A coolant circulating within a sealed system cools the engine. See Figure 1. The cooling system components include a radiator and fan combination with a water pump, a thermostat, an oil cooler, a coolant filter and a surge tank. A fan driven by a hydraulic motor draws air through the radiator, thus lowering the coolant temperature.

Section 09: **Hydraulic System** provides servicing information about some of the cooling system components located outside the engine.

The surge tank pressure-regulating valve keeps the cooling system under pressure. A thermostat, located at the front of the engine, controls the coolant temperature within the engine. The cooling system is filled or replenished through the surge tank filler hole. See Figures 2 and 3.

Hot water for the passenger compartment heating is provided by the engine cooling system and is supplemented by an auxiliary heater. See section 14: **Heating and Ventilation** for more details.

A buzzer sounds and a warning light, located on the instrument panel, lights up to warn the driver whenever the engine starts overheating.

A coolant filter, located on the right side of the engine, (when viewed from the rear of the bus) prevents corrosion and the built-up of debris within the cooling system.
Figure 3 - Typical Cooling System Plumbing
CIRCULATION

A centrifugal-type water pump circulates coolant within the engine. A full blocking thermostat is used in the water outlet passage to control the flow of coolant, providing fast engine warm-up and regulating coolant temperature. Coolant circulation during warm-up differs from circulation after the engine has reached normal operating temperature, as explained in the following paragraphs. See Figures 1 and 3.

ENGINE PRE-HEATING

During pre-heating, the water pump pushes the coolant through the engine block. The coolant first enters the thermostat housing and then circulates through the cylinder head and the engine block. As long as the engine is cold, the thermostat remains closed, thus preventing the coolant from going through the radiator; instead, the coolant is sent back directly to the water pump, through bypass openings in the thermostat box.

AFTER PRE-HEATING

When the coolant reaches 180°F (82°C), which is the engine thermostat opening temperature, it begins circulating through the radiator. See Figure 1. The engine temperature is then high enough to actuate the fan control valve and start the fan. The coolant keeps flowing through the air compressor, the transmission oil cooler, the heater lines and the surge tank. It flows to its maximum when it reaches 200°F (93°C), temperature when the thermostat is completely open.

DRAINING THE COOLING SYSTEM

CAUTION:

Wait until the temperature is below 120°F (50°C) before removing the coolant system pressure cap. Failure to do so can cause personal injury from heated coolant spray.

CAUTION:

Avoid prolonged and repeated skin contact with used antifreeze. Such contact can cause skin disorders or other injury.

WARNING:

Handling and disposal of used antifreeze can be subject to federal and local regulations. Use authorized waste disposal facilities. If in doubt, contact your local authorities for guidance as to the proper handling of used antifreeze.
3. Remove the water inlet hose at the transmission oil cooler. See Figure 4c.

FILLING THE COOLING SYSTEM

See section 14: HEATING AND VENTILATION for instructions covering draining of the heater lines.

FILLING THE COOLING SYSTEM

See Figure 5.

NOTE:
See the INSPECTIONS heading in this section for the coolant level checking procedure.

NOTE:
See the Cummins Owner’s Manual for additional coolant information and recommendations.

CAUTION:
Before topping up or filling the system, it is very important that the following conditions are met to ensure environmental safety and proper system operation.

1. The engine must be shut down and cold.
2. The heating system drain valves (floor radiator valves and main drain valve, located at the front of the bus, must be closed. The valves of the defroster return/supply lines (optional) must be open. See section 14: HEATING AND VENTILATION for the location of these components.
3. The valves located under the oil cooler of the transmission retarder, and the recirculating pump valve, must be closed. (optional)
4. The DRIVER’S TEMPERATURE CONTROL lever, on the front ventilation control panel, must be placed to the extreme right (cable control)
or
The central knob must be completely turned clockwise (electronic control).

NOTE:
See the manufacturer’s manuals for the specific HVAC unit installed in the vehicle for additional information.

5. a) Vehicles with an MCC HVAC roof unit:
   • The exterior temperature sensor, located in front of the electronic control panel of the roof unit (hinge side), must be disconnected.
   • The PASSENGER’S AUTOMATIC CLIMATE CONTROL switch on the overhead control panel must be set to the On position.

b) Vehicles with a Carrier HVAC roof unit:
   • The PASSENGER’S CLIMATE CONTROL switch on the overhead control panel must be set to the Heat position.
   • If the overhead control panel is equipped with a PASSENGER’S AUTOMATIC CLIMATE CONTROL switch, it must be set to the Auto position.

c) Vehicles with a Thermo-King HVAC roof unit:
Controls are automatically managed by the sensors; therefore no additional step is necessary.

Figure 5 - Typical Configuration of the Filling System
TOPPING UP THE COOLANT LEVEL

See Figure 5.

