➤ If the resistance between RTD **pin 1** and **pin 3** is **between 80 and 120 ohms** and there **is continuity** between RTD **pin 1** and **pin 4**, the RTD is functioning properly. Replace the RTD cable.
   - ➤ If the resistance between RTD **pin 1** and **pin 3** is **not between 80 and 120 ohms** or there is **no continuity between pin 1** and **pin 4**, the RTD is malfunctioning. Replace the RTD. *See* **SECTION 5.2.11.**

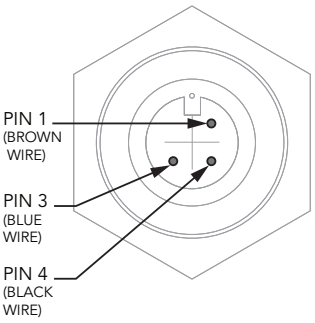


Figure 22. RTD pins 1, 3 and 4. The resistance between pin 1 and pin 3 should measure between 80 and 120 ohms. There should be continuity between pin 1 and pin 4.

5.2.11 RESISTANCE TEMPERATURE DEVICE (RTD)

⚠ WARNING

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

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

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

1. De-energize the heating system. Allow fluid to cool.
2. Close isolation valves. Drain fluid from the heating tank. Locate the RTD that requires replacement. *See Figure 23.*
3. Unscrew RTD plug. Remove plug. *See Figure 23.*
4. Unscrew RTD from tank. *See Figure 24.*
5. Screw replacement RTD into tank. When tightening, ensure plug is aligned with notch toward top of tank. *See Figure 25.*
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 check heating system for proper operation. *Refer to* **SECTION 4.3.1** *for system start-up procedures.*

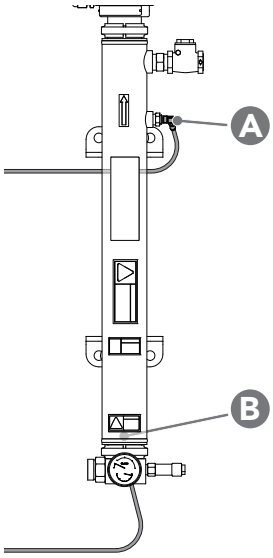
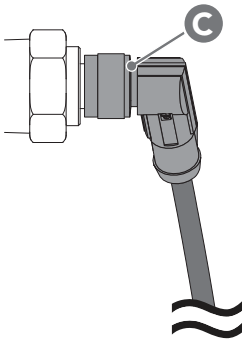


Figure 23. Modular CLV high-limit RTD **(A)**, *control RTD behind tank assembly* **(B)** *and RTD plug detail* **(C)**.



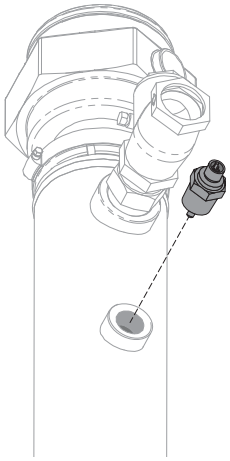


Figure 24. High-limit RTD plug shown removed from CLV heating tank.

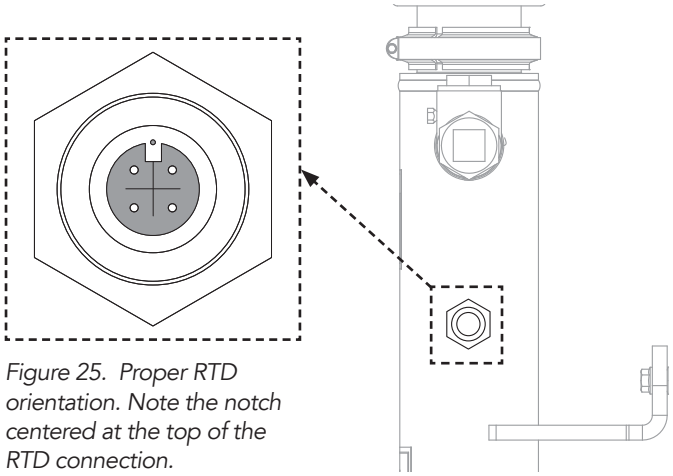
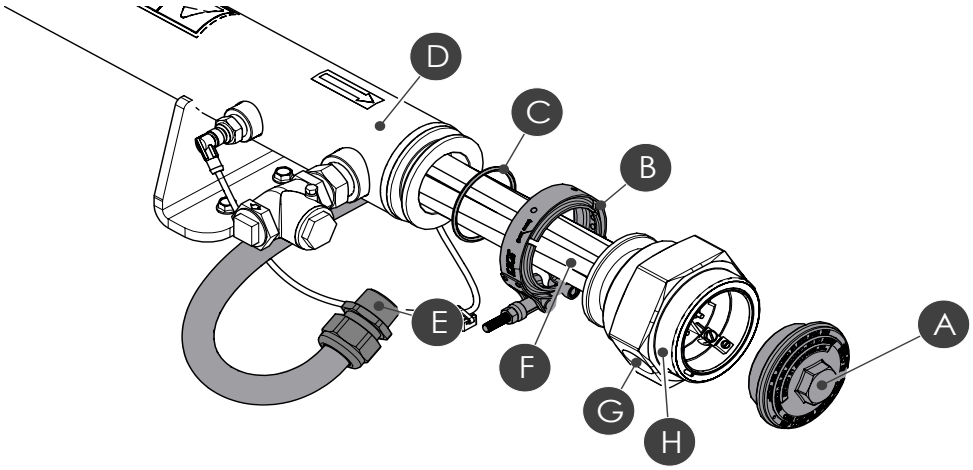


