

SAFETY.CAT.COM™

# **C18**

# **MARINE ENGINE**

**Maintenance Intervals**

Excerpted from Operation & Maintenance Manual (SEBU7689-10)

i03542891

# Maintenance Interval Schedule

**SMCS Code:** 1000; 7500

Ensure that all safety information, warnings and instructions are read and understood before any operation or any maintenance procedures are performed.

The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, filters, and the replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Use distance, fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance.

**Note:** Before each consecutive interval is performed, all maintenance from the previous interval must be performed.

Some maintenance intervals will depend on the operating environment of the vessel and on the operating time. Operating in water that contains silt, sediment, the algae and salt will adversely affect the maintenance intervals for some items. In addition, intermittent use of the vessel will adversely affect the maintenance intervals for some items.

## When Required

|   |     |
|---|-----|
| Battery - Recycle .....                     | 85  |
| Battery - Replace .....                     | 85  |
| Battery or Battery Cable - Disconnect ..... | 86  |
| Engine - Clean .....                        | 100 |
| Engine Oil Level Gauge - Calibrate .....    | 104 |
| Engine Storage Procedure - Check .....      | 110 |
| Fuel System - Prime .....                   | 112 |
| Heat Exchanger - Inspect .....              | 121 |
| Maintenance Recommendations .....           | 123 |
| Sea Water Strainer - Clean/Inspect .....    | 129 |
| Zinc Rods - Inspect/Replace .....           | 132 |

## Daily

|   |     |
|---|-----|
| Closed Crankcase Ventilation (CCV) Filter Service Indicator - Inspect ..... | 87  |
| Cooling System Coolant Level - Check .....                                  | 95  |
| Engine Air Cleaner Service Indicator - Inspect ...                          | 102 |
| Engine Oil Level - Check .....  | 103 |
| Fuel System Primary Filter/Water Separator - Drain .....                    | 114 |
| Walk-Around Inspection .....  | 131 |

## Initial 20 to 40 Service Hours

|                                      |    |
|--------------------------------------|----|
| Belts - Inspect/Adjust/Replace ..... | 86 |
|--------------------------------------|----|

## Every 50 Service Hours or Weekly

|  |     |
|--|-----|
| Aftercooler Condensate Drain Valve - Inspect/Clean ..... | 83  |
| Sea Water Strainer - Clean/Inspect .....                 | 129 |
| Zinc Rods - Inspect/Replace .....                        | 132 |

## Initial 500 Hours (for New Systems, Refilled Systems, and Converted Systems)

|  |    |
|--|----|
| Cooling System Coolant Sample (Level 2) - Obtain ..... | 98 |
|--|----|

## Every 500 Service Hours

|  |    |
|--|----|
| Cooling System Coolant Sample (Level 1) - Obtain ..... | 96 |
|--|----|

## Every Year

|  |    |
|--|----|
| Cooling System Coolant Sample (Level 2) - Obtain ..... | 98 |
|--|----|

## Every 6000 Service Hours or 3 Years

|  |    |
|--|----|
| Cooling System Coolant Extender (ELC) - Add .... | 95 |
|--|----|

## Every 12 000 Service Hours or 6 Years

|   |    |
|---|----|
| Cooling System Coolant (ELC) - Change ..... | 92 |
|---|----|

## First 14 400 L (3750 US gal) of Fuel or 250 Service Hours

|  |     |
|--|-----|
| Engine Valve Lash - Inspect/Adjust ..... | 110 |
| Fuel Injector - Inspect/Adjust .....     | 111 |

## Every 14 400 L (3750 US gal) of Fuel or 250 Service Hours or 1 Year

|  |     |
|--|-----|
| Auxiliary Water Pump (Rubber Impeller) - Inspect .....               | 85  |
| Battery Electrolyte Level - Check .....                              | 86  |
| Belts - Inspect/Adjust/Replace .....                                 | 86  |
| Cooling System Supplemental Coolant Additive (SCA) - Test/Add .....  | 98  |
| Engine - Clean .....   | 100 |
| Engine Air Cleaner Element - Clean/Replace ....                      | 100 |
| Engine Crankcase Breather - Clean .....                              | 102 |
| Engine Oil Sample - Obtain .....                                     | 105 |
| Engine Oil and Filter - Change .....                                 | 105 |
| Fuel System Primary Filter (Water Separator) Element - Replace ..... | 113 |
| Fuel System Secondary Filter - Replace .....                         | 115 |
| Fuel Tank Water and Sediment - Drain .....                           | 120 |
| Hoses and Clamps - Inspect/Replace .....                             | 122 |

---

**Every 28 500 L (7500 US gal) of Fuel or 500 Service Hours or 1 Year (Deep Sump)**

Engine Oil and Filter - Change ..... 105

**Every 57 000 L (15 000 US gal) of Fuel or 1000 Service Hours**

Aftercooler Core - Clean/Test ..... 83

Closed Crankcase Ventilation (CCV) Fumes Disposal Filter - Replace ..... 87

Heat Exchanger - Inspect ..... 121

Turbocharger - Inspect ..... 130

**Every 170 400 L (45 000 US gal) of Fuel or 3000 Service Hours**

Auxiliary Water Pump (Bronze Impeller) - Inspect ..... 84

Cooling System Coolant (DEAC) - Change ..... 89

Cooling System Water Temperature Regulator - Replace ..... 99

Crankshaft Vibration Damper - Inspect ..... 99

Engine Mounts - Inspect ..... 103

Engine Speed/Timing Sensor - Clean/Inspect .... 109

Engine Valve Lash - Inspect/Adjust ..... 110

Engine Valve Rotators - Inspect ..... 111

Fuel Injector - Inspect/Adjust ..... 111

Starting Motor - Inspect ..... 129

**Every 284 000 L (75 000 US gal) of Fuel or 5000 Service Hours**

Alternator - Inspect ..... 84

Maintenance Recommendations ..... 123

Oil Cooler Core - Check/Clean/Test ..... 125

Overhaul (Top End) ..... 128

Water Pump - Inspect ..... 132

**Every 570 000 L (150 000 US gal) of Fuel or 10 000 Service Hours**

Maintenance Recommendations ..... 123

Overhaul (Major) ..... 126

i03626622

## Aftercooler Condensate Drain Valve - Inspect/Clean

**SMCS Code:** 1063-042-DN, VL

### NOTICE

Failure to keep the condensate drain valve functional can cause severe damage to the engine.

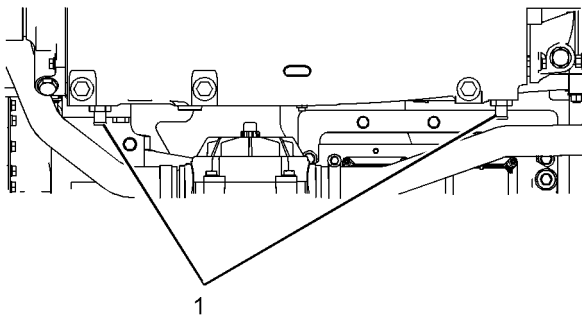


Illustration 37

g01638393

Typical

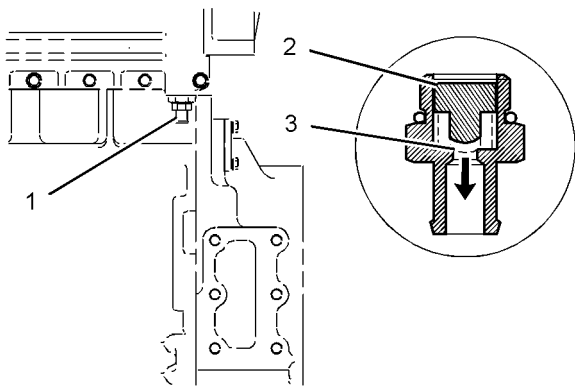


Illustration 38

g01348104

- (1) Valve  
(2) Plunger  
(3) Valve seat

The engine boost pressure forces the plunger to move down to the valve seat. The plunger must close against the seat at a pressure of 27.5 kPa (4 psi). When the engine is stopped, the absence of boost pressure allows the plunger to rise to the open position, which allows condensation from the aftercooler to drain out.

The plunger must be able to move freely in order to close the system when the engine is running. The plunger must be able to move freely in order to allow condensation to drain from the aftercooler when the engine is stopped. Residue from normal engine operation could cause the plunger to stick.

1. Remove the valve from the adapter. Check the valve in order to determine if the plunger moves freely. If the plunger does not move easily, clean the valve with solvent.
2. Reassemble the aftercooler condensate drain valve. See Specifications Manual, SENR3130, "Torque Specifications" for more information on the proper torques.

i03635591

## Aftercooler Core - Clean/Test

**SMCS Code:** 1064-070; 1064-081

**Note:** An aftercooler that circulates fresh water or treated water may require cleaning less often than an aftercooler which circulates salt water. The maintenance interval for an aftercooler which circulates fresh water or treated water should be evaluated when the aftercooler is cleaned and tested after the first 1000 hours of engine operation. The interval will vary depending on operating conditions.

### Clean the Aftercooler Core

Remove the core. Refer to the Disassembly and Assembly Manual, "Aftercooler - Remove" for the procedure.

1. Turn the aftercooler core on one side in order to remove debris. Remove the debris that is accessible.

### NOTICE

Do not use a high concentration of caustic cleaner to clean the core. A high concentration of caustic cleaner can attack the internal metals of the core and cause leakage. Only use the recommended concentration of cleaner.

2. Back flush the core with cleaner.

Caterpillar recommends the use of Hydrosolv liquid cleaner. Table 13 lists Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 13

| Hydrosolv Liquid Cleaners <sup>(1)</sup> |                |                    |
|--|----------------|--------------------|
| Part Number                              | Description    | Size               |
| 1U-5490                                  | Hydrosolv 4165 | 19 L (5 US gallon) |
| 174-6854                                 | Hydrosolv 100  | 19 L (5 US gallon) |

<sup>(1)</sup> Use a two to five percent concentration of the cleaner at temperatures up to 93°C (200°F). Refer to Application Guide, NEHS0526 or consult your Caterpillar dealer for more information.

i02676048

3. Steam clean the core in order to remove any residue. Flush the fins of the aftercooler core. Remove any other trapped debris from the inside and from the outside of the core.

**Note:** Do not use high pressure when the fins are cleaned. High pressure can damage the fins.

4. Wash the core with hot, soapy water.
5. Flush the core thoroughly in order to remove residue and remaining debris. Flush the core with clean, fresh water until the water that is exiting the core is clear and free of debris.

 **WARNING**

**Personal injury can result from air pressure.**

**Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.**

**The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the air nozzle is deadheaded.**

6. Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.

## Test the Aftercooler Core

1. Inspect the core for trapped debris and cleanliness. If necessary, remove the debris and repeat the cleaning procedure.
2. Inspect the core for damage and perform a pressure test in order to detect leaks. Many shops that service radiators are equipped to perform pressure tests.
3. Plug both ends of the aftercooler core and pressurize the core to 205 kPa (30 psi). Submerge the core in water. Look for bubbles which are being emitted from the core. The bubbles are evidence of leaks.
4. If any leaks are found, do not attempt to repair the core.

Install a core that is clean and a core that passes the pressure test in step 3. Refer to the Disassembly and Assembly Manual, "Aftercooler - Install" for the procedure.

For more information on cleaning the core, consult your Caterpillar dealer.

## Alternator - Inspect

**SMCS Code:** 1405-040

Caterpillar recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and proper battery charging. Inspect the ammeter (if equipped) during engine operation in order to ensure proper battery performance and/or proper performance of the electrical system. Make repairs, as required.

Check the alternator and the battery charger for proper operation. If the batteries are properly charged, the ammeter reading should be very near zero. All batteries should be kept charged. The batteries should be kept warm because temperature affects the cranking power. If the battery is too cold, the battery will not crank the engine. The battery will not crank the engine, even if the engine is warm. When the engine is not run for long periods of time or if the engine is run for short periods, the batteries may not fully charge. A battery with a low charge will freeze more easily than a battery with a full charge.

i01042055

## Auxiliary Water Pump (Bronze Impeller) - Inspect

**SMCS Code:** 1371-040

Impellers and seals require periodic inspection. Impellers have a service life that is limited. The service life depends on the engine operating conditions.

Inspect the components more frequently when the pump is exposed to debris, sand, or other abrasive materials. Inspect the components if the pump is operating at a differential pressure of more than 103 kPa (15 psi).

Check the following components for wear or damage:

- Bearings
- Impeller
- Seals
- Wear plate

If wear or damage is found, replace the components which are worn or damaged. Use the proper repair kit for the pump. Refer to the Disassembly and Assembly for more information on servicing the auxiliary water pump.

i01041983

i02153996

## Auxiliary Water Pump (Rubber Impeller) - Inspect

**SMCS Code:** 1371-040

Impellers and seals require periodic inspection. Impellers have a service life that is limited. The service life depends on the engine operating conditions.

Inspect the components more frequently when the pump is exposed to debris, sand, or other abrasive materials. Inspect the components if the pump is operating at a differential pressure of more than 103 kPa (15 psi).

Check the following components for wear or damage:

- Bearings
- Impeller
- Seals
- Wear plate

If wear or damage is found, replace the components which are worn or damaged. Use the proper repair kit for the pump. Refer to the Disassembly and Assembly for more information on servicing the auxiliary water pump.

i00993589

## Battery - Recycle

**SMCS Code:** 1401-561

Always recycle a battery. Never discard a battery.

Always return used batteries to one of the following locations:

- A battery supplier
- An authorized battery collection facility
- Recycling facility

## Battery - Replace

**SMCS Code:** 1401-510

### **WARNING**

**Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.**

**Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.**

### **WARNING**

**The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.**

**Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.**

1. Turn the key start switch to the OFF position. Remove the key and all electrical loads.
2. Turn OFF the battery charger. Disconnect the charger.
3. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the ground plane. Disconnect the cable from the NEGATIVE “-” battery terminal.
4. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.

**Note:** Always recycle a battery. Never discard a battery. Return used batteries to an appropriate recycling facility.

5. Remove the used battery.
6. Install the new battery.

**Note:** Before the cables are connected, ensure that the key start switch is OFF.

7. Connect the cable from the starting motor to the POSITIVE “+” battery terminal.

8. Connect the cable from the ground plane to the NEGATIVE “-” battery terminal.

i02601752

## Battery Electrolyte Level - Check

SMCS Code: 1401-535

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing.

### WARNING

**All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.**

1. Remove the filler caps. Maintain the electrolyte level to the “FULL” mark on the battery.

If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

2. Check the condition of the electrolyte with the 245-5829 Coolant Battery Tester Refractometer.
3. Keep the batteries clean.

Clean the battery case with one of the following cleaning solutions:

- A mixture of 0.1 kg (0.2 lb) of baking soda and 1 L (1 qt) of clean water
- A mixture of 0.1 L (0.11 qt) of ammonia and 1 L (1 qt) of clean water

Thoroughly rinse the battery case with clean water.

Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit properly. Coat the clamps and the terminals with 5N-5561 Silicone Lubricant, petroleum jelly or MPGM.

i01492654

## Battery or Battery Cable - Disconnect

SMCS Code: 1402-029

### WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.
2. Disconnect the negative battery terminal at the battery that goes to the start switch. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, the negative side of two batteries must be disconnected.
3. Tape the leads in order to help prevent accidental starting.
4. Proceed with necessary system repairs. Reverse the steps in order to reconnect all of the cables.

i02856850

## Belts - Inspect/Adjust/Replace

SMCS Code: 1357-025; 1357-040; 1357-510

### Inspection

Inspect the alternator belt and any accessory belts for wear and for cracking. Replace the belts if the belts are not in good condition.

To check the belt tension, apply 110 N (25 lb) of force midway between the pulleys. A correctly adjusted belt will deflect 13 to 19 mm (0.50 to 0.75 inch).

Slippage of loose belts can reduce the efficiency of the driven components. Vibration of loose belts can cause unnecessary wear on the following components:

- Belts
- Pulleys

- Bearings

If the belts are too tight, unnecessary stress is placed on the components. This reduces the service life of the components.

## Replacement

For applications that require multiple drive belts, replace the drive belts in matched sets. Replacing one drive belt of a matched set will cause the new drive belt to carry more load because the older drive belts are stretched. The additional load on the new drive belt could cause the new drive belt to fail.

## Alternator Belt Adjustment

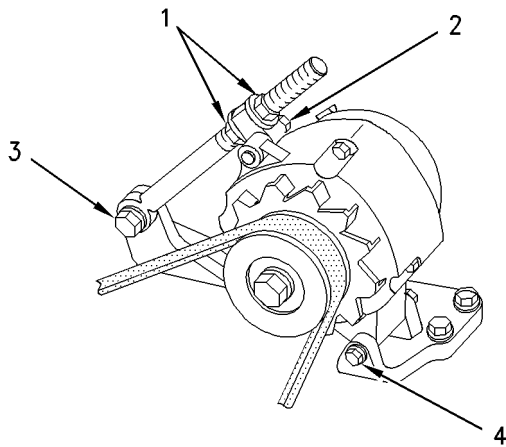


Illustration 39

g00960176

- (1) Adjusting nuts
- (2) Mounting bolt
- (3) Mounting bolt
- (4) Mounting bolt

1. Remove the drive belt guard.
2. Loosen mounting bolts (2), (3), and (4). Loosen adjusting nuts (1).
3. Turn adjusting nuts (1) in order to increase or decrease the drive belt tension.
4. Tighten adjusting nuts (1). Tighten mounting bolts (2), (3), and (4).
5. Reinstall the drive belt guard.

