# 02 COOLING SYSTEM

## COOLING SYSTEM • INDEX

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General

• If work is performed by people who do not have the necessary training to carry out the work or if this information is handled carelessly or totally ignored, this may result in severe injury and/or death. In addition, serious damage to the vehicle may occur.

• Always read the safety instructions in full before starting certain operations. The safety instructions stipulate which aspects must be considered to achieve maximum safety. The information that is given is very important for health and safety.

• Always work in adequately ventilated rooms with sufficient lighting, free from dirt and clutter. Never leave tools or parts lying around, keep away from (high-) voltage sources that present a risk of short-circuiting. Always wear protective clothing. Do not wear any damaged or loose-fitting clothing and remove jewelery before starting the work. In case of long hair use a hairnet.
3. Structure And Operation

3.1. Cooling System

The engine is cooled by forced circulation of coolant by the water pump. The cooling installation is the assembly that, in conjunction with the engine, removes heat from the engine to the outside air. The cooling fan coupling controls the speed of fan depending upon engine coolant temperatures. There is a plate bimetal which senses the temperature of the air flowing through the radiator and causes the amount of the hydraulic fluid in the coupling to change.

3.2. Radiator

Corrugated fin type with pressure cap and water reservoir. The radiator, with a tube and corrugated-fin type core not only cools the engine coolant but also separates vapor from liquid water and regulates pressure in the cooling system. The radiator is a simple closed type. The coolant is stored in the reservoir tank maintaining the radiator full with coolant at all times. The radiator have positioned in such a way that it can be properly cooled by the air stream. It is also easily accessible for cleaning.

3.3. Water Pump

When the engine is started, coolant circulates with forced by the water pump. The water pump pumps the coolant through the cooling ducts of the engine block.

3.4. Thermostat

The thermostat opens when the engine reached its operating temperature 83 C. The coolant then flows through the radiator where it is cooled and then returns to the water pump.

2. Specifications

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum operating block coolant temperature</td>
<td>160ºF - 71ºC</td>
</tr>
<tr>
<td>Coolant Capacity</td>
<td>13.1 quarts - 12.2 L</td>
</tr>
<tr>
<td>Engine coolant circuit thermostat opening temperature</td>
<td>180ºF - 82ºC</td>
</tr>
<tr>
<td>Minimum fill rate (low level alarm required for most engines)</td>
<td>200ºF - 93ºC</td>
</tr>
<tr>
<td>Minimum coolant expansion space (% total system capacity)</td>
<td>3 gpm - 11 L/min</td>
</tr>
<tr>
<td>Minimum drawdown (% total system capacity): 5% minimum + 1% greater than amount not filled at initial fill)</td>
<td>6%</td>
</tr>
<tr>
<td>Maximum deaeration time</td>
<td>25 min</td>
</tr>
<tr>
<td>Minimum pressure cap rating at sea level</td>
<td>15 psi - 103 kPa</td>
</tr>
</tbody>
</table>
3.5. Cooling Circuit

3.6. Cooling System Flow Diagram
4. Service Procedure
4.1. Removal of the Reservoir Tank

1. Disconnect the pump connection hose clamp (reservoir tank side), then remove the hose from reservoir, drain coolant.
2. Disconnect the hose (connect to the engine air ventile) clamp, then remove hose from reservoir.
3. Disconnect drainage hose connection clamp bolts, then remove the hose from the radiator.
4. Disconnect the reservoir tank chassis connection bolts and nuts then remove the reservoir tank from vehicle.
4.2. Removal of the Radiator

1. Lift up the vehicle with the lifting jack.
2. Support the frame by rigid rack after lifting bus.
3. Loosen the hot water radiator pipe clamp.
4. Disconnect the hot water radiator pipe from the radiator and drain coolant.
5. Disconnect the radiator air outlet pipe connection clamps.
6. Remove air pipe from the radiator.
7. Isolation plates should be removed.
8. Radiator chocks should be removed (4 chocks).

**WARNING**

Before draining the coolant, loosen the reservoir tank pressure cap to reduce the pressure in the cooling system.
4.2. Removal of the Radiator

9. Remove the fan drive radiator connection upper bracket bolts, tool size 22mm.
10. Remove the fan drive radiator connection lower bracket bolts, tool size 22mm.
4.2. Removal of the Radiator

11. Loosen the cold water radiator pipe clamp.
12. Disconnect the radiator air inlet pipe connection clamps.
13. Remove air pipe from the radiator.
4.2. Removal of the Radiator

14. Place the radiator lifting jack under the vehicle.

**WARNING**

Before dismounting the radiator, check that the piping and fixations have been completely disconnected.