**WARNING:**
If the engine has overheated, wait until the coolant has stopped boiling and until the engine has cooled down before adding cold water. Check the coolant temperature on the coolant temperature gauge. The gauge is located on the driver’s side of the bus and can by accessed by the main side engine compartment door.

Then, with the engine running, slowly add water according to the following procedure:

1. Make sure the check points indicated at the beginning of the FILLING THE COOLING SYSTEM heading of this section have been checked.
2. Connect the coolant filling hose to the quick connect fitting (1), located in the engine compartment, at the rear of the bus.
3. Start the filling unit pump and press the discharge valve knob (2), located under the quick connect fitting, to empty the air from the surge tank.

**CAUTION:**
To avoid pressure build-up in the tank, it is very important to keep the discharge valve knob pressed during the entire filling operation.

4. Fill the system until the low level indicator on the engine control box (3) goes off. If needed, check the inspection glass on the surge tank to ensure an adequate fluid level is reached.
5. Start the engine to make the cooling fluid circulate within the system. Meanwhile, press the air discharge valve knob so that the cooling circuit keeps filling.
6. Stop filling when the low level indicator goes off again. Stop the filling unit pump and disconnect the filling hose.
7. If the coolant level is very low, open a roof unit air-bleed valve (right or left), not all units are so equipped, to remove air from the system. See Figure 6. When all air is removed, close the valve.

FILLING AN EMPTY SYSTEM

See Figure 5.

1. Make sure the check points indicated at the beginning of the FILLING THE COOLING SYSTEM heading of this section have been checked.
2. Remove the cap on the side of the surge tank (see Figure 2) and add a non-chromate rust inhibitor. See the Cummins Owner’s Manual for additional information. Replace the cap.
3. Connect the coolant filling hose to the quick connect fitting (1). It is located in the engine compartment, at the rear of the bus.
4. Purge the heating system. See section 14: HEATING AND VENTILATION for instructions on how to drain the heating system when filling an empty system.
5. Start the filling unit pump and press the discharge valve knob (2), located under the quick connect fitting, to empty the air from the surge tank.

**CAUTION:**
To avoid pressure build-up in the tank, it is very important to keep the discharge valve knob pressed during the entire filling operation.

6. Fill the system until the low level indicator on the engine control box (3) goes off. If needed, check the inspection glass on the surge tank to ensure an adequate fluid level is reached.
7. Start the engine to make the cooling fluid circulate within the system. Meanwhile, press the air discharge valve knob so that the cooling circuit keeps filling.
8. Stop filling when the low level indicator goes off again. Stop the filling unit pump and disconnect the filling hose.
9. Open a roof unit air-bleed valve (right or left), not all units are so equipped, to remove air from the system. See Figure 6. When all air is removed, close the valve.

INSPECTIONS

**NOTE:**
See the Cummins Operation and Maintenance Manual for the complete inspection procedure.
COOLANT LEVEL

Use the inspection glass on the surge tank. If the coolant is visible through the glass, the system does not need replenishment. If it is not visible, the circuit needs to be filled. A low coolant indicator on the engine control box also lights up when the coolant level is low.

When the coolant level is low, water needs to be added. See the Topping up the Coolant Level heading in this section for the procedures on how to add water to the system.

COOLING SYSTEM COMPONENTS

The cooling system elements should be inspected periodically to determine if maintenance is required. Checking those elements systematically and on a regular basis will indicate if maintenance or replacement is required before a failure occurs.

NOTE: See the Troubleshooting Guide at the end of this section for information on possible system failures.

1. Check the hose fittings and tighten their clamps as needed. All hoses showing cracks, bubbles or other signs of damage must be replaced.
2. Examine the thin-walled tubes of the radiator and heater cores to detect leaks and check if dirt accumulation prevents air circulation. Clean cores with a low pressure air jet.

WARNING: Failure to repair any leaking component of the cooling system, such as a pump, a valve, the motor or a tube, could result in a fire.

3. Check the clearance between fan blades and the radiator core and between blade tips and the radiator shroud. Make adjustments if needed. See Figure 7.
4. Inspect the radiator supports and tighten the fastening bolts if necessary. Look for worn or damaged isolating blocks, and for loose or missing bolts. See Figure 7.
5. Inspect the shroud joints around the radiator. The sealing joints must be in good condition.
6. Check the fan hydraulic motor operation. It must turn at reduced rpm while the bus engine is cold; the fan full speed should be reached only when the bus engine has reached its normal operating temperature. See Figure 7.

Figure 7 - Typical Radiator Components
*NOTE:* See section 09: Hydraulic System for the cooling system operational temperature diagram.