If new drive belts are installed, check the drive belt tension again after 30 minutes of engine operation at the rated rpm.

i01852860

## Closed Crankcase Ventilation (CCV) Filter Service Indicator - Inspect

SMCS Code: 1317-040-FI

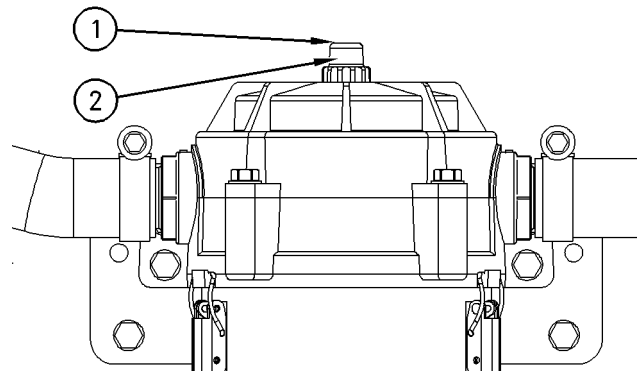


Illustration 40

g00744250

- (1) Plastic cover
- (2) Service indicator

The Closed Crankcase Ventilation system (CCV) is equipped with a service indicator. If the fumes disposal filter becomes plugged prior to the normal service interval, increased restriction of the filter will cause the crankcase pressure to become positive. When the pressure continues to rise, the service indicator will show through the plastic cover. The service indicator indicates the need for the fumes disposal filter to be changed. Refer to the Operation and Maintenance Manual, "Closed Crankcase Ventilation (CCV) Fumes Disposal Filter - Replace" topic for more information.

**Note:** Check the service indicator when the engine is running at low idle.

i03615046

## Closed Crankcase Ventilation (CCV) Fumes Disposal Filter - Replace

SMCS Code: 1317-510-FI

The engine may look like one of the engines which are pictured below.

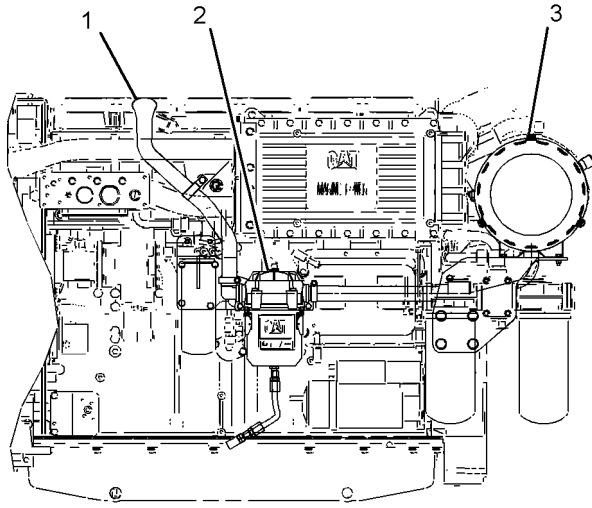


Illustration 41

g01637464

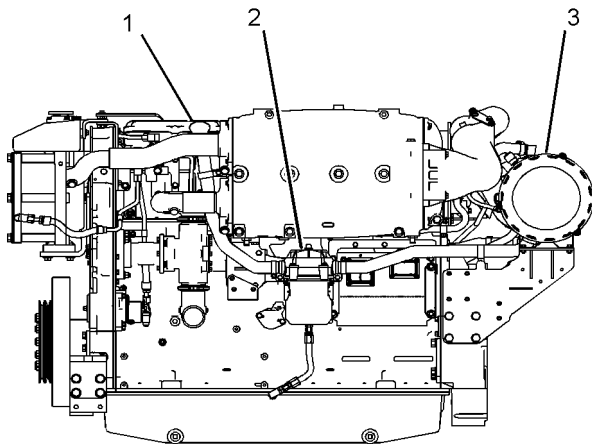


Illustration 42

g01637466

- (1) Crankcase breather  
 (2) Filter base and filter for fumes disposal  
 (3) Air cleaner

The Closed Crankcase Ventilation system (CCV) requires the replacement of the fumes disposal filter. The service interval of the CCV will be affected by the following items:

- Engine load
- Soot concentration
- Condition of the engine

The CCV is equipped with a service indicator. If the fumes disposal filter becomes plugged prior to the normal service interval, increased restriction of the filter will cause the vacuum to become positive. When the pressure continues to rise, the service indicator will show through the cap. The service indicator indicates the need for the fumes disposal filter to be changed. Reset the service indicator by using the following procedure:

## Resetting the Service Indicator

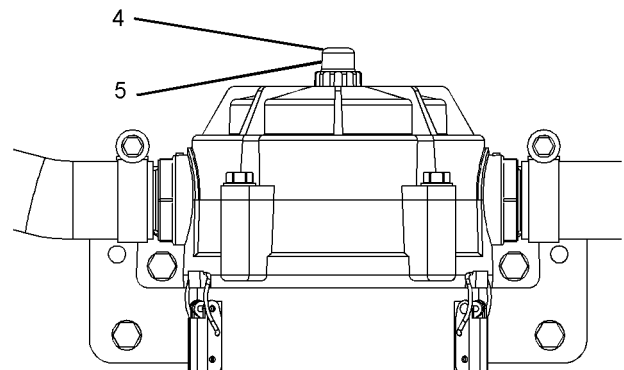


Illustration 43

g01292899

- (4) Plastic cover  
 (5) Service indicator

1. Remove the plastic cover.
2. Push down on the service indicator.
3. Replace the cover.

## Replacing the Fumes Disposal Filter

### **WARNING**

**Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.**

**Note:** When possible, perform the maintenance while the engine is off.

i03211768

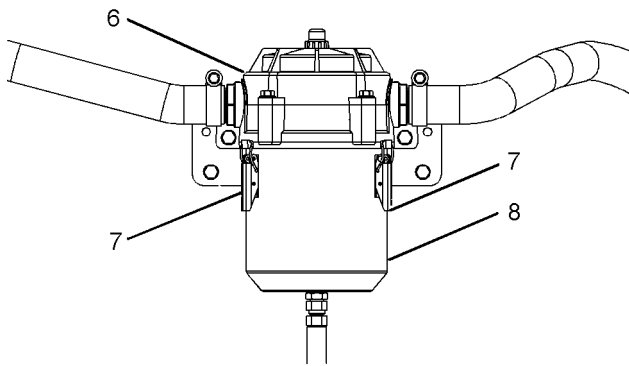


Illustration 44

g01938796

- (6) Filter base assembly  
(7) Latches  
(8) Canister

1. Release the latches that hold the canister to the filter base assembly .
- Note:** Removal of the canister may be difficult while the engine is operating. The canister has negative air pressure while the engine is operating. This creates a vacuum.
2. Lower the canister in order to expose the element. There may be oil in the bottom of the canister. Avoid spilling the oil.
  3. Remove the filter element by pulling down. Dispose of the used element properly.
  4. Remove the O-ring assembly on the top end cap of the used element.
  5. Replace the O-ring seal on the bottom of the filter base assembly.
  6. Install the new O-ring on the top end cap of the element. Install the element into the correct place.
  7. Replace the canister and align the canister with the boss on the filter base assembly.
  8. Clamp the latches in the closed position.

## Cooling System Coolant (DEAC) - Change

SMCS Code: 1350-070; 1395-044

### WARNING

**Personal injury can result from hot coolant, steam and alkali.**

**At operating temperature, engine coolant is hot and under pressure. The heat exchanger and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.**

**Remove the filler cap slowly to relieve pressure only when the engine is stopped and the filler cap for the heat exchanger is cool enough to touch with your bare hand.**

**Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.**

### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming of the coolant
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

**Note:** Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

## Drain

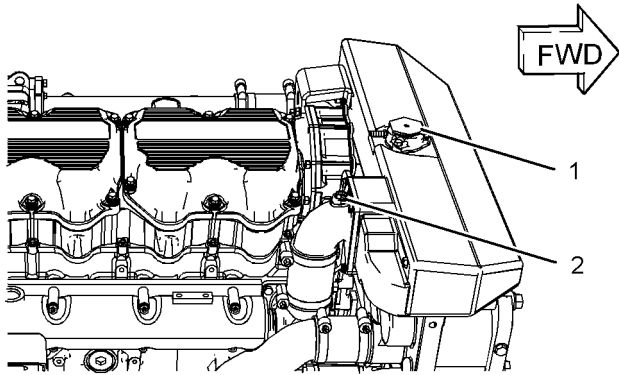


Illustration 45

g01355994

1. Stop the engine and allow the engine to cool. Loosen expansion tank filler cap (1) slowly in order to relieve any pressure. Remove the expansion tank filler cap.
2. Open the cooling system drain valve (if equipped).
3. In order to fully drain the coolant, remove the following plugs:
  - a. Remove plug (2) in order to vent the water near the water temperature regulator.

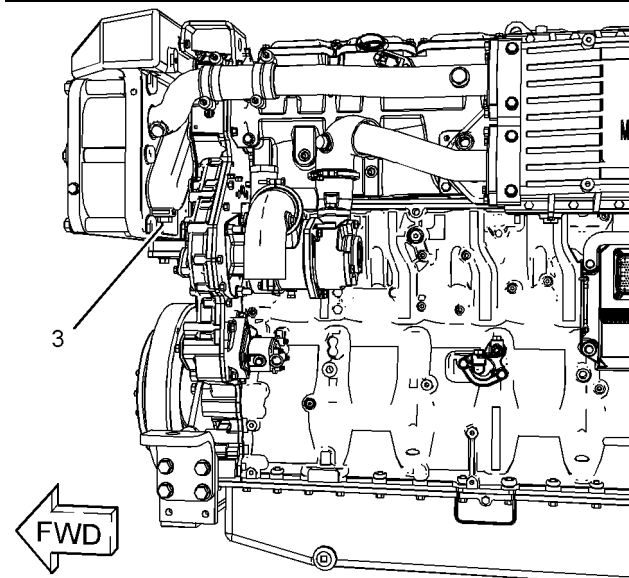


Illustration 46

g01355995

Commercial application

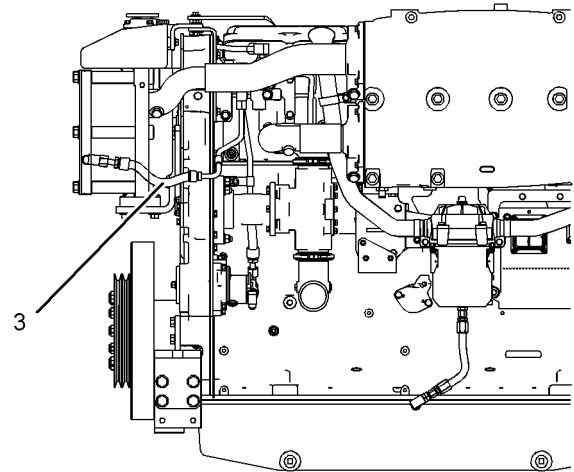


Illustration 47

g01637916

Pleasure craft

- b. Remove drain plug (3) from the bottom heat exchanger.

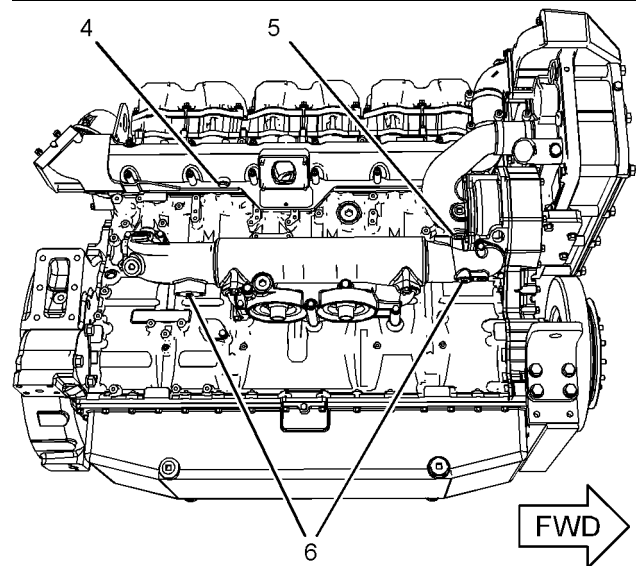


Illustration 48

g01355996

- c. Remove drain plug (4) from the bottom of the water cooled exhaust manifold.
  - d. Remove drain plugs (5) from the bottom of the jacket water pump inlet.
  - e. Remove drain plug (6) from the bottom of the oil cooler.
4. Allow coolant to drain.

---

**NOTICE**

Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

---

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Caterpillar Service Technology Group:

Outside Illinois: 1-800-542-TOOL  
Inside Illinois: 1-800-541-TOOL  
Canada: 1-800-523-TOOL

---

**Flush****NOTICE**

Use of commercially available cooling system cleaners may cause damage to cooling system components. Use only cooling system cleaners that are approved for Caterpillar engines.

---

1. Flush the cooling system with clean water in order to remove any debris.
  2. Close the drain valve (if equipped). Clean the drain plugs. Reinstall the drain plugs. Refer to the Operation and Maintenance Manual for more information on the proper torques.
- 

**NOTICE**

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

---

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Install the expansion tank filler cap.
4. Start the engine and run the engine for a minimum of 30 minutes with a coolant temperature of at least 82°C (180°F).
5. Stop the engine and allow the engine to cool. Loosen the expansion tank filler cap slowly in order to relieve any pressure. Remove the expansion tank filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Reinstall the drain plugs. Refer to the Specifications Manual for more information on the proper torques.

---

**Cooling Systems with Heavy Deposits or Plugging**

**Note:** For the following procedure to be effective, there must be some active flow through the cooling system components.

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Reinstall the drain plugs. Refer to the Operation and Maintenance Manual for more information on the proper torques.
3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity. Install the expansion tank filler cap.
4. Start and run the engine at low idle for a minimum of 90 minutes. The coolant temperature should be at least 82°C (180°F).
5. Stop the engine and allow the engine to cool. Loosen the expansion tank filler cap slowly in order to relieve any pressure. Remove the expansion tank filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Reinstall the drain plugs. Refer to the Operation and Maintenance Manual for more information on the proper torques.

---

**Fill****NOTICE**

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

---

**Engines That Are Equipped with a Coolant Recovery Tank**

1. Fill the system to the top with the mixture of coolant/antifreeze that is recommended. Refer to the Operation and Maintenance Manual for more information on cooling system specifications.
2. Reinstall the filler cap on the coolant recovery tank.
3. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at 1500 rpm for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
4. Remove filler cap from the coolant recovery tank.

i03211792

5. Pour the coolant/antifreeze into the tank until the coolant reaches the "COLD FULL" mark. Do not fill the tank above the "COLD FULL" mark.
6. Clean the filler cap. Install the filler cap onto the recovery tank. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

### Engines That Are Not Equipped with a Coolant Recovery Tank

1. Fill the expansion tank with the coolant/antifreeze. Do not install the expansion tank filler cap.
2. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at 1500 rpm for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).
4. Clean the expansion tank filler cap. Inspect the gasket on the filler cap for the expansion tank. If the gasket for the filler cap for the expansion tank is damaged, discard the old filler cap and install a new filler cap for the expansion tank. If the gasket for the filler cap for the expansion tank is not damaged, use a 9S-8140 Pressurized Pump Group in order to pressure test the filler cap for the expansion tank. The correct pressure for the filler cap of the expansion tank is stamped on the face of the filler cap for the expansion tank. If the expansion tank filler cap does not retain the correct pressure, install a new expansion tank filler cap.
5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

## Cooling System Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

### WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The heat exchanger and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove the filler cap slowly to relieve pressure only when the engine is stopped and the filler cap for the heat exchanger is cool enough to touch with your bare hand.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.

### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming of the coolant
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

**Note:** When the cooling system is cleaned, only clean water is needed when the ELC is drained and replaced.

**Note:** Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

## Drain

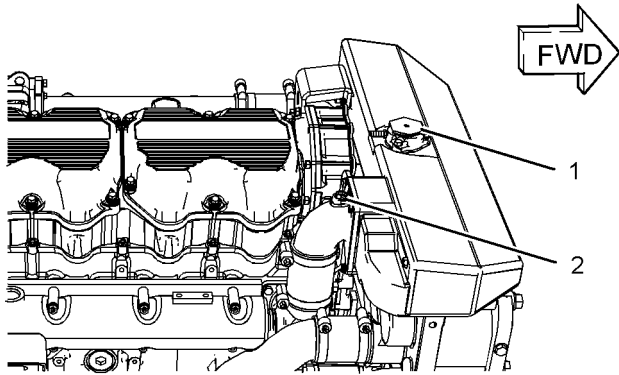


Illustration 49

g01355994

1. Stop the engine and allow the engine to cool. Loosen expansion tank filler cap (1) slowly in order to relieve any pressure. Remove the expansion tank filler cap.
2. Open the cooling system drain valve (if equipped).
3. In order to fully drain the coolant, remove the following plugs:
  - a. Remove plug (2) in order to vent the water near the water temperature regulator.