Figure 25. Proper RTD orientation. Note the notch centered at the top of the RTD connection.

Figure 26. Removing and replacing the heating tank element. The heating system should be drained, cleaned and flushed annually. See **SECTION 5.4**.

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



5.2.12 HEATING TANK/ELEMENT

⚠ WARNING

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

At least once per year, clean the interior of the heating tank and the heating element with a wire brush and/or damp cloth. Periodically check for 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 26.* The wattage and phase of the heating element are listed on the identification plate on the outside of the element **(H)**. 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 **(D)**.
4. Remove the cap **(A)** from the heating element service entrance enclosure.
5. The wire connections inside the enclosure correspond to one of the jumper configurations shown. Note your unit's jumper configuration. *See Figure 27.*

   NOTE: Replacement elements may be a different jumper configuration.
6. Disconnect the ground (green/yellow) and power electrical wires from the posts inside the assembly.
7. Unscrew cable gland **(E)** from conduit connector entrance **(G)**. Remove electrical cable and wires from the heating element.
8. Loosen V-clamp nut to remove V-clamp **(B)** Detach the heating element assembly from tank.
9. Replace the heating element **(F)** or perform the necessary cleaning procedure. Ensure the O-ring **(C)** is intact and in place before securing V-clamp.

5.2.13 REASSEMBLY OF HEATING ELEMENT AND TANK

Tighten the following components:

- V-clamp nut **(B)** to 180 lbf-in (20 Nm)
- Element terminal nuts to 14 lbf-in (1.6 Nm)

NOTE: System heating wattage may be changed by installing a different 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.

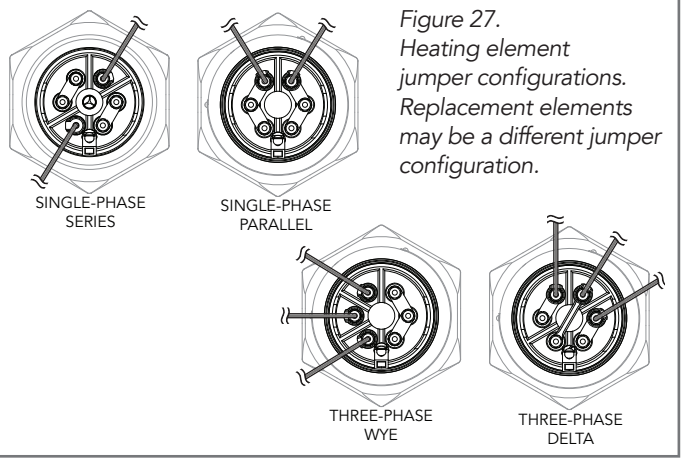


Figure 27. Heating element jumper configurations. Replacement elements may be a different jumper configuration.

5.2.14 RECOMMENDED MAINTENANCE

See part drawings for replacement parts.

INTERVAL	MAINTENANCE TASK
At initial start-up	Tighten electrical connections. *See* **SECTION 5.2.2**.
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**.

5.3 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.

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.