7. Inspect the coolant filter and replace it if necessary, as indicated in the Cummins Operation and Maintenance Manual.

**MAINTENANCE**

*NOTE:*

For the welding of cooling system piping, all in-house and industrial welding norms and standards must be respected. The components must be properly prepared. Cut end of the tubes must be flush and squared and surfaces cleaned and roughed to encourage adhesion. Equipment required, beside the buffing pad, are the acetylene blowtorch, flux, and alloy soldering rod 97-3 (heating temperature 445°F, [230°C]). Clean and buff the seal after the joint has cooled.

*NOTE:*

For information on components related to the cooling system that are not mentioned in this section, see the Cummins Operation and Maintenance Manual or the Service Manual.

**Radiator**

The radiator is located on the left hand side, at the rear of the bus and is covered by a vent grille. It is mounted on flexible supports and is divided in three parts: the upper part (charge air cooler), the middle part (oil cooler) and the lower part (coolant).

A damaged or fouled-up radiator must be cleaned or repaired by a specialist, or replaced by a new one. Special tools and equipment are required for the mandatory tests and are essential for the efficient repair of the radiator.

If the radiator core must be painted, spray with a paint specially made for radiators. Do not use a paint mixed with oil because such a product will act as an insulating barrier and will prevent efficient heat dissipation.

*WARNING:*

Before starting any work on the radiator, make sure the vehicle is completely stationary. Isolate the engine starting circuit from the control box located at the rear of the vehicle.

Cleanliness is vital when working on the radiator.

**REMOVAL**

1. Open the engine access panel.
2. Open and remove the radiator vent grille.
3. Open the radiator coolant drain plug.
4. Remove the compressor’s air input line. Dismantle the linkage. Remove the pipe.

*NOTE:*

The air intake restriction indicator should be removed to prevent damage when the air piping is removed.

5. Disconnect and remove the engine’s air intake pipe.
6. Disconnect the air hose at the radiator intake. Make sure it is unobstructed for removal of the radiator.
7. Remove the engine de-aeration pipe.
8. Unscrew the two fan-mount securing screws at the base of the radiator.
9. Unscrew the four bolts at the base of the radiator.

*WARNING:*

Put a retaining clip around the radiator to support it during its displacement.

10. Unscrew the radiator’s two upper retaining bolts. Do not unscrew the fan support’s retaining bolts.
11. Remove the radiator.

**INSTALLATION**

1. Repeat steps 4 to 10 of the Removal subsection in the reverse order to install the radiator.
2. Install and close the radiator vent grille.

*CAUTION:*

Make sure to plug all piping to prevent dust or dirt from getting in.

*NOTE:*

The power steering oil is the same as that used for hydraulic system operation.
SURGE TANK

The surge tank, mounted above the radiator, is equipped with a pressure-regulating valve. This valve has two regulated openings: one relieves excess pressure and one lets outside air come in to compensate for the coolant retraction when the engine stops running and cools down. An overflow tube is connected to the pressure-regulating valve.

INSPECTION GLASS

The surge tank has a built-in inspection glass that allows direct checking of the coolant level. This see-through glass is threaded and is screwed in a threaded hole in the surge tank. This assembly is sealed by an o-ring. To remove the glass, unscrew it by turning counterclockwise.

COOLANT LOW LEVEL INDICATOR

This sensor is a maintenance-free solid state device. When the coolant level is low, the sensor sends a signal to the low level indicator light on the engine panel, which lights up. The sensor is designed to resist the normal contamination of the cooling system. It does not need any adjustment nor maintenance.

Low coolant level does not automatically mean there is a leak in the system. However, it is very important to check the cooling system for leaks as soon as possible, and to make the necessary repairs if necessary.

COOLANT FILTER

The spin-on coolant filter is used to filter and purify water used in the cooling system. The filtering element must be replaced every 15,000 mi (24,000 km).

For the complete replacement and maintenance procedures, see the Cummins Troubleshooting and Repair Manual.

THERMOSTAT

For the complete replacement and maintenance procedures, see the Cummins Operation and Maintenance Manual.

CHARGE AIR COOLER (CAC)

See Figure 8.

The function of the CAC is to cool the engine by making air circulate through the coils of the cooler (upper radiator).

At regular intervals, check the CAC for leaks, improper mounting, and loose fasteners. Inspect the hoses, clamps, and plumbing for damage or leaks.

CAUTION:
The CAC and the CAC plumbing are under pressure, and are more prone to leakage than any unpressurized system.

PLUMBING REPLACEMENT

NOTE:
For the replacement of the plumbing, the power plant should be removed from the rear compartment of the bus. See section 09: Engine and Accessories of this manual for the complete removal procedure.

REMOVAL
1. Loosen all Breeze clamps attaching tubing from the air charging cooler to the engine.
2. Remove the CAC tubes; replace if necessary.
3. Check the rubber tubes and replace if necessary.

INSTALLATION
1. Insert the CAC tubes in the rubber tubes.
2. Tie the Breeze clamps. See section 99: General Practices for the Breeze clamp installation method.