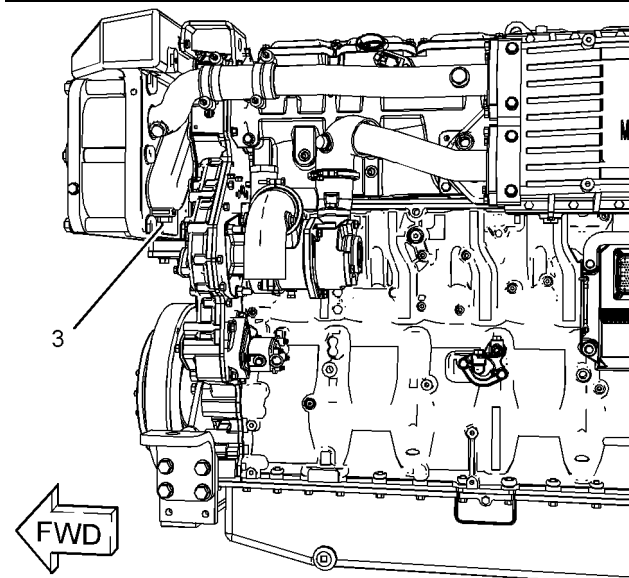


Illustration 50

g01355995

Commercial application

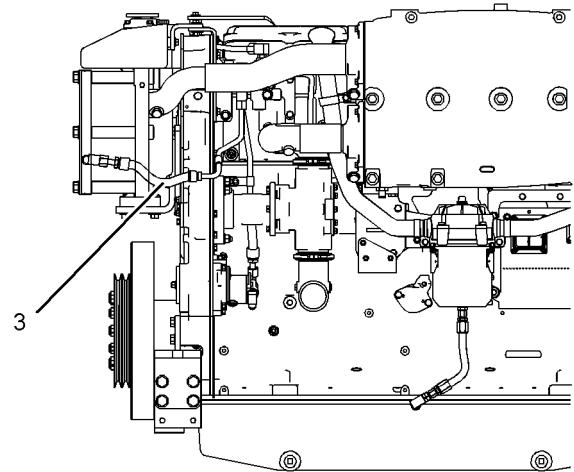


Illustration 51

g01637916

Pleasure craft

- b. Remove drain plug (3) from the bottom heat exchanger.

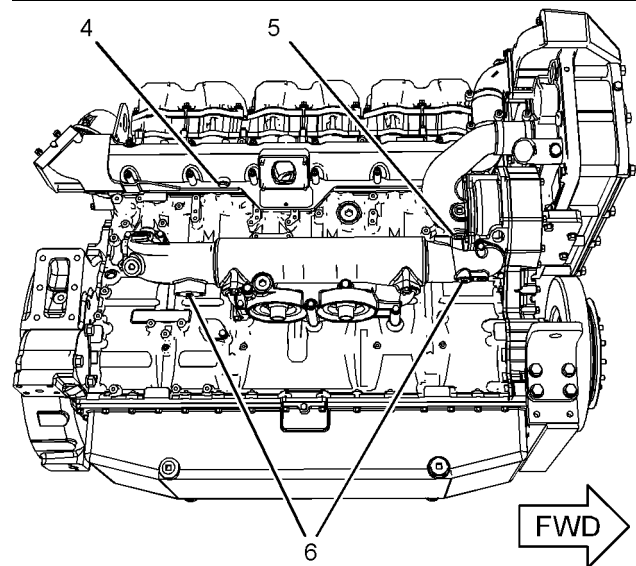


Illustration 52

g01355996

- c. Remove drain plug (4) from the bottom of the water cooled exhaust manifold.
  - d. Remove drain plugs (5) from the bottom of the jacket water pump inlet.
  - e. Remove drain plug (6) from the bottom of the oil cooler.
4. Allow coolant to drain.

---

**NOTICE**

Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

---

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Caterpillar Service Technology Group:

Outside Illinois: 1-800-542-TOOL  
Inside Illinois: 1-800-541-TOOL  
Canada: 1-800-523-TOOL

## Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Reinstall the drain plugs. Refer to the Operation and Maintenance Manual for more information on the proper torques.
3. Fill the cooling system with clean water. Reinstall the expansion tank filler cap. Operate the engine until the temperature reaches 49 to 66°C (120 to 150°F).
4. Stop the engine and allow the engine to cool. Loosen the expansion tank filler cap slowly in order to relieve any pressure. Remove the expansion tank filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water.
5. If necessary, repeat step 2 through step 4.

## Fill

---

**NOTICE**

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

---

## Engines That Are Equipped with a Coolant Recovery Tank

1. Fill the expansion tank to the top with the ELC. Refer to the Operation and Maintenance Manual for more information on cooling system specifications.
2. Reinstall the filler cap for the recovery tank.

3. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at 1500 rpm for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
4. Loosen the filler cap of the recovery tank slowly in order to relieve any pressure. Remove the filler cap from the recovery tank.
5. Pour the ELC into the tank until the coolant reaches the "COLD FULL" mark. Do not fill the tank above the "COLD FULL" mark.
6. Clean the filler cap of the recovery tank. Reinstall the filler cap onto the recovery tank. Start the engine. Inspect the coolant recovery tank for coolant leaks and for proper operating temperature.

## Engines That Are Not Equipped with a Coolant Recovery Tank

1. Fill the expansion tank with the ELC. Do not reinstall the expansion tank filler cap.
2. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at 1500 rpm for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).
4. Clean the expansion tank filler cap. Inspect the gasket of the filler cap for the expansion tank. If the gasket is damaged, discard the old expansion tank filler cap and install a new expansion tank filler cap. If the gasket is not damaged, use a 9S-8140 Pressurized Pump Group in order to pressure test the expansion tank filler cap. The correct pressure for the filler cap of the expansion tank is stamped on the face of the filler cap for the expansion tank. If the expansion tank filler cap does not retain the correct pressure, install a new expansion tank filler cap.
5. Start the engine. Inspect the engine for coolant leaks and for proper operating temperature.

i02482066

## Cooling System Coolant Extender (ELC) - Add

**SMCS Code:** 1352-045; 1395-081

Cat ELC (Extended Life Coolant) does not require the frequent additions of any supplemental cooling additives which are associated with the present conventional coolants. The Cat ELC Extender only needs to be added once.

### NOTICE

Use only Cat Extended Life Coolant (ELC) Extender with Cat ELC.

Do NOT use conventional supplemental coolant additive (SCA) with Cat ELC. Mixing Cat ELC with conventional coolants and/or conventional SCA reduces the Cat ELC service life.

Check the cooling system only when the engine is stopped and cool.

### WARNING

**Personal injury can result from hot coolant, steam and alkali.**

**At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.**

**Remove cooling system pressure cap slowly to relieve pressure only when engine is stopped and cooling system pressure cap is cool enough to touch with your bare hand.**

**Do not attempt to tighten hose connections when the coolant is hot, the hose can come off causing burns.**

**Cooling System Coolant Additive contains alkali. Avoid contact with skin and eyes.**

### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Loosen the cooling system filler cap slowly in order to relieve pressure. Remove the cooling system filler cap.
2. It may be necessary to drain enough coolant from the cooling system in order to add the Cat ELC Extender.
3. Add Cat ELC Extender according to the requirements for your engine's cooling system capacity. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" article for more information.
4. Clean the cooling system filler cap. Inspect the gaskets on the cooling system filler cap. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.

i02456586

## Cooling System Coolant Level - Check

**SMCS Code:** 1395-082

Check the coolant level when the engine is stopped and cool.

## Engines That Are Equipped with a Coolant Recovery Tank

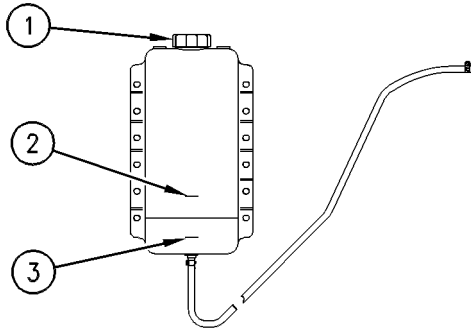


Illustration 53

g00103638

- (1) Filler cap
- (2) "COLD FULL" mark
- (3) "LOW ADD" mark

1. Observe the coolant level in the coolant recovery tank. Maintain the coolant level to "COLD FULL" mark (2) on the coolant recovery tank.
2. Loosen filler cap (1) slowly in order to relieve any pressure. Remove the filler cap.
3. Pour the proper coolant mixture into the tank. Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" for information about coolants. Do not fill the coolant recovery tank above "COLD FULL" mark (2).
4. Clean filler cap (1) and the receptacle. Reinstall the filler cap and inspect the cooling system for leaks.

**Note:** The coolant will expand as the coolant heats up during normal engine operation. The additional volume will be forced into the coolant recovery tank during engine operation. When the engine is stopped and cool, the coolant will return to the engine.

## Engines That Are Not Equipped with a Coolant Recovery Tank

### **WARNING**

**Pressurized System:** Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Remove the cooling system filler cap slowly in order to relieve pressure.

2. Maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level to the proper level in the sight glass.

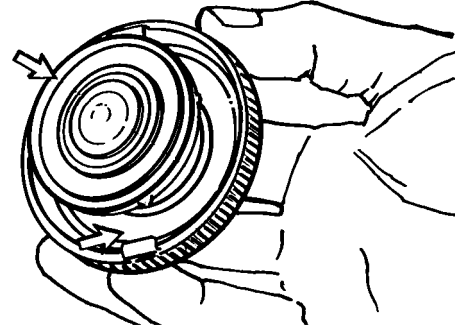


Illustration 54

g00103639

Typical filler cap gaskets

3. Clean the cooling system filler cap and inspect the condition of the filler cap gaskets. Replace the cooling system filler cap if the filler cap gaskets are damaged. Reinstall the cooling system filler cap.
4. Inspect the cooling system for leaks.

i03619060

## Cooling System Coolant Sample (Level 1) - Obtain

**SMCS Code:** 1350-008; 1395-008; 1395-554; 7542

**Note:** Obtaining a Coolant Sample (Level 1) is optional if the cooling system is filled with Cat ELC (Extended Life Coolant). Cooling systems that are filled with Cat ELC should have a Coolant Sample (Level 2) that is obtained at the recommended interval that is stated in the Maintenance Interval Schedule.

**Note:** Obtain a Coolant Sample (Level 1) if the cooling system is filled with any other coolant instead of Cat ELC. This includes the following types of coolants:

- Commercial long life coolants that meet the Caterpillar Engine Coolant Specification - 1 (Caterpillar EC-1)
- Cat DEAC (Diesel Engine Antifreeze/Coolant)
- Commercial heavy-duty coolant/antifreeze

Table 14

| Recommended Interval |                                |  |
|----------------------|--------------------------------|--|
| Type of Coolant      | Level 1                        | Level 2  |
| Cat DEAC             | Every 500 Hours <sup>(1)</sup> | Initial 500 Hours and Yearly <sup>(1)(2)</sup> |
| Cat ELC              | Optional <sup>(2)</sup>        | Initial 500 Hours and Yearly <sup>(2)</sup>    |

(1) This is the recommended interval for coolant samples for all conventional heavy-duty coolant/antifreeze. This is also the recommended interval for coolant samples of commercial coolants that meet the Cat EC-1 specification for engine coolant.

(2) The Level 2 Coolant Analysis should be performed sooner if a problem is suspected or identified.

#### NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

**Note: Level 1 results may indicate a need for Level 2 Analysis.**

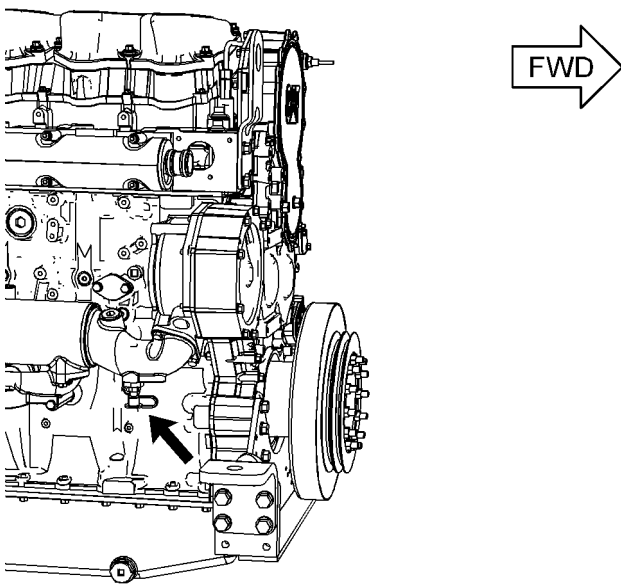


Illustration 55

g01942100

Coolant sampling valve on bottom of the inlet bonnet for the oil cooler

The coolant sampling valve for the engine coolant is located on the right side of the engine on the inlet bonnet for the oil cooler.

#### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Caterpillar Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Obtain the sample of the coolant as close as possible to the recommended sampling interval. In order to receive the full effect of S·O·S analysis, you must establish a consistent trend of data. In order to establish a pertinent history of data, perform consistent samplings that are evenly spaced. Supplies for collecting samples can be obtained from your Caterpillar dealer.

Use the following guidelines for proper sampling of the coolant:

- Complete the information on the label for the sampling bottle before you begin to take the samples.
- Keep the unused sampling bottles stored in plastic bags.
- Obtain coolant samples directly from the coolant sample port. You should not obtain the samples from any other location.
- Keep the lids on empty sampling bottles until you are ready to collect the sample.
- Place the sample in the mailing tube immediately after obtaining the sample in order to avoid contamination.
- Never collect samples from expansion bottles.
- Never collect samples from the drain for a system.

Submit the sample for Level 1 analysis.

For additional information about coolant analysis, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" or consult your Caterpillar dealer.

i01987714

## Cooling System Coolant Sample (Level 2) - Obtain

**SMCS Code:** 1350-008; 1395-008; 1395-554; 7542

### NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

Refer to Operation and Maintenance Manual, "Cooling System Coolant Sample (Level 1) - Obtain" for the guidelines for proper sampling of the coolant.

Submit the sample for Level 2 analysis.

For additional information about coolant analysis, see Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engines Fluids Recommendations" or consult your Caterpillar dealer.

i03509177

## Cooling System Supplemental Coolant Additive (SCA) - Test/Add

**SMCS Code:** 1352-045; 1395-081

**Note:** This maintenance is NOT required for cooling systems that are filled with Extended Life Coolant.

### **WARNING**

Cooling system coolant additive contains alkali. To help prevent personal injury, avoid contact with the skin and eyes. Do not drink cooling system coolant additive.

### NOTICE

Excessive supplemental coolant additive concentration can form deposits on the higher temperature surfaces of the cooling system, reducing the engine's heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components.

Excessive supplemental coolant additive concentration could also result in blockage of the heat exchanger, overheating, and/or accelerated wear of the water pump seal.

Do not exceed the recommended amount of supplemental coolant additive concentration.

### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" and to Special Publication, GECJ0003, "Cat Shop Supplies and Tools" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to applicable regulations and mandates.

**Note:** Caterpillar recommends an S-O-S coolant analysis (Level 1).

## Cooling Systems that Use Conventional Coolant

### Test the Concentration of the SCA

### NOTICE

Do not exceed the recommended six percent supplemental coolant additive concentration.

Test the concentration of the SCA with the 4C-9301 Coolant Conditioner Test Kit.

## Add the SCA, If Necessary

### WARNING

**Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.**

1. Remove the cooling system filler cap slowly.
2. If necessary, drain some coolant in order to allow space for the addition of the SCA.
3. Add the proper amount of SCA. For the proper amount of SCA, refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic. The proper concentration of SCA depends on the type of coolant that is used. For the proper concentration of SCA, refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations".
4. Clean the cooling system filler cap. Install the cooling system filler cap.

i03645060

## Cooling System Water Temperature Regulator - Replace

**SMCS Code:** 1355-510

Replace the water temperature regulator before the water temperature regulator fails. This is a recommended preventive maintenance practice. Replacing the water temperature regulator reduces the chances for unscheduled downtime. Refer to this Operation and Maintenance Manual, "Maintenance Interval Schedule" for the proper maintenance interval.

A water temperature regulator that fails in a partially opened position can cause overheating or overcooling of the engine.

A water temperature regulator that fails in the closed position can cause excessive overheating. Excessive overheating could result in cracking of the cylinder head or piston seizure problems.

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner.

### NOTICE

Failure to replace your water temperature regulator on a regularly scheduled basis could cause severe engine damage.

Caterpillar engines incorporate a shunt design cooling system and require operating the engine with a water temperature regulator installed.

If the water temperature regulator is installed incorrectly, the engine may overheat, causing cylinder head damage. Ensure that the new water temperature regulator is installed in the original position. Ensure that the water temperature regulator vent hole is open.

Do not use liquid gasket material on the gasket or cylinder head surface.

Refer to two articles in the Disassembly and Assembly Manual, "Water Temperature Regulators - Remove and Water Temperature Regulators - Install" for the replacement procedure of the water temperature regulator, or consult your Caterpillar dealer.

**Note:** If only the water temperature regulators are replaced, drain the coolant from the cooling system to a level that is below the water temperature regulator housing.

i03175962

## Crankshaft Vibration Damper - Inspect

**SMCS Code:** 1205-040

Damage to the crankshaft vibration damper or failure of the crankshaft vibration damper can increase torsional vibrations. This can result in damage to the crankshaft and to other engine components. A deteriorating damper can cause excessive gear train noise at variable points in the speed range.

The damper is mounted to the crankshaft which is located behind the belt guard on the front of the engine.

i01646701

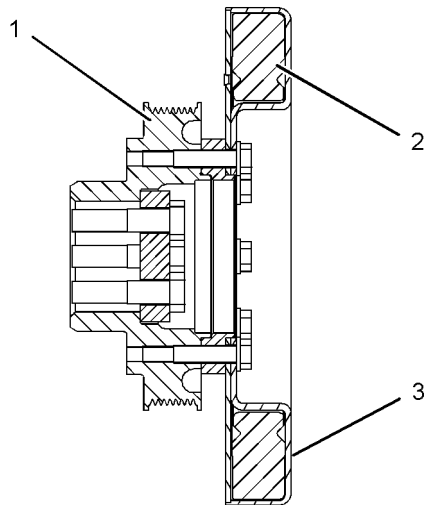


Illustration 56

g01134779

Viscous vibration damper

Typical example

- (1) Crankshaft pulley
- (2) Weight
- (3) Case

## Inspection

Inspect the damper for the following conditions:

- The damper is dented, cracked, or fluid is leaking from the damper.
- The paint on the damper is discolored from excessive heat.
- The damper is bent.
- The bolt holes are worn or there is a loose fit for the bolts.
- The engine has had a crankshaft failure due to torsional forces.