5.4 TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSES	SOLUTION
Heating system fault	Pump not primed properly	Bleed all trapped air from lines. Restart system.
	Isolation valves may be closed	Open valves. Restart system.
	Hose kinked or crushed	Remove obstruction. Restart system.
	Leak in suction line	Repair leak. Restart system.
	Pump motor turning backwards	Reverse any two leads on power (in three-phase system). Restart system. *See* **SECTION 4.3**. For single-phase systems, contact Hotstart.
	Control TCR failure: closed	Check and replace if necessary. *See* **SECTION 5.2.10**.
	Motor failure	Check and replace if necessary. Restart system.
	Motor contactor failure	Check contacts and replace if needed. Restart system.
	Motor protection switch tripped	Check and reset switch. If problem occurs again, check motor. Restart system.
	RTD failure	Check TCR and RTD. See **SECTION 5.2.10**.
	RTD cable failure	Check TCR and RTD. See **SECTION 5.2.10**.
Coolant temperature too low	Motor failure	Check motor. Replace if necessary.
	Heating element failed	Check elements for continuity. Replace element if necessary.
	Element breaker tripped	Check for element short to ground. If no short, reset breaker.
	Element contactor failed	Check contacts and coil. Replace if necessary.
	Motor contactor failed	Check contacts and coil. Replace if necessary.
	Control TCR failure: open	Check and replace if necessary. *See* **SECTION 5.2.10**.
	Control TCR set point too low	Adjust set point for control TCR. *See* **SECTION 4.1.2.**
	RTD failure	Check TCR and RTD. See **SECTION 5.2.10**
	RTD cable failure	Check TCR and RTD. See **SECTION 5.2.10**.

5.5 REPLACEMENT PARTS LIST

5.5.1 ALL MODELS

DESCRIPTION	PART NUMBER
Pump, Coolant Circulating	PRP228083-000
Pump, Coolant Circulating: Seal Kit	PRP203256-000
Relay, Temperature Control	PRP224146-000
Resistance Temperature Device (RTD)	PRP224308-001

5.5.2 CLV MODEL: CLV32404-M00

DESCRIPTION	PART NUMBER
Element	E24043E-C0NV-00
Motor, Coolant Pump	PRP236272-000
Switch, Motor Protection	PRA232071-002

6 APPENDIX

The following section contains additional product documentation intended for installation and operation. See part drawings for dimensions and specifications. Documentation includes:

6.1 INSTALLATION KITS

The following kits are available for CLV installation:

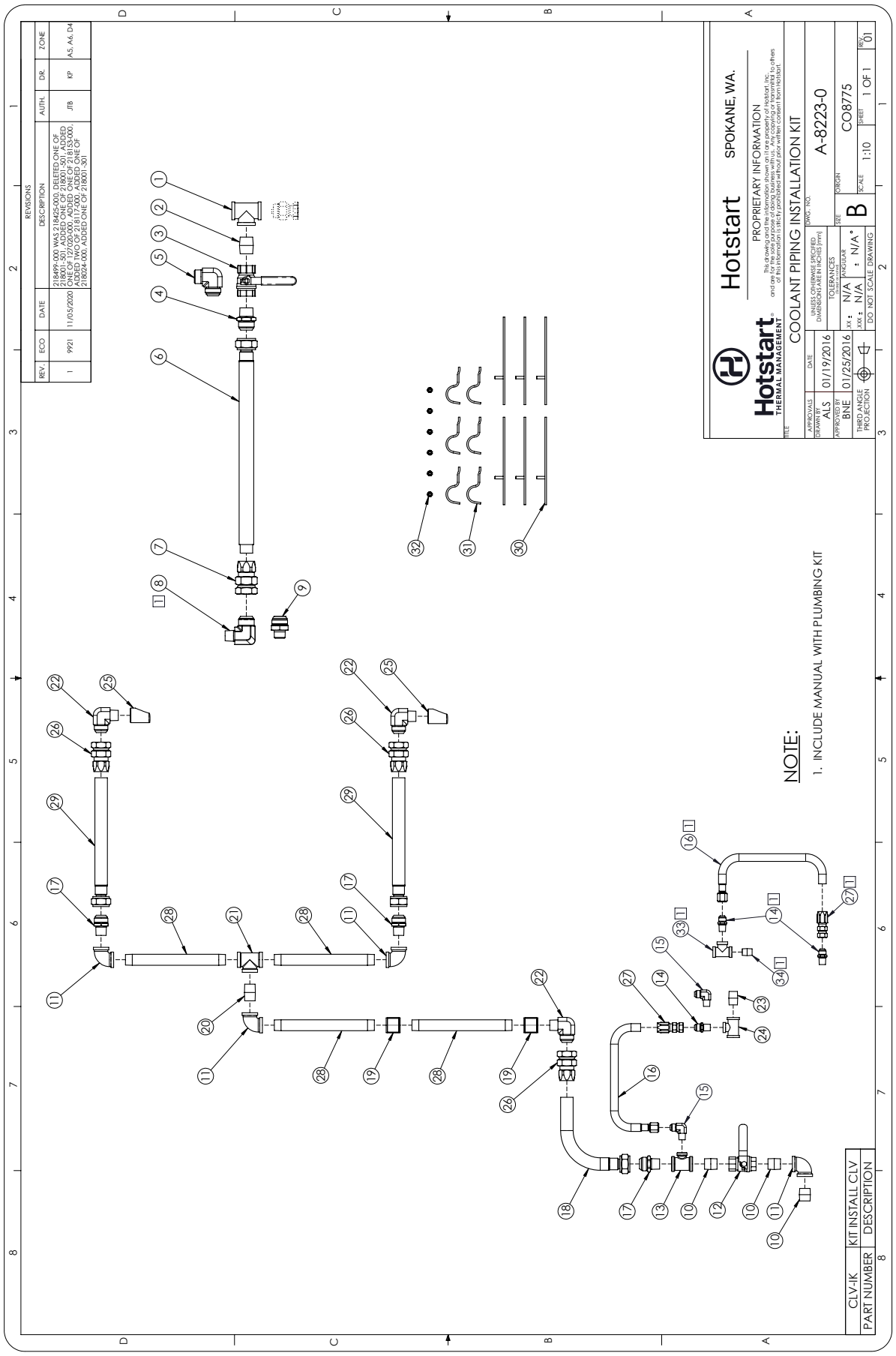
6.1.1 CLV Installation Kit (Optional)