COOLANT COMPOSITION

NOTE:
This heading only provides general coolant information. For more specific information or recommendations, see the Cummins Owner’s Manual.

ANTIFREEZE

To protect the cooling system from freezing, use a permanent-type, ethylene glycol based antifreeze. Solutions with concentrations of less than 40% antifreeze do not provide sufficient protection against corrosion and freezing. Solutions containing over 60% antifreeze also provide less protection against freezing and may have a reduced efficiency as a heat transfer medium. The recommended mixing ratio for water and antifreeze according to Cummins is 50/50.

TESTING THE ANTIFREEZE SOLUTION

Always test the antifreeze solution before adding water or new antifreeze.
1. Warm up the engine at the normal operating temperature.
2. Fill up and flush out the tester several times to warm it up before use. Keep the tester clean. Some testers will not indicate the freezing point unless the check is done at a specific temperature. Other testers, equipped with thermometers and tables, indicate freezing point temperatures corresponding to readings taken at several temperatures. Neglecting to take into account the solution temperature may introduce an error of as much as 30 °F (18 °C). Make sure to read and apply the manufacturer’s instructions.
Figure 8 - Charge Air Cooler Plumbing
**RUST INHIBITORS**

A rust inhibitor is a water-soluble chemical compound that protects metallic surfaces of the cooling system against corrosion. Chromates, non-chromates (borates, nitrates, nitrites) and soluble oil are amongst the few more commonly used rust inhibiting agents.

**Non-chromate** inhibitors (borates, nitrates, nitrites, etc.) protect the cooling system against corrosion and may be used with water or with a solution of ethylene glycol and water.

**Chromate** inhibitors should not be used in ethylene glycol based antifreeze solutions. The so-called green mud, or chrome hydroxide, can result from the use of chromate inhibitors in permanent-type antifreeze.

**SUPPLEMENTAL COOLANT ADDITIVE (SCA)**

The cooling system of diesel engines must undergo a particular chemical treatment to increase its durability, or pitting could appear on the liners, and lead to the breakdown of the engine. See the Cummins manuals.

**COLD WEATHER OPERATION**

In a cold climate, antifreeze must be used in the cooling system in order to prevent damage due to freezing. Before adding the antifreeze mixture, the cooling system should be inspected and maintained as previously described. Also tighten the bolts on the cylinder head and, if necessary, replace the seal to avoid coolant leaks in the cooling system.

**THAWING THE COOLING SYSTEM**

If the cooling system has frozen, place the bus in a heated building until the frozen coolant has completely thawed.

**WARNING:**

Under any circumstances, the engine should never be started and run while the cooling system is frozen.

**TECHNICAL SPECIFICATIONS**

**COOLING SYSTEM**

Capacity............................................ 19.8 gal (75 liters)*  
* Quantities are an approximation and include the coolant in the heating system.

**THERMOSTATS-WATER CIRCULATION**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Cracking open at</th>
<th>Wide open at</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>180 °F (82 °C)</td>
<td>200 °F (93 °C)</td>
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**SURGE TANK PRESSURE-REGULATING VALVE**

Valve opens at.............. 15 to 17 psi (103 to 117 kPa)

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**TROUBLESHOOTING GUIDE**

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
<th>SOLUTION</th>
</tr>
</thead>
</table>
| Engine overheats | a. Cooling system has low coolant level.  
b. Loose or worn drive belts.  
c. Clogged cooling system.  
d. Faulty thermostat.  
e. Leaks in cooling system.  
f. Incorrect ignition timing.  
g. Inoperative water pump. | a. Replenish coolant. Add antifreeze solution as required.  
b. Adjust belt tension or replace belts.  
c. Clean cooling system.  
d. Remove and test thermostat. Replace if necessary.  
e. Inspect cooling system for leaks, paying particular attention to hose or radiator connections. Replace hose or leaking radiator.  
f. Check ignition timing, electrical troubleshooting procedure.  
g. Replace water pump. |
| Loss of coolant | a. Hose leaks.  
b. Drain plug leak.  
c. Radiator cap inoperative.  
d. Water pump or radiator core leaks.  
e. Leaking head gasket.  
f. Cracked cylinder head or block. | a. Tighten clamps or replace hose.  
b. Tighten or replace drain plug.  
c. Replace cap.  
d. Replace water pump or radiator.  
e. Overhaul engine.  
f. Overhaul engine. |
| Engine fails to reach normal operating temperature | a. Defective or incorrect thermostat installed in vehicle.  
b. Temperature sending unit defective.  
c. Temperature indicator defective. | a. Inspect and test thermostat. Replace if defective or incorrect heat range.  
b. Trouble shoot temperature indicator and sending unit.  
c. Trouble shoot temperature indicator and sending unit. |

*Table 1 - Troubleshooting Guide*