Replace the damper if any of these conditions exist.

## Removal and Installation

Refer to this Operation and Maintenance Manual, "Belts - Inspect/Adjust/Replace" for information on removing and on installing the belt. Refer to the Disassembly and Assembly Manual, "Vibration Damper and Pulley - Remove and Install" for information on removing and installing the damper.

## Engine - Clean

SMCS Code: 1000-070

### WARNING

Personal injury or death can result from high voltage.

Moisture can create paths of electrical conductivity.

Make sure that the electrical system is OFF. Lock out the starting controls and tag the controls "DO NOT OPERATE".

### NOTICE

Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

Periodic cleaning of the engine is recommended. Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

**Note:** Caution must be used in order to prevent electrical components from being damaged by excessive water when you clean the engine. Avoid electrical components such as the alternator, the starter, and the ECM.

i01756656

## Engine Air Cleaner Element - Clean/Replace

SMCS Code: 1054-070; 1054-510

### NOTICE

Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent airborne debris from entering the air inlet.

## Type 1

**Note:** Use the 102-9720 Cleaning Kit. This product contains the detergent and oil that is made specifically for the maintenance of the air cleaner elements.

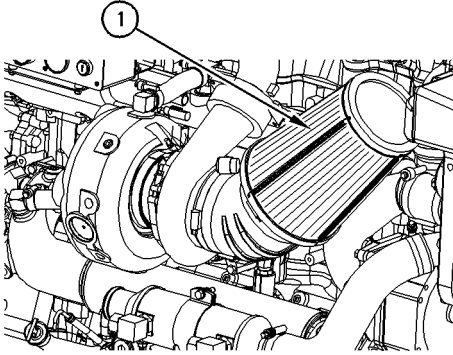


Illustration 57

g00898593

(1) Air cleaner element

**Note:** This type of air cleaner element should be replaced after three cleanings.

1. Remove the air cleaner element (1). Tap the air cleaner element in order to dislodge dirt particles. Gently brush the air cleaner element with a soft bristle brush.

### NOTICE

Do not use gasoline, steam, caustic or unapproved detergents, or parts cleaning solvents. Do not use high pressure water or air to clean the air cleaner element. Any of those liquids or methods can cause air cleaner element damage.

2. Spray the air cleaner element with the cleaning solution. Allow the air cleaner element to stand for 10 minutes.
3. Rinse the air cleaner element with low water pressure. The maximum water pressure for this procedure is 275 kPa (40 psi). Tap water is acceptable. Start to rinse the air cleaner element from the clean side (inside). Next, clean the dirty side (outside) in order to flush out dirt. Inspect the air cleaner element for tears and/or holes after the air cleaner element is cleaned. Do not reuse damaged air cleaner elements.

### NOTICE

Do not use compressed air, open flame, or hot air to dry the air cleaner element. Excess heat shrinks cotton fiber, and compressed air may blow holes in the material. Allow the air cleaner element to air dry.

4. Shake excess water off the air cleaner element, and allow the air cleaner element to air dry. Drying the air cleaner element in the sun speeds the process.

### NOTICE

Do not use transmission fluid, engine oil, diesel fuel, or other lubricant to oil the air cleaner element. The air cleaner element can not function correctly if improper oil is used. Never operate an engine with a dry air cleaner element. The air cleaner element can not function correctly without oil. Always saturate the clean air cleaner element with the recommended oil.

5. The dry air cleaner element should be oiled before installation. Apply small amounts of oil across the top of each pleat. Allow the oil to soak into the air cleaner element for 20 minutes. Oil any remaining "white" spots.
6. Inspect the housing and the clamp for air cleaner element (1). Install the clean, oiled air cleaner element. Replace the housing and the clamp, if necessary. Refer to Specifications, SENR3130, "Torque Specifications" for the proper torque of the clamp.

## Type 2

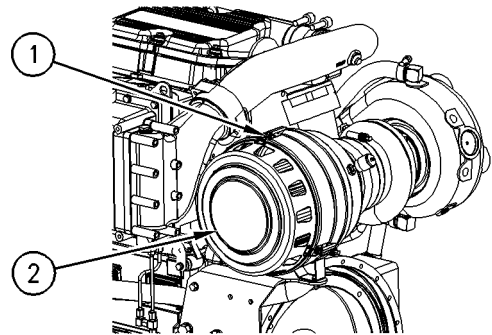


Illustration 58

g00898590

1. Disconnect latches (1).
2. Remove cover (2).
3. Remove the air cleaner element.

**Note:** This type of air cleaner element may be cleaned up to six times.

4. Refer to Guideline for Reusable Parts and Salvage Operations, SEBF8062 for cleaning instructions or replace the air cleaner element.
5. Install the air cleaner element.

6. Install cover (2).
7. Fasten cover (2) with latches (1).

i03612108

## Engine Air Cleaner Service Indicator - Inspect

**SMCS Code:** 7452-040

A service indicator may be mounted on the air cleaner element or in a remote location.

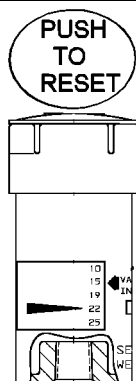


Illustration 59

g01640336

Typical air cleaner service indicator

Some engines may be equipped with a different service indicator.

Observe the service indicator. Clean the air cleaner element or replace the air cleaner element when the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.
- The air restriction reaches 6 kPa (25 inches of H<sub>2</sub>O).

### Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.
- Check the movement of the yellow core when the engine is accelerated to the engine rated rpm. The yellow core should latch approximately at the greatest vacuum that is attained.

If the service indicator does not reset easily, or if the yellow core does not latch at the greatest vacuum, the service indicator should be replaced. If the new service indicator will not reset, the fitting for the service indicator may be plugged.

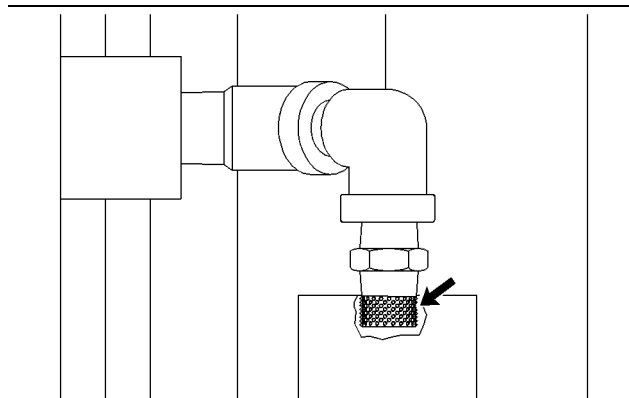


Illustration 60

g00351792

Porous filter

A porous filter is part of a fitting that is used for mounting of the service indicator. Inspect the filter for cleanliness. Clean the filter, if necessary. Use compressed air or a clean, nonflammable solvent.

The service indicator may need to be replaced frequently in environments that are severely dusty, if necessary. Replace the service indicator annually regardless of the operating conditions. Replace the service indicator when the engine is overhauled, and whenever major engine components are replaced.

**Note:** When a new service indicator is installed, excessive force may crack the top of the service indicator. Tighten the service indicator to a torque of 2 N·m (18 lb in).

i02751871

## Engine Crankcase Breather - Clean

**SMCS Code:** 1317-070

### NOTICE

Perform this maintenance with the engine stopped.

If the crankcase breather is not maintained on a regular basis, the crankcase breather will become plugged. A plugged crankcase breather will cause excessive crankcase pressure that may cause crankshaft seal leakage.

i02456872

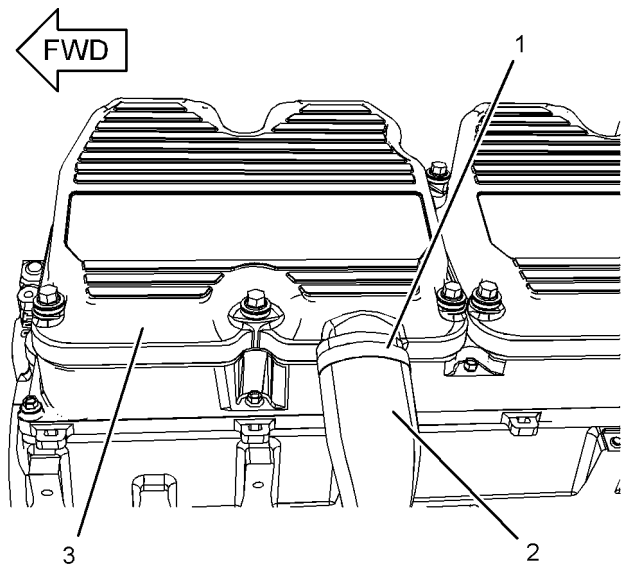


Illustration 61

g01377732

1. Loosen hose clamp (1) and remove breather hose (2) from valve cover (3).
2. Remove valve cover (3). Refer to the Disassembly and Assembly Manual.

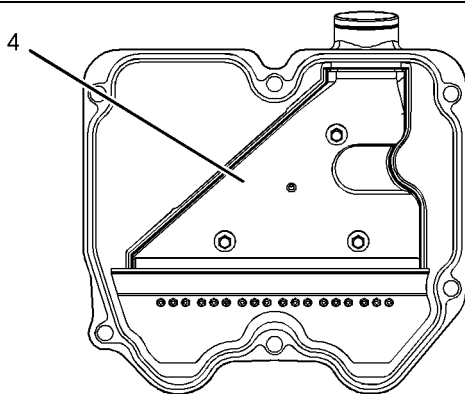


Illustration 62

g01377736

3. Wash breather (4) in solvent that is clean and nonflammable. Allow the breather to dry before installation.
4. Install the valve cover. Refer to the Disassembly and Assembly Manual.
5. Install the breather hose on the valve cover. Install the hose clamp.

## Engine Mounts - Inspect

**SMCS Code:** 1152-040

Inspect the engine mounts for deterioration and for proper bolt torque. Engine vibration can be caused by the following conditions:

- Improper mounting of the engine
- Deterioration of the engine mounts

Any engine mount that shows deterioration should be replaced. Refer to Special Publication, SENR3130, "Torque Specifications" for the recommended torques. Refer to the OEM recommendations for more information.

i02703852

## Engine Oil Level - Check

**SMCS Code:** 1348-535-FLV

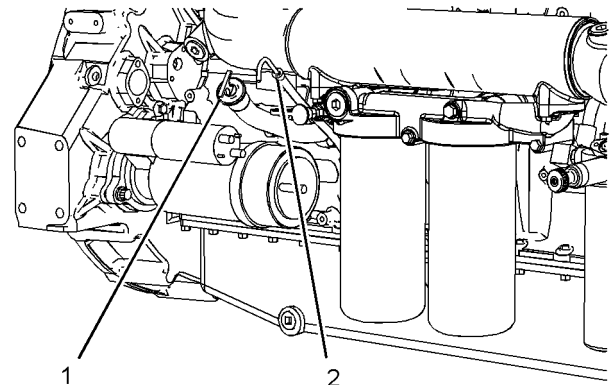


Illustration 63

g01356472

Right hand service shown

1. Stop the engine and allow the engine oil to drain into the crankcase for approximately ten minutes.

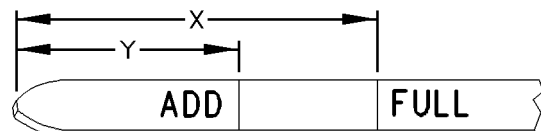


Illustration 64

g00110310

Oil level gauge

(Y) "ADD" mark

(X) "FULL" mark

2. Check the engine oil. Maintain the engine oil level between "ADD" mark (Y) and "FULL" mark (X) on engine oil level gauge (2). Do not fill the crankcase above "FULL" mark (X).

#### NOTICE

Operating your engine when the oil level is above the "FULL" mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil's lubricating characteristics and could result in the loss of power.

3. Remove engine oil filler cap (1) and add oil, if necessary. Clean the engine oil filler cap. Reinstall the engine oil filler cap.

i02703804

## Engine Oil Level Gauge - Calibrate

**SMCS Code:** 1326-524

The engine is shipped with an engine oil level gauge that is not marked. The engine oil level gauge is not marked because the following features can be different for each engine:

- Angle of the installation
- Side for service

The engine oil level gauge must be calibrated after the engine is installed in the vessel.

**Note:** The engine may be equipped with auxiliary engine oil filters. The extra filters require more engine oil than the standard amounts. Refer to the OEM specifications.

Use the following procedure in order to calibrate and mark the engine oil level gauge.

1. Ensure that the engine is properly aligned and that the engine is in the design trim. The engine must be installed properly in the vessel.

**Note:** If the engine has oil in the crankcase, skip step 2 and proceed to step 3.

2. If there is no oil in the engine, use information in this Operation and Maintenance Manual, "Refill Capacities and Recommendations" in order to select the correct oil for the engine. Add engine oil to the crankcase by using the procedure in this Operation and Maintenance Manual, "Engine Oil and Filter - Change". Choose the appropriate amount of oil from the following types of sumps:

- **Standard Oil Sump:** Fill the crankcase with 45.4 L (48 qt) of the recommended oil.
- **Deep Oil Sump:** Fill the crankcase with 64.3 L (68 qt) of the recommended oil.

Clean the engine oil level gauge and install the engine oil level gauge.

**Note:** If the engine contains oil, perform steps 3 through 7. Skip steps 3 through 7 if you are filling the engine with oil for the first time.

3. Operate the engine until normal operating temperature is achieved. Stop the engine. Drain the engine oil by using the procedure in this Operation and Maintenance Manual, "Engine Oil and Filter - Change".
4. Replace the engine oil filter by using the procedure in this Operation and Maintenance Manual, "Engine Oil and Filter - Change".
5. Clean the engine oil level gauge and install the engine oil level gauge.
6. Use the information in Operation and Maintenance Manual, "Refill Capacities and Recommendations" in order to select the correct oil for the engine.
7. Add engine oil to the crankcase by using the procedure in this Operation and Maintenance Manual, "Engine Oil and Filter - Change". Choose the appropriate amount of oil from the following two sumps:
  - **Standard Oil Sump:** Fill the crankcase with 45.4 L (48 qt) of the recommended oil.
  - **Deep Oil Sump:** Fill the crankcase with 64.3 L (68 qt) of the recommended oil.
8. Start the engine. Ensure that the lubrication system and the new engine oil filter are filled. Inspect the lubrication system for leaks.
9. Stop the engine and allow the engine oil to drain into the engine crankcase for approximately ten minutes.
10. Check the engine oil level. Use a marking tool in order to engrave the "ADD" mark (Y) to the correct location on the gauge assembly.
11. Add 3.8 L (4 qt) of the recommended oil grade and weight of engine oil to the crankcase. Add this amount for both standard sumps and deep sumps.
12. Check the engine oil level. Use a marking tool in order to engrave "FULL" mark (X) onto the correct location on the gauge assembly.

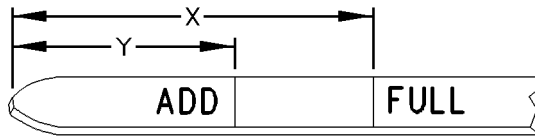


Illustration 65

g00110310

Oil Level Gauge "ADD" mark (Y) and "FULL" mark (X)

i03542996

## Engine Oil Sample - Obtain

**SMCS Code:** 1000-008; 1348-554-SM;  
7542-554-OC, SM

In addition to a good preventive maintenance program, Caterpillar recommends using S·O·S oil analysis at regularly scheduled intervals in order to monitor the condition of the engine and the maintenance requirements of the engine. S·O·S oil analysis provides infrared analysis, which is required for determining nitration and oxidation levels.

### Obtain the Sample and the Analysis

#### **WARNING**

**Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.**

Before you take the oil sample, complete the Label, PEEP5031 for identification of the sample. In order to help obtain the most accurate analysis, provide the following information:

- Engine model
- Service hours on the engine
- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

To ensure that the sample is representative of the oil in the crankcase, obtain a warm, well mixed oil sample.

To avoid contamination of the oil samples, the tools and the supplies that are used for obtaining oil samples must be clean.

Caterpillar recommends using the sampling valve in order to obtain oil samples. The quality and the consistency of the samples are better when the sampling valve is used. The location of the sampling valve allows oil that is flowing under pressure to be obtained during normal engine operation.

The 169-8373 Fluid Sampling Bottle is recommended for use with the sampling valve. The fluid sampling bottle includes the parts that are needed for obtaining oil samples. Instructions are also provided.

#### NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

If the engine is not equipped with a sampling valve, use the 1U-5718 Vacuum Pump. The pump is designed to accept sampling bottles. Disposable tubing must be attached to the pump for insertion into the sump.

For instructions, see Special Publication, PEGj0047, "How To Take A Good S·O·S Oil Sample". Consult your Caterpillar dealer for complete information and assistance in establishing an S·O·S program for your engine.

i02683617

## Engine Oil and Filter - Change

**SMCS Code:** 1318-510; 1348-044

#### **WARNING**

**Hot oil and components can cause personal injury.**

**Do not allow hot oil or components to contact skin.**

If the engine is equipped with duplex oil filters, the engine oil filter elements can be changed while the engine is in operation. This is useful if the oil filter elements require more frequent replacement than the engine oil. Refer to "Replacing the Engine Oil Filters During Engine Operation".

The oil change interval can be affected by several factors:

- Air/fuel ratio

- Ambient air conditions
- Engine application
- Fuel type
- Oil type
- Size of the oil sump

The S·O·S oil analysis program analyzes used oil in order to determine if the oil change interval is suitable for your specific engine.