15. Loosen the right and left side bracket bolts then remove radiator from the chassis completely.

**WARNING**

When taking out the radiator from the body, be careful that it does not hit surrounding body parts.
Removal Sequence

27 - 30 - 29 - 28  18
>23>
24 - 26 - 25  13
27 - 30 - 29 - 28 - 31
>23 > 20
24 - 26 - 25
32 - 34 - 33 > 31
3 - 5 - 4 - 2
9 - 10 - 8 - 6 - 7 > 1
10 - 12 - 13 - 11
15 - 17 - 16 - 14 > 11
42 - 41 - 40 - 39 - 43
45 - 46 - 47
38 - 43 - 37 - 36
56 > 35
54 - 55
53 - 43
52 - 41
### 4.4. Cooling System Filling Procedure

<table>
<thead>
<tr>
<th>Step</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>All manual valves are opened.</td>
</tr>
<tr>
<td>2</td>
<td>Reserve tank is filled up to full level.</td>
</tr>
<tr>
<td>3</td>
<td>Engine is started and works at idle speed.</td>
</tr>
<tr>
<td>4</td>
<td>Water is added slowly by observing reduction.</td>
</tr>
<tr>
<td>5</td>
<td>Engine works approximately 10 minutes.</td>
</tr>
<tr>
<td>6</td>
<td>Electrical valves and water pump is opened.</td>
</tr>
<tr>
<td>7</td>
<td>Water is added as it reduces within the level observed.</td>
</tr>
<tr>
<td>8</td>
<td>Engine works for 10 to 15 minutes.</td>
</tr>
<tr>
<td>9</td>
<td>Then engine works at full throttle.</td>
</tr>
<tr>
<td>10</td>
<td>Add necessary water.</td>
</tr>
<tr>
<td>11</td>
<td>Wait until thermostat opens.</td>
</tr>
<tr>
<td>12</td>
<td>Add water if needed.</td>
</tr>
<tr>
<td>13</td>
<td>Finally vehicle is sent to test shop and rework dept.</td>
</tr>
<tr>
<td>14</td>
<td>In this period if water is observed to be reduced then added.</td>
</tr>
</tbody>
</table>
5. Cleaning Procedure

Run the engine and keep the coolant at a temperature of approximately 90 °C/194 °F such that the thermostat valves remain open and the coolant circulates continuously in the radiator.
- To increase the coolant temperature quickly, cover the front of the radiator with cardboard or a similar material.
- If cleaning is carried out after a large amount of rust has accumulated, the radiator may start to leak.
- Carefully examine the radiator for leaks after cleaning the cooling system. Soft water to be used should have the following properties.

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total hardness</td>
<td>300 ppm or less</td>
</tr>
<tr>
<td>Sulfate SO₄</td>
<td>100 ppm or less</td>
</tr>
<tr>
<td>Chloride Cl</td>
<td>100 ppm or less</td>
</tr>
<tr>
<td>Total dissolved solids</td>
<td>500 ppm or less</td>
</tr>
<tr>
<td>pH</td>
<td>6 to 8</td>
</tr>
</tbody>
</table>

As shown below, the cleaning method for the cooling system depends on the system’s condition.

- **Ordinary condition**
  - Clean using water
  - (Work procedure)
  - Drain out coolant.
  - Make mixture of water and cleaning fluid, using 5-10 parts cleaning fluid to 100 parts water.
  - (Work procedure)
  - Pour mixture into surge tank.
  - Let engine idle for 30 minutes with coolant at 90°C.

- **Coolant extremely dirty**
  - Clean using special cleaning fluid or equivalent
  - (Work procedure)

- **Radiator clogged**
  - Drain out coolant.
  - Fill surge tank with soft water (preferably boiling).
  - Let engine idle for 10 minutes with coolant at 90°C.
  - Drain out soft water.
  - Cleaning is complete if drained water is clear. Repeat procedure if drained water is dirty.

**CAUTION**
Do not use hard water as it causes scale and rust.

**WARNING**
Coolant, Antifreeze, and Radiator Antirust are flammable. Keep them away from heat and naked flames.

**DANGER**
If you accidently splash Coolant, Antifreeze, or Radiator Antirust in your eyes, wash it out immediately with water and seek medical help.