This optional kit includes suitable hoses and fittings for most typical CLV coolant plumbing installations. Contact Hotstart with questions concerning special installations. *See page 23.*

6.1.2 CLV Installation Kit Parts List

This list contains all parts for the optional CLV installation kit. *See page 24.*

6.1.1 COOLANT INSTALL KIT (OPTIONAL)CLV INSTALLATION KIT PARTS LIST



6.1.2 CLV INSTALLATION KIT PARTS LIST

REPLACEMENT PARTS			
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	218020-000	TEE, 1.25 BLACK	1
2	218001-601	NIPPLE, 1.25 X CLOSE BLACK	1
3	203011-001	VALVE, BALL 1.25 NPT NIBCO #NIT5857	1
4	218115-000	ADAPTER, ST 1.25MPT X #24 MJIC	1
5	218115-001	ADAPTER, 90 1.25MPT X #24 MJIC	1
6	127019-002	HOSE, #24 FJIC X 228 OAL	1
7	218150-000	#24 HOSE X #24 FJIC SWIVEL PARKER	1
8	218499-000	ELBOW 90DEG 24JIC MALE X 1.0NPT MALE	1
9	218115-003	ADAPTER, ST 1.0MPT X #24 MJIC PLATED	1
10	218001-502	NIPPLE 1.0 NPT CLOSE SCHED 40 STAINLESS WELDED	3
11	218031-002	ELBOW 1FNPT 90 DEGREE BLACK IRON	4
12	203011-000	VALVE, BALL 1NPT	1
13	218022-000	TEE, 1 X 1 X .50 BLK	1
14	218117-000	ADAPTER ST .5MPT X 10MJIC PARKER #	3
15	218117-003	ADAPTER 90 .5MPT X 10MJIC 90	2
16	127020-000	HOSE, #10 FJIC X 144 OAL	2
17	218117-001	ADAPTER ST 1MPT X 20MJIC	3
18	127018-006	HOSE, #20 FJIC X 360 OAL	1
19	218042-000	COUPLING, 1 STEEL (BLK) KELLER HAS	2
20	218001-504	NIPPLE, 1.0 X 2.0 BLACK	1
21	218023-000	TEE, 1.0 BLACK	1
22	218117-002	ADAPTER 90 1MPT X 20MJIC	3
23	218001-401	NIPPLE, .75 X CLOSE BLACK	1
24	218027-000	TEE, .75 X .75 X .50 BLK	1
25	218042-001	COUPLING,1 STEEL COPED 45DEG TO FIT	2
26	218152-000	#20 HOSE #20 FJIC SWIVEL PARKER 206	3
27	218153-000	#10 HOSE #10 FJIC SWIVEL PARKER 206	2
28	218003-600	NIPPLE, 1 X 12 BLK	4
29	127018-007	HOSE, #20 FJIC X 36 OAL	2
30	215175-000	APU BASE HOSE CLAMP	6
31	215175-002	APU CLAMP #24 HOSE	6
32	220011-906	NUT 5/16-18 ZN KEP	6
33	218024-000	TEE, .50 BLACK	1
34	218001-301	NIPPLE, .50 X CLOSE BLK	1
-	216061-056	INSTRUCTIONS, HOSE ASM. COR, DDHS,	1
-	216307-000	OPERATION MANUAL - CLV - ENGLISH	1