## Drain the Oil

Do not drain the oil when the engine is cold. As the oil cools, waste particles settle on the bottom of the oil pan. The waste particles are not removed when the cold oil is drained. Drain the crankcase when the oil is warm. This method allows proper draining of the waste particles that are suspended in the oil.

Failure to follow this recommended procedure will allow the waste particles to be recirculated through the engine lubrication system with the new oil.

1. After the engine has been operated at normal operating temperature, STOP the engine.
2. Drain the oil according to the equipment on the engine.

**Note:** Drain the oil into a suitable container. DO NOT drain the oil into the bilge sump. Dispose of the oil according to local regulations.

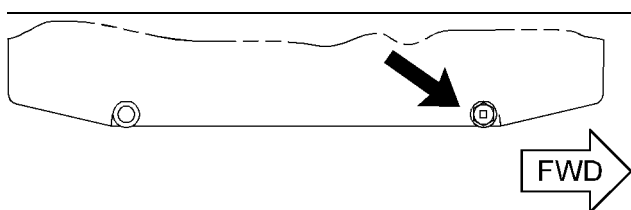


Illustration 66  
Oil drain plug

g01348195

**Note:** If a suction device is used in order to remove the oil from the oil pan, ensure that the suction device is clean. This will prevent dirt from entering into the oil pan. Be careful not to strike the engine oil suction tubes or the piston cooling jets.

- a. If the engine does not have a drain valve or a pump, remove an oil drain plug. Allow the oil to drain. After the oil has drained, clean the drain plug and clean the fitting for the drain plug. Install the drain plug. Tighten the drain plug to  $70 \pm 15$  N·m ( $52 \pm 11$  lb ft).

- b. If the engine has an oil drain valve, open the valve. After the oil has drained, close the valve.
- c. If the engine has a pump for removing dirty oil, connect a hose to the outlet of the pump. Place the hose in a suitable container. Open the valve for the drain line. The two marks on the valve must be turned so that one mark points to the pump and the second mark points to the drain line. Operate the pump until the crankcase is empty. Close the valve to the drain line. Disconnect the hose.
- d. If the oil drain valve has a “quick connect” coupling, attach the coupling. Open the drain valve in order to drain the crankcase. After the oil has drained, close the drain valve. Disconnect the coupling.

3. Replace the engine oil filter elements before filling the crankcase with new oil.

## Replace the Oil Filter Elements

Replace the engine oil filters when any of the following conditions occur:

- Every oil change
- The engine oil filter differential pressure reaches 103 kPa (15 psi).
- The oil filter elements have been used for 1000 service hours.

**Note:** Do not attempt to clean the used oil filters. Used oil filters will retain waste particles. The used oil filters would not filter the oil properly.

Service tools are available to aid in the service of oil filters. Consult your Caterpillar dealer for the part names and the part numbers. Follow the instructions that are supplied with the service tools. If the service tools are not used, perform the following appropriate procedure.

## Replacing the Engine Oil Filters With the Engine Stopped (Standard Oil Filters)

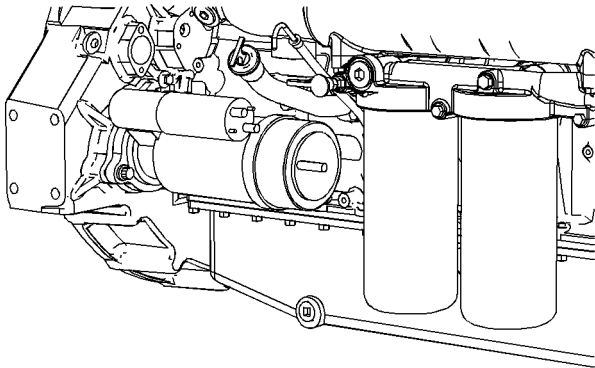


Illustration 67  
Standard Oil Filters  
Right hand service

g01356351

Perform the following procedure after the oil has been drained.

1. Remove used oil filters and properly discard the used oil filters.



Illustration 68  
Typical filter mounting base and filter gasket

g00103713

2. Clean the sealing surface of the filter mounting base. Make sure that the former oil filter gaskets are removed.
3. Apply a thin film of clean engine oil to the seal of each new filter gasket.

### NOTICE

Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components.

4. Install the filters by hand. Tighten each filter until the sealing surface contacts the base. Note the position of the index marks on each filter in relation to a fixed point on the filter base.

**Note:** Caterpillar filters have rotation index marks that are spaced 90° or 1/4 of a turn away from each other. When you tighten the filters, use the rotation index marks as a guide.

5. Tighten each filter according to the instructions that are printed on the filter.

**Note:** You may need to use a Caterpillar strap wrench, or another suitable tool, in order to turn the filters to the amount that is required for final installation. Make sure that the installation tool does not damage the filters. Do not overtighten the oil filter.

## Replacing the Engine Oil Filters During Engine Operation (Duplex Oil Filter System Only)

### WARNING

This filter contains hot, pressurized oil that can cause burns and fire hazards, which may result in bodily injury or death. Follow the instructions given in this Operation and Maintenance Manual and stop the engine if rapid air movement exists to blow the oil.

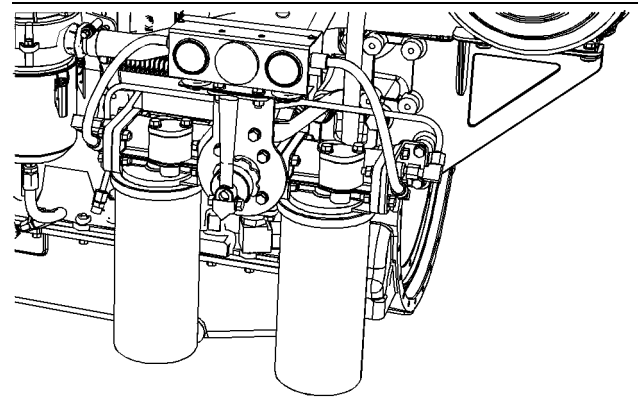


Illustration 69  
Duplex Oil Filter System  
Left hand service

g01356340

If the engine is equipped with duplex oil filters, the engine oil filter elements can be changed while the engine is in operation. This is useful if the oil filter elements require more frequent replacement than the engine oil.

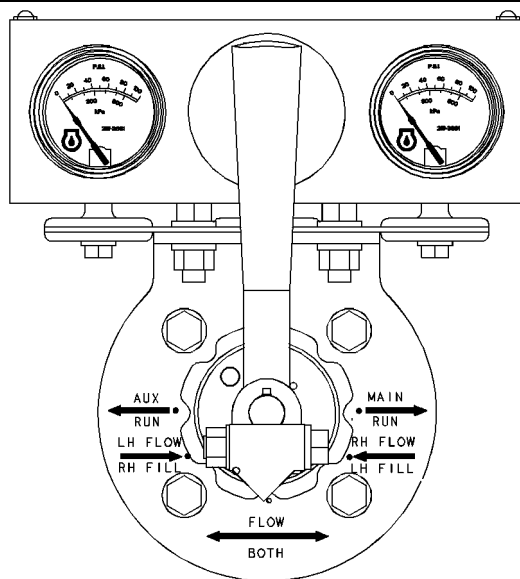


Illustration 70

g01034883

1. Open the "FILL" valve for a minimum of five minutes in order to fill the oil filter elements that will not be serviced. The oil filters that will not be serviced must be full of engine oil. Close the FILL valve.
2. Move the control valve to the "AUX RUN" position in order to change the main oil filter elements. Move the selector valve to the "MAIN RUN" position in order to change the auxiliary oil filter elements.
3. Allow the oil pressure gauge for the oil filter that is being changed to reach a "ZERO" pressure reading.
4. Perform Step 1 through Step 5 of "Replacing the Engine Oil Filters With the Engine Stopped".
5. Open the "FILL" valve for a minimum of five minutes in order to fill the new oil filter elements.
6. Close the "FILL" valve. Rotate the control valve to the "RUN" position for the oil filter that was serviced.
7. Inspect the oil filters for oil leaks. If any leaks exist, stop the engine and make any necessary repairs.
8. If the engine oil filters were replaced without changing the crankcase oil, maintain the oil level between the "FULL" mark and the "ADD" mark on the oil level gauge. If necessary, add oil.

## Fill the Crankcase

### NOTICE

Only use oils that are recommended by Caterpillar. For the proper oil to use, refer to this Operation and Maintenance Manual, "Engine Oil" topic (Maintenance Section).

### NOTICE

If the engine is equipped with an auxiliary oil filter system, extra oil must be added when filling the crankcase. If equipped with an auxiliary oil filter system that is not supplied by Caterpillar, follow the recommendations of the OEM.

### NOTICE

Engine damage can occur if the crankcase is filled above the "FULL" mark on the oil level gauge (dipstick).

An overfull crankcase can cause the crankshaft to dip into the oil. This will reduce the power that is developed and also force air bubbles into the oil. These bubbles (foam) can cause the following problems: reduction of the oil's ability to lubricate, reduction of oil pressure, inadequate cooling, oil blowing out of the crankcase breathers, and excessive oil consumption.

Excessive oil consumption will cause deposits to form on the pistons and in the combustion chamber. Deposits in the combustion chamber lead to the following problems: guttering of the valves, packing of carbon under the piston rings, and wear of the cylinder liner.

If the oil level is above the "FULL" mark on the oil level gauge, drain some of the oil immediately.

1. Remove the oil filler cap. Fill the crankcase through the oil filler tube only. For the amount of oil and type of oil to use, refer to Operation and Maintenance Manual, "Refill Capacities and Recommendations" (Maintenance Section). Clean the oil filler cap. Install the oil filler cap.

### NOTICE

To prevent crankshaft or bearing damage, crank engine with fuel off to fill all filters before starting.

Do Not crank engine for more than 30 seconds.

2. Close the fuel supply line and crank the engine until the oil pressure gauge indicates 70 kPa (10 psi). Open the fuel supply line. Allow the starting motor to cool for two minutes before cranking again.

3. Ensure that the oil level is to the "FULL" mark on the oil level gauge. Start the engine and operate the engine at low idle for two minutes. This will ensure that the lubrication system has oil and that the oil filters are filled with oil. Inspect the engine and the oil filters for oil leaks. If any leaks exist, stop the engine and make any necessary repairs.
4. Stop the engine and allow the oil to drain back into the sump for a minimum of ten minutes.
5. Remove the oil level gauge and check the oil level. Maintain the oil level between the "FULL" mark and the "ADD" mark on the oil level gauge. If necessary, add oil.

## Inspect the Used Oil Filter Elements

Cut the oil filter open with a 175-7546 Oil Filter Cutter Gp. Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the element. Ferrous metals may indicate wear on the steel and the cast iron parts of the engine. Nonferrous metals may indicate wear on the aluminum parts, the brass parts, or the bronze parts of the engine. Parts that may be affected include the following components: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

Aluminum debris may indicate problems with the bearings of the front gears. If you find aluminum debris, inspect the crankshaft vibration damper and the idler gear bearings.

Due to normal wear and friction, it is not uncommon to find small amounts of debris in the oil filter element. If an excessive amount of debris is found in the oil filter element, consult your Caterpillar dealer in order to arrange for further oil analysis.

i03572058

## Engine Speed/Timing Sensor - Clean/Inspect

**SMCS Code:** 1905-040; 1905-070; 1907-040;  
1907-070

### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Caterpillar Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

## Camshaft Speed/Timing Sensor

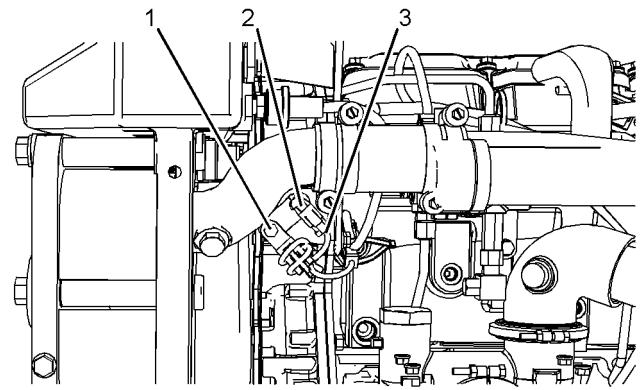


Illustration 71

g01368433

- (1) Bolt
- (2) Sensor
- (3) Harness assembly

## Removal Procedure

1. Disconnect the harness assembly.
2. Remove the bolt and the sensor.
3. Remove the O-ring seal from the sensor.

## Procedure for Cleaning and Inspecting

Check the condition of the plastic end of the sensor for wear and for contaminants. Clean the metal shavings and other debris from the face of the sensor.

## Installation Procedure

1. Install a new O-ring seal on the sensor. Lubricate the O-ring seal with clean engine oil.
2. Position the sensor in the housing and install the bolt.

3. Connect the harness assembly.

i02703023

## Crankshaft Speed/Timing Sensor

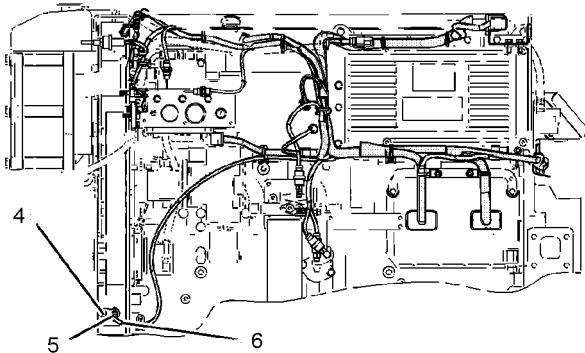


Illustration 72

g01900805

- (4) Bolt
- (5) Sensor
- (6) Harness

### Removal Procedure

1. Disconnect the harness assembly.
2. Remove the bolt and the sensor.
3. Remove the O-ring seal from the sensor.

### Procedure for Cleaning and Inspecting

Check the condition of the plastic end of the sensor for wear and for contaminants. Clean the metal shavings and other debris from the face of the sensor.

### Installation Procedure

1. Install a new O-ring seal on the sensor. Lubricate the O-ring seal with clean engine oil.
2. Install the position sensor in the front housing and install the bolt.
3. Connect the harness assembly.

## Engine Storage Procedure - Check

**SMCS Code:** 1000-535

Caterpillar recommends storage procedures and start-up procedures for all engines that are stored for more than 1 month. These procedures provide maximum protection to internal engine components. Refer to Special Instruction, SEHS9031, "Storage Procedure For Caterpillar Products" for information on these procedures.

An extension of the oil change interval to 12 months is permitted if you follow the required procedures for storage and start-up. This extension is permitted if the following intervals in the Operation and Maintenance Manual, "Maintenance Interval Schedule" have not been reached:

- Operating hours
- Fuel consumption

i00869413

## Engine Valve Lash - Inspect/Adjust

**SMCS Code:** 1102-025

The initial valve lash adjustment on new engines, rebuilt engines, or remanufactured engines is recommended at the first scheduled oil change. The initial adjustment is necessary due to initial wear of the valve train components and seating of the valve train components.

This maintenance is recommended by Caterpillar as part of a lubrication and preventive maintenance schedule in order to help provide maximum engine life.

## Adjustment of the Electronic Unit Injector

Adjust the electronic unit injector (preload) at the same interval as the valve lash adjustment. The operation of Caterpillar engines with improper valve adjustments and with improper adjustments of the electronic unit injector can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.

**NOTICE**

Only qualified service personnel should perform this maintenance. Refer to the Service Manual or your Caterpillar dealer for the complete valve lash adjustment procedure.

Operation of Caterpillar engines with improper valve adjustments can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.

**⚠ WARNING**

Ensure that the engine can not be started while this maintenance is being performed. To help prevent possible injury, do not use the starting motor to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting valve lash clearance.

i01597115

**Engine Valve Rotators - Inspect**

SMCS Code: 1109-040

**⚠ WARNING**

When inspecting the valve rotators, protective glasses or face shield and protective clothing must be worn, to help prevent being burned by hot oil or spray.

Engine valve rotators rotate the valves when the engine runs. This helps to prevent deposits from building up on the valves and the valve seats.

Perform the following steps after the engine valve lash is set, but before the valve covers are installed:

1. Start the engine according to Operation and Maintenance Manual, "Engine Starting" (Operation Section) for the procedure.
2. Operate the engine at low idle.
3. Observe the top surface of each valve rotator. The valve rotators should turn slightly when the valves close.

**NOTICE**

A valve rotator which does not operate properly will accelerate valve face wear and valve seat wear and shorten valve life. If a damaged rotator is not replaced, valve face guttering could result and cause pieces of the valve to fall into the cylinder. This can cause piston and cylinder head damage.

If a valve fails to rotate, consult your Caterpillar dealer.

i03534881

**Fuel Injector - Inspect/Adjust**

SMCS Code: 1290-025

**⚠ WARNING**

Be sure the engine cannot be started while this maintenance is being performed. To prevent possible injury, do not use the starting motor to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting the unit injectors.

The electronic unit injectors use high voltage. Disconnect the unit injector enable circuit connector in order to prevent personal injury. Do not come in contact with the injector terminals while the engine is running.

The operation of Caterpillar engines with improper adjustments of the electronic unit injector can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.

Only qualified service personnel should perform this maintenance. Refer to the Systems Operation, Testing and Adjusting, "Electronic Unit Injector - Test" for the test procedure, and Systems Operation, Testing and Adjusting, "Electronic Unit Injector - Adjust" for the adjustment procedure for the injectors.

i03570039

## Fuel System - Prime

SMCS Code: 1258-548

### WARNING

**Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.**

### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Caterpillar Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

### NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

**Note:** Refer to this Operation and Maintenance Manual, "Fuel System Secondary Filter - Replace" for information on replacing the filter.