**WARNING**
Do not leave an empty SCA filter on an ELC system. The filter housing may corrode and leak causing an engine failure. Remove the SCA filter base and plug off or by-pass the coolant lines with Extended Life Coolant.

**WARNING**
Do not use a commercial coolant / anti-freeze that only meets the ASTM D3306 or D4656 specification. This type of coolant / antifreeze is made for light duty automotive applications.
5. Cleaning Procedure

Note:
- After cleaning the cooling system with cleaning fluid, fill it with coolant immediately.
- To prevent freezing of the coolant and corrosion of the cooling system, add the specified amount of Antifreeze or Radiator Antirust to the coolant.

5.1. Air Bleeding of Cooling System

- Fill the system with coolant until the coolant level in the surge tank is slightly lower than the tank opening. If the level were up to the opening, the coolant would over flow the opening as it becomes warm and expands.
- Let the engine idle with the coolant at a temperature of 90°C/194 °F until the cooling system is completely bled of air.
- After bleeding the cooling system of air, add coolant to the reservoir tank and surge tank as required.

5.2. Gas Leak Testing

The presence of air or exhaust gas in the coolant increase scorrosion and rust in the cooling system. Check for air or exhaust gas in the coolant using the following procedure.

- Remove the pressure cap.
- Run the engine and let the coolant temperature reach approximately 90°C/194 °F.
- If bubbles appear continuously in the coolant, air or exhaust gas is leaking into the cooling system.
- If the coolant contains air, the cylinder head bolts, water pump mounting bolts, or hose connections may be loose. Alternatively, the hoses may be damaged.
- If the coolant contains exhaust gas, it is possible that the cylinder head gasket is damaged or that the cylinder head is cracked.

Do not use hard water as it causes scale and rust.
### 6. Troubleshooting

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Possible Cause</th>
<th>Possible Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal Noise</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Overcooling</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Overheating (Insufficient Cooling)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Excessive Coolant Loss</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Excessive Tension</td>
<td>V-Belt</td>
<td></td>
</tr>
<tr>
<td>Oil on Belt</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bearing Faulty</td>
<td>Automatic Coupling</td>
<td></td>
</tr>
<tr>
<td>Bearing Defective</td>
<td>Idler Pulley</td>
<td></td>
</tr>
<tr>
<td>Impeller Defective</td>
<td>Bearing Case</td>
<td></td>
</tr>
<tr>
<td>Unit Seal Defective</td>
<td>Water Pump</td>
<td></td>
</tr>
<tr>
<td>Water Pump Fitted Poorly</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Water Leaking from Water Temperature Sensor, Overheat Unit, and/or Water Temperature Gauge Unit</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Valve Opening Temperature too High, Valve Remains Closed</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Valve Opening Temperature too Low, Valve Remains Open</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Space between Core and Fins Clogged</td>
<td>Radiator</td>
<td></td>
</tr>
<tr>
<td>Core Cracked and/or soldered Joints Separated</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pressure Cap not Sufficiently airtight</td>
<td>Surge Tank</td>
<td></td>
</tr>
<tr>
<td>Water Leaking from Water Level Sensor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan Shroud Fitted Poorly</td>
<td>Cooling Fan</td>
<td></td>
</tr>
<tr>
<td>Oil Cooler Fitted Poorly</td>
<td>Oil Cooler</td>
<td></td>
</tr>
<tr>
<td>Gasket Defective</td>
<td>Gasket Defective</td>
<td></td>
</tr>
</tbody>
</table>

**Possible Causes**

- V-Belt
- Automatic Coupling
- Idler Pulley
- Bearing Case
- Water Pump
- Radiator
- Surge Tank
- Cooling Fan
- Oil Cooler
### 6. Troubleshooting

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<td></td>
</tr>
<tr>
<td>Overcooling</td>
<td></td>
</tr>
</tbody>
</table>

- Cylinder Head Fitted Poorly                      | Cylinder Head                                 |
- Casket Defective                                  |                                               |
- Coolant Quantity Insufficient and/or Coolant Dirty|
- Coolant Passage Dirty and/or Clogged              |
- Hoses Fitted Poorly                               |                                               |
- Ambient Temperature Extremely Low                 |                                               |