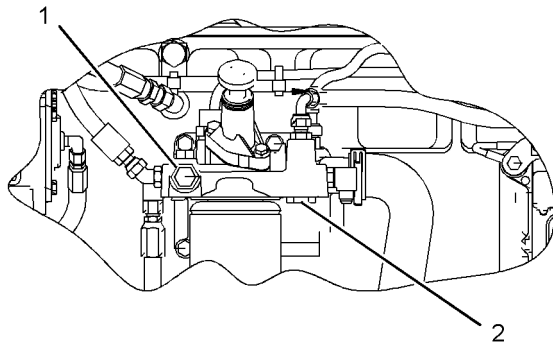


Illustration 73

g01096972

Hand priming pump

- (1) Air purge screw
- (2) Fuel pressure regulating valve

## The Secondary Fuel Filter Has Been Replaced

1. Turn the ignition switch to the "OFF" position.
2. Open the air purge screw for the fuel filter by three full turns. Do not remove the air purge screw.

### NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

3. Start the engine. The engine should start and the engine should run smoothly. If the engine does not start after 30 seconds, allow the starting motor to cool for two minutes before attempting to start the engine again.

**Note:** You may use the hand priming pump for the fuel filter (if equipped) instead of starting the engine and running the engine.

4. While the engine is running, observe the air purge screw. When a small drop of fuel appears at the threads of the air purge screw, close and tighten air purge screw.

**Note:** There may be a noticeable change in the sound of the running engine when the air purge screw is tightened. The change in the sound of the engine is normal.

**Note:** Failure to tighten all fittings could result in serious fuel leaks.

5. Clean any residual fuel from the engine components.

## The Engine Has Been Run Out of Fuel

1. Turn the ignition switch to the "OFF" position.
2. Fill the fuel tank(s) with clean diesel fuel.
3. Open the fuel pressure regulating valve by two and one half turns. The regulating valve is located in the integral fuel filter base.

**Note:** Do not remove the regulating valve completely. Open the valve enough to allow the air that is trapped in the cylinder head to be purged from the fuel system.

**NOTICE**

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

4. Crank the engine for 30 seconds. Use a suitable container to catch the fuel while you crank the engine. Allow the starting motor to cool for two minutes.

**Note:** You may use the hand priming pump for the fuel filter (if equipped) instead of cranking the engine.

5. Crank the engine for 30 seconds. Allow the starting motor to cool for two minutes.
6. Close and tighten the fuel pressure regulating valve.
7. Crank the engine for 30 seconds. Allow the starting motor to cool for two minutes.
8. Repeat Step 7 until the engine starts and the engine runs.

**Note:** Failure to tighten all fittings could result in serious fuel leaks.

9. Clean any residual fuel from the engine components.

**The Engine Has Been Rebuilt**

1. Turn the ignition switch to the "OFF" position.
2. Fill the fuel tank (s) with clean diesel fuel.
3. Open the the air purge screw for the fuel filter by three full turns. Do not remove the air purge screw.
4. Open the fuel pressure regulating valve by two and one half turns. The regulating valve is located in the integral fuel filter base.

**Note:** Do not remove the regulating valve completely. Open the valve enough to allow the air that is trapped in the cylinder head to be purged from the fuel system.

**NOTICE**

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

5. Crank the engine for 30 seconds. Use a suitable container to catch the fuel while you crank the engine. Allow the starting motor to cool for two minutes.

**Note:** You may use the hand priming pump for the fuel filter (if equipped) instead of cranking the engine.

6. Crank the engine for 30 seconds. Allow the starting motor to cool for two minutes.
7. Close and tighten the air purge screw.
8. Crank the engine for 30 seconds. Allow the starting motor to cool for two minutes.
9. Close and tighten the fuel pressure regulating valve.

**Note:** Failure to tighten all fittings could result in serious fuel leaks.

10. Crank the engine for 30 seconds. Allow the starting motor to cool for two minutes.
11. Repeat Step 10 until the engine starts and runs.
12. Clean any residual fuel from the engine components.

i02049797

**Fuel System Primary Filter (Water Separator) Element - Replace**

**SMCS Code:** 1260-510-FQ; 1263-510-FQ

Water in the fuel can cause the engine to run rough. Water in the fuel may cause an electronic unit injector to fail. If the fuel has been contaminated with water, the element should be changed before the regularly scheduled interval.

The primary filter/water separator also provides filtration in order to help extend the life of the secondary fuel filter. The element should be changed regularly. Install a vacuum gauge. Change the element for the primary filter/water separator if the pressure is at 50 to 70 kPa (15 to 20 inches Hg).

**Replace the Element**

**Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.**

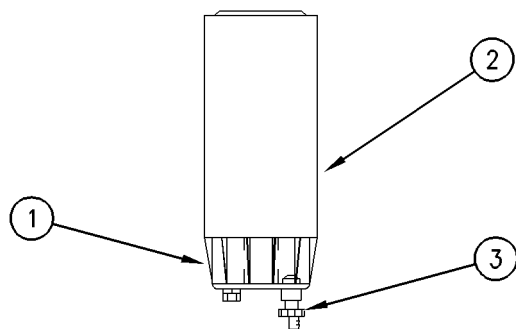


Illustration 74

g00668636

- (1) Bowl
- (2) Element
- (3) Drain

1. Stop the engine.
2. Turn the start switch to the "OFF" position.
3. Shut off the fuel tank supply valve to the engine.
4. If the primary fuel filter is equipped with a drain valve (3), open the drain valve in order to drain any fuel from the filter case. Close the drain valve (3).

#### NOTICE

Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

5. Remove the fuel filter bowl (1) and wash the fuel filter bowl with clean diesel fuel.
6. Remove the fuel filter (2).
7. Clean the gasket sealing surface of the fuel filter base. Ensure that all of the old gasket is removed.
8. Apply clean diesel fuel to the new fuel filter gasket.

#### NOTICE

In order to maximize fuel system life and prevent premature wear out from abrasive particles in the fuel, use Caterpillar fuel filters.

Consult your Caterpillar dealer for proper part numbers.

9. Install the new fuel filter (2). Spin the fuel filter onto the fuel filter base until the gasket contacts the base. Use the rotation index marks on the filters as a guide for proper tightening. Tighten the filter for an additional 3/4 turn by hand. Do not overtighten the filter.

#### NOTICE

Do not fill the fuel filters with fuel before installing them. The fuel would not be filtered and could be contaminated. Contaminated fuel will cause accelerated wear to fuel system parts.

10. Install the clean fuel filter bowl (1) on the new fuel filter.

#### NOTICE

The water separator is under suction during normal engine operation. Ensure that the vent plug is tightened securely to help prevent air from entering the fuel system.

11. Open the fuel tank supply valve.
12. Start the engine and check for leaks. Run the engine for one minute. Stop the engine and check the engine for leaks again.

Detection of leaks is very difficult especially if the engine is running. The primary filter/water separator is under suction. A leak will allow air to enter the fuel. The air in the fuel can cause low power due to aeration of the fuel. If air enters the fuel, check the components for overtightening or undertightening.

i02927285

## Fuel System Primary Filter/Water Separator - Drain

SMCS Code: 1260-543; 1263-543

### WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

i03572801

**NOTICE**

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

**NOTICE**

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

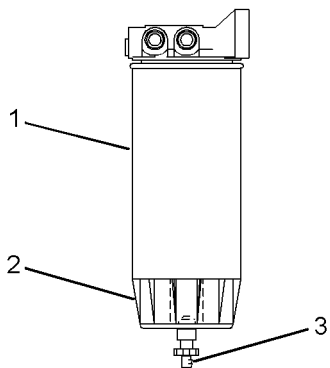


Illustration 75

g01453091

- (1) Element
- (2) Bowl
- (3) Drain

Bowl (2) should be monitored daily for signs of water. If water is present, drain the water from the bowl.

1. Open drain (3). The drain is a self-ventilated drain. Catch the draining water in a suitable container. Dispose of the water properly.
2. Close drain (3).

**NOTICE**

The water separator is under suction during normal engine operation. Ensure that the drain valve is tightened securely to help prevent air from entering the fuel system.

**Fuel System Secondary Filter - Replace**

**SMCS Code:** 1261-510-SE

**! WARNING**

**Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. Clean up fuel spills immediately.**

**NOTICE**

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Caterpillar Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

**Note:** If the engine is equipped with duplex fuel filters, the fuel filter elements can be replaced while the engine is in operation. Refer to "Replacing the Fuel Filter Elements During Engine Operation For Engines That Are Equipped With Duplex Fuel Filters".

**Replacing the Fuel Filter Elements with the Engine Stopped****NOTICE**

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

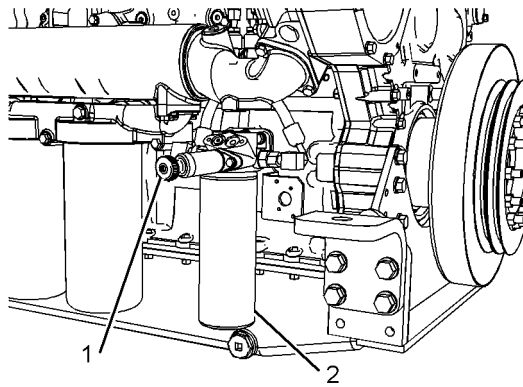


Illustration 76

g01902879

Right hand service

- (1) Fuel priming pump
- (2) Fuel filter

1. Stop the engine.
2. Turn off the start switch or disconnect the battery (starting motor) when maintenance is performed on fuel filters.
3. Shut off the fuel tank supply valve to the engine.

#### NOTICE

Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

4. Unlock the fuel priming pump in order to relieve residual pressure in the fuel system.
5. Remove the used fuel filter. Use a cloth or use a container in order to catch excess fuel.
6. Clean the gasket sealing surface of the fuel filter base. Ensure that all of the old gasket is removed.
7. Apply clean diesel fuel to the new fuel filter gasket.

#### NOTICE

Do not fill the secondary fuel filter with fuel before installing. The fuel would not be filtered and could be contaminated. Contaminated fuel will cause accelerated wear to fuel system parts.

8. Install the new fuel filter. Tighten the fuel filter until the gasket contacts the base. Tighten the fuel filter by hand according to the instructions that are shown on the fuel filter. Do not overtighten the fuel filter.

**Note:** DO NOT remove the plug in the fuel filter base in order to release the air from the fuel system during periodic service of the fuel filter. Periodic removal of the plug will result in increased wear of the threads in the fuel filter base.

9. Operate the fuel priming pump plunger until a strong resistance is felt and until the check valve clicks. This procedure will require considerable strokes. Lock the fuel priming pump.
10. Open the fuel tank supply valve.
11. Start the engine according to the normal operating procedures. Immediately increase the engine rpm between 1000 to 1200 rpm with no load. The engine will begin to misfire briefly until air from the fuel filter is purged. No damage to the engine will occur.

#### NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

12. If the engine stalls during the purging of the air, refer to the Operation and Maintenance Manual, "Fuel System - Prime" for more information.

## Replacing the Fuel Filter Elements During Engine Operation For Engines That Are Equipped With Duplex Fuel Filters

If the engine is equipped with duplex fuel filters, the fuel filters can be replaced while the engine is in operation.

### **WARNING**

**This filter contains pressurized fuel that can cause a fire hazard, which may result in bodily injury or death. Follow the instructions given in this Operation and Maintenance Manual and stop the engine if rapid air movement exists to blow the fuel.**

## Replacing the Main Fuel Filter

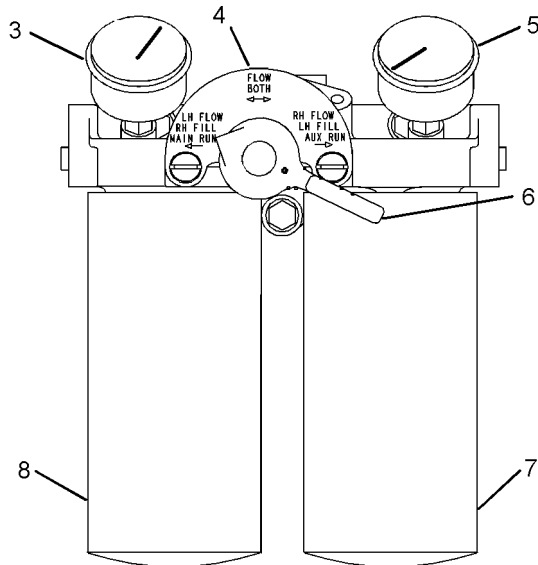


Illustration 77 g01902892

### Duplex fuel filters

Engines are shipped from the factory with the control valve in the MAIN RUN position.

- (3) Fuel pressure gauge for the main fuel filter
- (4) Plate that shows the position of the valve
- (5) Fuel pressure gauge for the auxiliary fuel filter
- (6) Control valve
- (7) Auxiliary fuel filter
- (8) Main fuel filter

Use the following procedure in order to replace the main fuel filter while the engine is in operation.

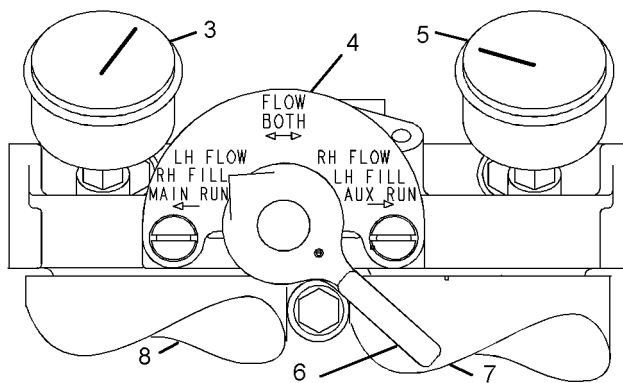


Illustration 78 g01902917

1. Move the control valve to the LH FLOW - RH FILL position as marked on plate. The fuel pressure gauge for the main fuel filter should indicate full pressure. The fuel pressure gauge for the auxiliary fuel filter should indicate slight pressure. Five minutes may be required in order to fill the auxiliary fuel filter. The auxiliary fuel filter must become full of fuel.

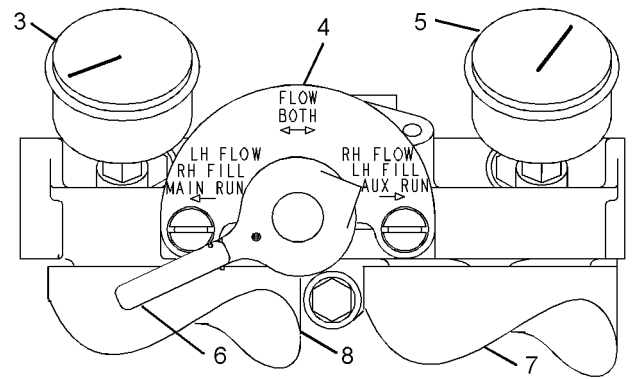


Illustration 79

g01902918

2. Move the control valve to the AUX RUN position. The fuel pressure gauge for the auxiliary fuel filter should indicate full pressure. The fuel pressure gauge for the main fuel filter should indicate no pressure.

### NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

### NOTICE

Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

3. Remove the used main fuel filter. Use a cloth or use a container in order to catch excess fuel.
4. Clean the gasket sealing surface of the main fuel filter base. Ensure that all of the old gasket is removed.
5. Apply clean diesel fuel to the new main fuel filter gasket.
6. Install a new main fuel filter. Tighten the fuel filter until the gasket contacts the base. Tighten the fuel filter by hand according to the instructions that are shown on the fuel filter. Do not overtighten the fuel filter.

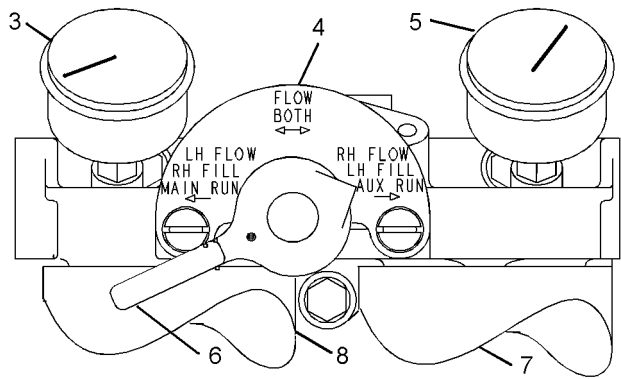


Illustration 80 g01902918

7. Move the control valve to the RH FLOW - LH FILL position. The fuel pressure gauge for the auxiliary fuel filter should indicate full pressure. The fuel pressure gauge for the main fuel filter should indicate slight pressure. Five minutes may be required in order to fill the main fuel filter. The main filter must become full of fuel.

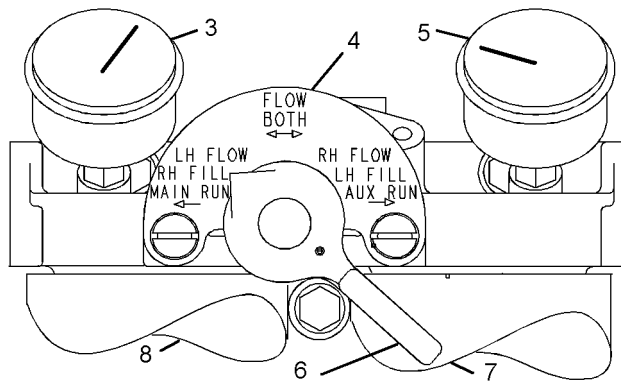


Illustration 81 g01902917

8. Move the control valve to the MAIN RUN position. The fuel pressure gauge for the main fuel filter should indicate full pressure. The fuel pressure gauge for the auxiliary fuel filter should indicate no pressure.

### replacing the Auxiliary Fuel Filter

The procedure for replacing the auxiliary fuel filter is similar to the procedure for replacing the main fuel filter.

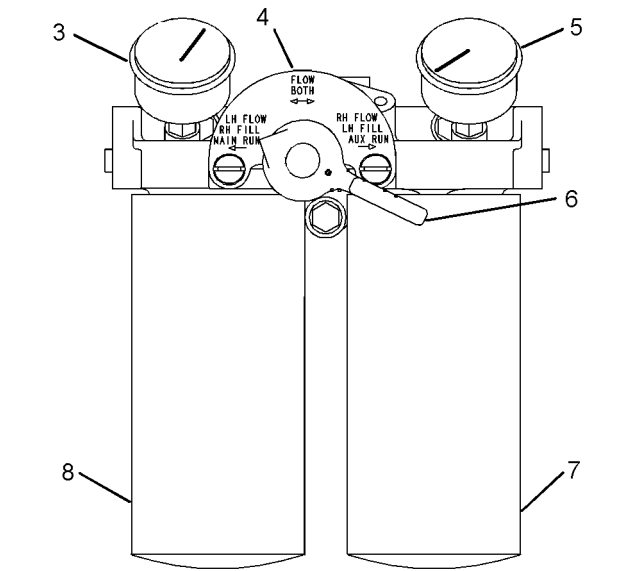


Illustration 82 g01902892

Duplex fuel filters

The engine is operating with the control valve in the AUX RUN position.

- (3) Fuel pressure gauge for the main fuel filter
- (4) Plate that shows the position of the valve
- (5) Fuel pressure gauge for the auxiliary fuel filter
- (6) Control valve
- (7) Auxiliary fuel filter
- (8) Main fuel filter

Use the following procedure in order to replace the auxiliary fuel filter while the engine is in operation.

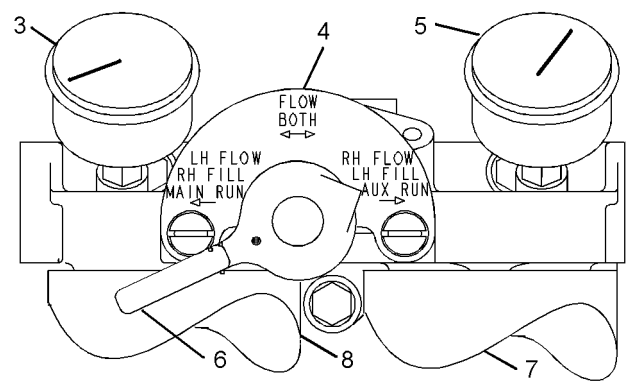


Illustration 83 g01902918

1. Move the control valve to the RH FLOW - LH FILL position. The fuel pressure gauge for the auxiliary fuel filter should indicate full pressure. The fuel gauge for the main fuel filter should indicate slight pressure. Five minutes may be required for filling the main fuel filter. The main fuel filter must become full of fuel.

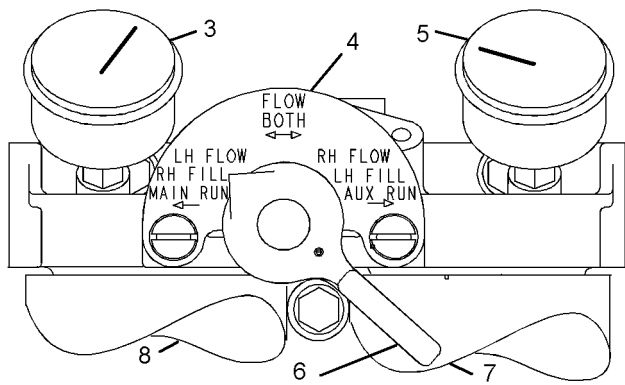


Illustration 84

g01902917

2. Move the control valve to the MAIN RUN position. The fuel pressure gauge for the main fuel filter should indicate full pressure. The fuel pressure gauge for the auxiliary fuel filter should indicate no pressure.

#### NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

#### NOTICE

Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

3. Remove the used auxiliary fuel filter. Use a cloth or use a container in order to catch excess fuel.
4. Clean the gasket sealing surface of the auxiliary fuel filter base. Ensure that all of the old gasket is removed.
5. Apply clean diesel fuel to the new auxiliary fuel filter gasket.
6. Install a new auxiliary fuel filter. Tighten the fuel filter until the gasket contacts the base. Tighten the fuel filter by hand according to the instructions that are shown on the fuel filter. Do not overtighten the fuel filter.

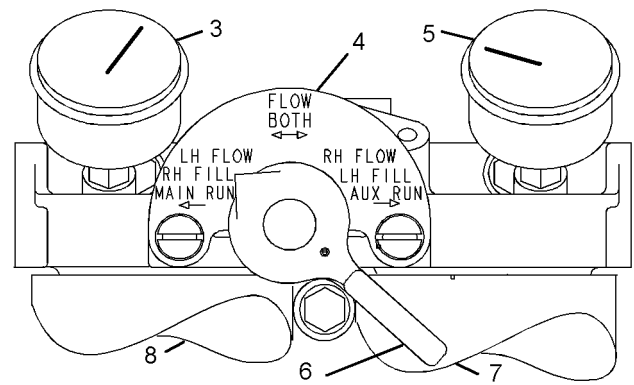


Illustration 85

g01902917

7. Move the control valve to the LH FLOW - RH FILL position. The fuel pressure gauge for the main fuel filter should indicate full pressure. The fuel pressure gauge for the auxiliary fuel filter should indicate slight pressure. Allow five minutes in order to fill the auxiliary fuel filter. The auxiliary fuel filter must become full of fuel.

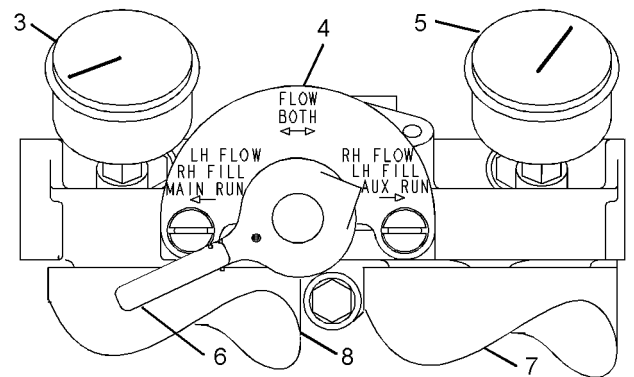


Illustration 86

g01902918

8. Move the control valve to the AUX RUN position. The fuel pressure gauge for the auxiliary fuel filter should indicate full pressure. The fuel pressure gauge for the main fuel filter should indicate no pressure.

Move the control valve to the FLOW BOTH position after both fuel filters are replaced.

i03645042

## Fuel Tank Water and Sediment - Drain

**SMCS Code:** 1273-543-M&S

### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Caterpillar Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

## Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive wear to the fuel system. Condensation occurs during the heating and cooling of fuel. The condensation occurs as the fuel passes through the fuel system and the fuel returns to the fuel tank. This causes water to accumulate in fuel tanks. Draining the fuel tank regularly and obtaining fuel from reliable sources can help to eliminate water in the fuel.

## Drain the Water and the Sediment

Fuel tanks should contain some provision for draining water and draining sediment from the bottom of the fuel tanks.

Open the drain valve on the bottom of the fuel tank in order to drain the water and the sediment. Close the drain valve.

**Note:** Failure to properly close the drain can allow air into the system, which could have detrimental results to performance.

Check the fuel daily. Drain the water and sediment from the fuel tank after operating the engine or drain the water and sediment from the fuel tank after the fuel tank has been filled. Allow five to ten minutes before performing this procedure.

Fill the fuel tank after operating the engine in order to drive out moist air. This will help prevent condensation. Do not fill the tank to the top. The fuel expands as the fuel gets warm. The tank may overflow.

Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe. Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

## Fuel Storage Tanks

Drain the water and the sediment from the fuel storage tank during the following conditions:

- Weekly
- Oil change
- Refill of the tank

This will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank. A four micron(c) absolute filter for the breather vent on the fuel tank is also recommended. Refer to Special Publication, SENR9620, "Improving Fuel System Durability".

If a bulk storage tank has been refilled or moved recently, allow adequate time for the sediment to settle before filling the engine fuel tank. Internal baffles in the bulk storage tank will also help trap sediment. Filtering fuel that is pumped from the storage tank helps to ensure the quality of the fuel. When possible, water separators should be used.

i02683693

## Heat Exchanger - Inspect

SMCS Code: 1379-040

### WARNING

**Personal injury can result from hot coolant, steam and alkali.**

**At operating temperature, engine coolant is hot and under pressure. The heat exchanger and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.**

**Remove the filler cap slowly to relieve pressure only when the engine is stopped and the filler cap for the heat exchanger is cool enough to touch with your bare hand.**

**Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.**

---

#### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

#### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

## Plate Type Heat Exchanger

The interval for the maintenance of the plate type heat exchanger depends on the operating environment of the vessel and on the operating time. The sea water that is circulated through the heat exchanger and the amount of operating time of the vessel affects the following items:

- Cleanliness of the heat exchanger plates
- Effectiveness of the heat exchanger system

Operating in water that contains the following will adversely affect the heat exchanger system: silt, sediment, salt, and algae. In addition, intermittent use of the vessel will adversely affect the heat exchanger system.

The following items indicate that the heat exchanger may require cleaning:

- Increased coolant temperature
- Engine overheating
- Excessive pressure drop between the water inlet and the water outlet

An operator that is familiar with the normal operating temperature of the coolant can determine when the coolant temperature is out of the normal range. Inspection of the heat exchanger and maintenance of the heat exchanger are required if the engine is overheating.

Your Caterpillar dealer has the equipment and the personnel in order to measure the pressure drop across the heat exchanger.

Consult your Caterpillar dealer or refer to the Service Manual for service information for the heat exchanger.

## Cleaning the Plate Type Heat Exchanger

Refer to the Disassembly and Assembly Manual for the engine. The heat exchanger must be disassembled in order to be cleaned. The Disassembly and Assembly Manual will contain instructions for cleaning the heat exchanger prior to reassembly. The following general guidelines are for cleaning a plate type heat exchanger. Refer to Table 15 for types of cleaners.

**NOTICE**

Do not use hydrochloric acid to clean stainless steel plates.

Do not use hydrofluoric acid to clean titanium plates.

Water that contains more than 300 ppm of chlorine should not be used to prepare cleaning solutions.

Do not use Ketones such as Acetone and Methyl-tyketone.

Do not use esters such as Ethylacetate and Butylac-  
 etate.

Do not use Halogenated hydrocarbons such as Chlorothene and Carbon Tetrachloride

Do not use Aromatics such as Benzene and Toluene.

3. Clean the plates with a cleaning solution and a soft brush. Pressurized water may also be used. Do not use steel wool or a wire brush, which may scratch the plate. Any iron scratches on the plates can lead to corrosion of the plates. Rinse the plates with water.

4. Assemble the heat exchanger.

i02121526

## Hoses and Clamps - Inspect/Replace

**SMCS Code:** 7554-040; 7554-510

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking
- Softness
- Loose clamps

Replace hoses that are cracked or soft. Tighten any loose clamps.

**NOTICE**

Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque.

Table 15

| Problem                 | Source   | Cleaners <sup>(1)</sup>  |
|-------------------------|--|--|
| Scaling                 | Calcium carbonate<br>Calcium sulfate<br>Silicates                | Nitric acid<br>Sulfamic acid<br>Citric acid<br>Phosphoric acid<br>Complexing agents<br>Sodium polyphosphates |
| Sediment <sup>(2)</sup> | Corrosion products<br>Metal oxides<br>Silt<br>Diatomic organisms |  |
| Gross fouling           | Seaweed<br>Chips of wood and fibers<br>Mussels<br>Barnacles      |  |
| Biological growth       | Bacteria<br>Nematodes<br>Protozoa                                |  |
| Residue                 | Oily films<br>Asphalt<br>Fats                                    |  |

(1) Cleaners should be mixed at a maximum concentration of 4 percent by weight. The temperature of the cleaning solution should be less than 60 °C (140 °F).

(2) The addition of surfactants to the cleaning solution may ease cleaning.

(3) Do not mix the solvent with water for cleaning. Dry the plates with a cloth or rinse the plates with water.

(4) Gaskets that are made from natural rubber, butyl rubber and EPDM rubber will swell in these solvents. Do not allow the solvent to contact the gasket more than half an hour.

1. Drain the heat exchanger.
2. Disassemble the heat exchanger and remove the plates. Keep the plates in order.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

Due to extreme temperature changes, the hose will heat set. Heat setting causes hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

## Replace the Hoses and the Clamps

### **WARNING**

**Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.**

1. Stop the engine. Allow the engine to cool.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

**Note:** Drain the coolant into a suitable, clean container. The coolant can be reused.

3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
4. Remove the hose clamps.
5. Disconnect the old hose.
6. Replace the old hose with a new hose.
7. Install the hose clamps with a torque wrench.

**Note:** Refer to the Specifications, SENR3130, "Torque Specifications" in order to locate the proper torques.

8. Refill the cooling system.
9. Clean the cooling system filler cap. Inspect the cooling system filler cap's gaskets. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.
10. Start the engine. Inspect the cooling system for leaks.

## Maintenance Recommendations

**SMCS Code:** 1000

### Maintenance Information

The operating conditions of an engine affect the maintenance intervals and the time between overhauls for the engine. The following conditions affect the maintenance intervals and the expected overhaul interval for the engine.

#### Severe Operation

Severe operation is the use of an engine that exceeds current published standards for the engine. Caterpillar maintains standards for the following engine parameters:

- Horsepower
- Range of rpm
- Fuel consumption
- Fuel quality
- Altitude
- Maintenance intervals
- Selection of oil
- Selection of coolant
- Environmental qualities
- Installation

Refer to the standards for your engine or consult your Caterpillar dealer in order to determine if your engine is operating within the defined parameters.

Severe operation can accelerate component wear. Engines that are operating under severe conditions may need more frequent maintenance intervals for the following reasons:

- Maximum reliability
- Retention of full service life

Because of individual applications, it is not possible to identify all of the factors which can contribute to severe operation. Consult your Caterpillar dealer about the maintenance that is needed for your specific engine.

The following factors can contribute to severe operation: environment, improper operating procedures, and improper maintenance practices.

## Environmental Factors

### Extreme Ambient Temperatures

Extended operation in environments that are extremely cold or hot can damage components. Valve components can be damaged by carbon buildup if the engine is frequently started and stopped in very cold temperatures. Extremely hot inlet air reduces the performance capabilities of the engine.

**Note:** See this Operation and Maintenance Manual, “Cold Weather Operation” topic (Operation Section), or see Supplement, SEBU5898, “Cold Weather Recommendations”.

### Cleanliness

Unless the equipment is cleaned regularly, extended operation in a dirty environment and in a dusty environment can damage components. Built up mud, dirt, and dust can encase components. This can make maintenance difficult. The buildup can contain corrosive chemicals. Corrosive chemicals and salt can damage some components.

## Improper Operating Procedures

- Extended operation at low idle
- Minimum cool down periods after high load factor operation
- Operating the engine beyond the guidelines for the engine rating
- Operating the engine at loads that are greater than the rated load
- Operating the engine at speeds that are greater than the rated speed
- Use of the engine for an application that is not approved

## Improper Maintenance Practices

- Extension of maintenance intervals
- Not using recommended fuel, lubricants, and antifreeze/coolant solutions

## Overhaul Information

Reduced hours of operation at full load will result in a lower average power demand. A decreased average power demand should increase both the engine service life and the overhaul interval.

The need for an overhaul is generally indicated by increased fuel consumption and by reduced power.

The following factors are important when a decision is being made on the proper time for an engine overhaul:

- The need for preventive maintenance
- The quality of the fuel that is being used
- The operating conditions
- The results of the S-O-S analysis

**Note:** Refer to this Operation and Maintenance Manual, “Overhaul (Top)” for further information about the top overhaul.

**Note:** Refer to this Operation and Maintenance Manual, “Overhaul (Major)” for further information about the major overhaul.

## Oil Consumption as an Overhaul Indicator

Oil consumption, fuel consumption, and maintenance information can be used to estimate the total operating cost for your Caterpillar engine. Oil consumption can also be used to estimate the required capacity of a makeup oil tank that is suitable for the maintenance intervals.

Oil consumption is in proportion to the percentage of the rated engine load. As the percentage of the engine load is increased, the amount of oil that is consumed per hour also increases.

The oil consumption rate (brake specific oil consumption) is measured in grams per kW/h (lb per bhp). The brake specific oil consumption (BSOC) depends on the engine load. Consult your Caterpillar dealer for assistance in determining the typical oil consumption rate for your engine.

When an engine's oil consumption has risen to three times the original oil consumption rate due to normal wear, an engine overhaul should be scheduled. There may be a corresponding increase in blowby and a slight increase in fuel consumption.

i03634803

## Overhaul Options

### Before Failure Overhaul

To minimize downtime, Caterpillar Inc. recommends a scheduled engine overhaul by your Caterpillar dealer before the engine fails. This will provide you with the best cost/value relationship.

**Note:** Overhaul programs vary according to the engine application and according to the dealer that performs the overhaul. Consult your Caterpillar dealer for specific information about the available overhaul programs and about overhaul services for extending the engine life.

A planned overhaul before failure may be the best value for the following reasons:

- Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the standards for reusable parts.
- The engine's service life can be extended without the risk of a major catastrophe due to engine failure.
- The best cost/value relationship per hour of extended life can be attained.

### After Failure Overhaul

If a major engine failure occurs and the engine must be removed from the hull, many options are available. An overhaul should be performed if the engine block or the crankshaft needs to be repaired.

If the engine block is repairable and/or the crankshaft is repairable, the overhaul cost should be between 40 percent and 50 percent of the cost of a new engine with a similar exchange core.

This lower cost can be attributed to three aspects:

- Specially designed Caterpillar engine features
- Caterpillar dealer exchange components
- Caterpillar Inc. remanufactured exchange components

## Oil Cooler Core - Check/Clean/Test (If Equipped)

**SMCS Code:** 1378-070; 1378-081; 1378-535

### Clean the Oil Cooler Core

Remove the core. Refer to the Disassembly and Assembly Manual, "Oil Cooler - Remove" for the procedure.

1. Turn the oil cooler core on one side in order to remove debris. Remove the debris that is accessible.

#### NOTICE

Do not use a high concentration of caustic cleaner to clean the core. A high concentration of caustic cleaner can attack the internal metals of the core and cause leakage. Only use the recommended concentration of cleaner.

2. Back flush the core with cleaner.

Caterpillar recommends the use of Hydrosolv liquid cleaner. Table 16 lists Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 16

| Hydrosolv Liquid Cleaners <sup>(1)</sup> |                |                    |
|--|----------------|--------------------|
| Part Number                              | Description    | Size               |
| 1U-5490                                  | Hydrosolv 4165 | 19 L (5 US gallon) |
| 174-6854                                 | Hydrosolv 100  | 19 L (5 US gallon) |

<sup>(1)</sup> Use a two to five percent concentration of the cleaner at temperatures up to 93°C (200°F). Refer to Application Guide, NEHS0526 or consult your Caterpillar dealer for more information.

3. Steam clean the core in order to remove any residue. Flush the fins of the oil cooler core. Remove any other trapped debris from the inside and from the outside of the core.
4. Wash the core with hot, soapy water.
5. Flush the core thoroughly in order to remove residue and remaining debris. Flush the core with clean, fresh water until the water that is exiting the core is clear and free of debris.

 **WARNING**

**Personal injury can result from air pressure.**

**Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.**

**The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the air nozzle is deadheaded.**

6. Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.

## Test the Oil Cooler Core

1. Inspect the core for trapped debris and cleanliness. If necessary, remove the debris and repeat the cleaning procedure.
2. Inspect the core for damage and perform a pressure test in order to detect leaks. Many shops that service radiators are equipped to perform pressure tests.
3. Plug both ends of the oil cooler core and pressurize the core to 205 kPa (30 psi). Submerge the core in water. Look for bubbles which are being emitted from the core. The bubbles are evidence of leaks.
4. If any leaks are found, do not attempt to repair the core.

Install a core that is clean and a core that passes the pressure test in step 3. Refer to the Disassembly and Assembly Manual, "Oil Cooler - Install" for the procedure.

For more information on cleaning the core, consult your Caterpillar dealer.

i03398635

## Overhaul (Major)

**SMCS Code:** 7595-020-MJ

The need for a major overhaul is determined by several factors.

- An increase of oil consumption
- An increase of crankcase blowby
- The total amount of fuel consumption
- The service hours of the engine

- The wear metal analysis of the lube oil
- An increase in the levels of noise and vibration

An increase of wear metals in the lube oil indicates that the bearings and the surfaces that wear may need to be serviced. An increase in the levels of noise and vibration indicates that rotating parts require service.

**Note:** It is possible for oil analysis to indicate a decrease of wear metals in the lube oil. The cylinder liners may be worn so that polishing of the bore occurs. Also, the increased use of lube oil will dilute the wear metals.

Monitor the engine as the engine accumulates service hours. Consult your Caterpillar dealer about scheduling a major overhaul.

**Note:** The driven equipment may also require service when the engine is overhauled. Refer to the literature that is provided by the OEM of the driven equipment.

For the major overhaul, all of the bearings, seals, gaskets, and components that wear are disassembled. The parts are cleaned and inspected. If necessary, the parts are replaced. The crankshaft is measured for wear. The crankshaft may require regrinding. Alternatively, the crankshaft may be replaced with a Caterpillar replacement part.

Your Caterpillar dealer can provide these services and components. Your Caterpillar dealer can ensure that the components are operating within the appropriate specifications.

## Replacement of Components

Replace the following components during the major overhaul:

- Camshaft bearings
- Connecting rod bearings
- Crankshaft seals
- Crankshaft thrust washers
- Electronic unit injectors
- Gear train bushings
- Gear train bearings
- Main bearings
- Piston rings
- Aftercooler core

## International Convention for Safety of Life at Sea (SOLAS)

Caterpillar recommends replacing the following:

- All shields that have been installed to cover up fuel and oil line connections per (SOLAS) regulations
- All marine certification society approved tapes are installed in order to cover up fuel line connections and oil line connections according to the SOLAS regulations.

## Inspection, Reconditioning or Exchanging of Components

Inspect the following components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, "Index of Publications on Reusability or Salvage of Used Parts".

Recondition the worn components or exchange the components, if necessary. Your Caterpillar dealer can provide these services and components.

- Camshaft followers
- Camshaft thrust washers
- Connecting rods
- Crankshaft vibration damper
- Cylinder head assembly
- Cylinder liners
- Engine mounts
- Scavenge oil pump
- Engine wiring harness
- Exhaust manifold seals
- Exhaust manifold bellows
- Fuel pressure regulating valve
- Fuel priming pump
- Fuel transfer pump
- Inlet manifold gaskets
- Inlet manifold seals
- Oil cooler core

- Oil pump
- Pistons
- Piston pins
- Prelube pump
- Pushrods
- Rocker arms
- Spacer plate
- Software update
- Turbocharger

## Inspection of Components

Inspect the following components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, "Index of Publications on Reusability or Salvage of Used Parts".

- Camshaft
- Crankshaft
- Driven equipment (alignment)
- Engine cylinder block
- Engine control module
- Flywheel
- Front gear train (gears)
- Oil suction screen
- Rear gear train

Inspect the camshaft for damage to the journals and the lobes.

Inspect the crankshaft for any of the following conditions:

- Deflection
- Damage to the journals
- Bearing material that has seized to the journals

Check the journal taper and the profile of the crankshaft journals. Check these components by interpreting the wear patterns on the following components:

- rod bearing
- main bearings

**Note:** If the crankshaft or the camshaft are removed for any reason, use the magnetic particle inspection process to check for cracks.

Replace the crankshaft vibration damper if any of the following conditions occur:

- Engine failure due to a broken crankshaft
- Excessive wear of the front bearing for the crankshaft
- Excessive wear of the gear train that is not caused by a lack of lubrication

Inspect the gears of the gear train and inspect the gear train bushings for the following conditions:

- Worn gear teeth
- Unusual fit
- Unusual wear

In addition to the inspection of components, inspect the alignment of the driven equipment. See the Application and Installation Guide for the engine or see the literature that is provided by the OEM of the driven equipment.

## Cleaning of Components

Clean the oil suction screen. Also, remove side covers in order to clean the oil sump. For instructions on removal and installation of components, see the Service Manual, "Disassembly and Assembly" module.

## Obtain a Coolant Analysis

For conventional heavy-duty coolant or antifreeze, check the concentration of supplemental coolant additive (SCA) regularly. The concentration of SCA can be checked with an S-O-S coolant analysis (Level I). A more detailed coolant analysis is recommended periodically.

For example, considerable deposits are found in the water jacket areas on the external cooling system, but the concentrations of coolant additives were carefully maintained. The coolant water probably contained minerals which were deposited on the engine over time.

A coolant analysis can be conducted in order to verify the condition of the water that is being used in the cooling system. A full water analysis may be obtained from the following sources:

- Caterpillar dealer
- Local water utility company
- Agricultural agent
- Independent laboratory

Caterpillar recommends an S-O-S coolant analysis (Level II). This is a comprehensive chemical evaluation of the coolant. This analysis is also a check of the overall condition of the inside of the cooling system. The following services are provided:

- Full Level I analysis
- Identification of the source of metal corrosion and of contaminants
- Identification of buildup of the impurities that cause corrosion
- Identification of buildup of the impurities that cause scaling
- Determination of possible electrolysis within the engines' cooling system

A report of the results of the analysis is provided. Maintenance recommendations are based on the results.

For more information about S-O-S coolant analysis, consult your Caterpillar dealer.

i03648042

## Overhaul (Top End)

**SMCS Code:** 7595-020-TE

A top end overhaul involves the removal, the inspection, and the rework of the cylinder head components. A few additional components are replaced and serviced.

Your Caterpillar dealer can provide these services and components. Your Caterpillar dealer can ensure that the components are operating within the appropriate specifications.

The following definitions explain the terminology for the services that are performed during an overhaul:

i00905687

**Inspect** – Inspect the components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”. The guidelines were developed in order to help Caterpillar dealers and customers to avoid unnecessary expenditures. New parts are not required if the existing parts can still be used, reconditioned, or repaired. If the components are not in the reusability guidelines, refer to the Service Manual, “Specifications” module.

**Rebuild** – The component is reconditioned in order to comply with reusability guidelines.

**Replace** – The service life of the part is exhausted. The part may fail before the next maintenance interval. The part must be replaced with a part that meets functional specifications. The replacement part may be a new part, a CAT remanufactured part, a rebuilt part, or a used part. Some worn components may be exchanged with your Caterpillar dealer for a credit on replacement parts. Consult your Caterpillar dealer about repair options for your engine.

If you elect to perform an overhaul without the services of a Caterpillar dealer, be aware of the recommendations in Table 17.

Table 17

| Recommendations for Top End Overhauls <sup>(1)</sup> |   |
|--|---|
| Service  | Top End Overhaul  |
| Inspect<br>Rebuild<br>Replace                        | Cylinder head assemblies  |
|  | Valves  |
| Inspect<br>Replace                                   | Rocker arms   |
|  | Valve bridges   |
|  | Fuel Injectors  |
| Clean/Test   | Oil cooler core <sup>(2)</sup><br>Aftercooler core (Fresh water or treated water system) <sup>(3)</sup> |
| Replace  | Cylinder head gaskets<br>Aftercooler core (salt water system)   |

(1) For instructions on removal and installation of components, see the Service Manual, “Disassembly and Assembly” module.

(2) Refer to this Operation and Maintenance Manual, “Oil Cooler Core - Check/Clean/Test” for the procedure.

(3) Refer to this Operation and Maintenance Manual, “Aftercooler Core - Clean/Test” for the procedure.

## Sea Water Strainer - Clean/Inspect

**SMCS Code:** 1371-040; 1371-070

The sea water strainer must be clean in order to allow proper engine cooling. Check the sea water strainer for plugging. Inspect the sea water strainer more frequently if the vessel is being operated in water which is shallow or dirty. Refer to the OEM recommendations for more information about inspecting and cleaning the sea water strainer.

Ensure that the auxiliary water pump is primed and that the suction line is open.

1. Remove the sea water strainer and clean the screen. Remove any dirt and debris.
2. Install the sea water strainer. Fill the sea water strainer and the suction line for the auxiliary water pump with water.

i01113939

## Starting Motor - Inspect

**SMCS Code:** 1451-040; 1453-040

If the starting motor fails, the engine may not start in an emergency situation. A scheduled inspection of the starting motor is recommended.

The starting motor pinion and the flywheel ring gear must be in good condition in order for the engine to start properly. The engine will not start if the starting motor pinion does not engage the flywheel ring gear. The teeth of the starting motor pinion and the flywheel ring gear can be damaged because of irregular engagement.

Inspect the starting motor for proper operation. Listen for grinding when the engine is started. Inspect the teeth of the starting motor pinion and the flywheel ring gear. Look for patterns of wear on the teeth. Look for teeth that are broken or chipped. If damaged teeth are found, the starting motor pinion and the flywheel ring gear must be replaced.

## Electric Starting Motor

**Note:** Problems with the electric starting motor can be caused by the following conditions: malfunction of the solenoid and malfunction of the electric starting system.

Inspect the electrical system for the following conditions:

- Loose connections
- Corrosion
- Wires that are worn or frayed
- Cleanliness

Make repairs, if necessary.

## Air Starting Motor

### **WARNING**

**Personal injury or death can result from improperly checking for a leak.**

**Always use a board or cardboard when checking for a leak. Escaping air or fluid under pressure, even a pin-hole size leak, can penetrate body tissue causing serious injury, and possible death.**

**If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.**

Inspect all of the components in the air circuit for the starting motor. Inspect all of the air lines and connections for leaks.

If the teeth of the starting motor pinion and/or the flywheel ring gear are damaged, the air circuit for the starting motor must be examined in order to determine the cause of the problem.

## Removal and Installation of the Starting Motor

Refer to the Service Manual, "Disassembly and Assembly" module for information on removing the starting motor and installing the starting motor.

Consult your Caterpillar dealer for assistance.

i01539769

## Turbocharger - Inspect

**SMCS Code:** 1052-040; 1052

Periodic inspection and cleaning is recommended for the turbocharger compressor housing (inlet side). Any fumes from the crankcase are filtered through the air inlet system. Therefore, by-products from oil and from combustion can collect in the turbocharger compressor housing. Over time, this buildup can contribute to loss of engine power, increased black smoke and overall loss of engine efficiency.

If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel can cause additional damage to the pistons, the valves, and the cylinder head.

### NOTICE

Turbocharger bearing failures can cause large quantities of oil to enter the air inlet and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of a turbocharger housing under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is repaired or replaced.

An inspection of the turbocharger can minimize unscheduled downtime. An inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

**Note:** Turbocharger components require precision clearances. The turbocharger cartridge must be balanced due to high rpm. Severe Service Applications can accelerate component wear. Severe Service Applications require more frequent inspections of the cartridge.

## Removal and Installation

For options regarding the removal, installation, repair and replacement, consult your Caterpillar dealer. Refer to the Service Manual for this engine for the procedure and specifications.

## Cleaning and Inspecting

1. Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil. Clean the interior of the pipes in order to prevent dirt from entering during reassembly.

2. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger must be reconditioned.
3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the wheel, there is a possibility of a failed turbocharger oil seal.  
  
The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the inlet air (plugged air filters), which causes the turbocharger to slobber.
4. Use a dial indicator to check the end clearance on the shaft. If the measured end play is greater than the Service Manual specifications, the turbocharger should be repaired or replaced. An end play measurement that is less than the minimum Service Manual specifications could indicate carbon buildup on the turbine wheel. The turbocharger should be disassembled for cleaning and for inspection if the measured end play is less than the minimum Service Manual specifications.
5. Inspect the bore of the turbine housing for corrosion.
6. Clean the turbocharger housing with standard shop solvents and a soft bristle brush.
7. Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

i02706582

## Walk-Around Inspection

**SMCS Code:** 1000-040

### Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only require a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections and trash buildup. Make repairs, as needed:

- The guards must be in the proper place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

---

#### NOTICE

For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

---



---

#### NOTICE

Accumulated grease and/or oil on an engine or deck is a fire hazard. Remove this debris with steam cleaning or high pressure water.

---

- Ensure that the cooling lines are tight and ensure that the cooling lines are properly clamped. Check for leaks. Check the condition of all pipes.
- Inspect the water pumps for coolant leaks.

**Note:** The water pump seal is lubricated by coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of water pumps and the installation of water pumps and/or seals, refer to the Service Manual for the engine or consult your Caterpillar dealer.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the valve cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.
- Inspect the alternator belt and the accessory drive belts for cracks, breaks or other damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt is replaced, the belt will carry more load than the belts that are not replaced. The older belts are stretched. The additional load on the new belt could cause the belt to break.

- Drain the water and the sediment from fuel tanks on a daily basis in order to ensure that only clean fuel enters the fuel system.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Inspect the ECM to the cylinder head ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges which are cracked and replace any gauges that can not be calibrated.

i03543200

## Water Pump - Inspect

**SMCS Code:** 1361-040; 1361

A failed water pump might cause severe engine overheating problems that could result in the following conditions:

- Cracks in the cylinder head
- A piston seizure
- Other potential damage to the engine

A failed water pump might cause severe engine overheating problems that could result in cracks in the cylinder head, a piston seizure or other potential damage to the engine.

Visually inspect the water pump for leaks. If leaking of the water pump seals is observed, replace all of the water pump seals. Refer to two articles in the Disassembly and Assembly Manual, "Water Pump - Disassemble and Water Pump - Assemble" for the disassembly and assembly procedure. If it is necessary to remove the water pump, refer to two articles in the Disassembly and Assembly Manual, "Water Pump - Remove and Water Pump - Install".

Inspect the water pump for wear, cracks, pin holes and proper operation. Refer to the Parts Manual for the correct part numbers for your engine or consult your Caterpillar dealer if repair is needed or replacement is needed.

i03612482

## Zinc Rods - Inspect/Replace

**SMCS Code:** 1388-040; 1388-510

Corrosion in sea water circuits can result in premature deterioration of system components, leaks, and possible cooling system contamination.

Zinc rods are inserted in the sea water cooling system of the engine in order to help prevent the corrosive action of salt water. The reaction of the zinc to the sea water causes the zinc rods to deteriorate. The zinc rods deteriorate instead of engine parts for the cooling system that are more critical. Rapid deterioration of zinc rods may indicate the presence of uncontrolled electrical currents from improperly installed electrical attachments or improperly grounded electrical attachments.

The zinc rods must be inspected at the proper intervals. The zinc rods must be replaced when deterioration occurs.

Inspect the zinc rods within 24 hours of initially filling the plumbing with sea water. If no significant corrosion is noted, inspect the zinc rods weekly or inspect the zinc rods after each 50 hours of engine operation. If no significant deterioration is noted, inspect the zinc rods weekly or inspect the zinc rods after each 50 hours of engine operation.

## Locations of the Zinc Rods

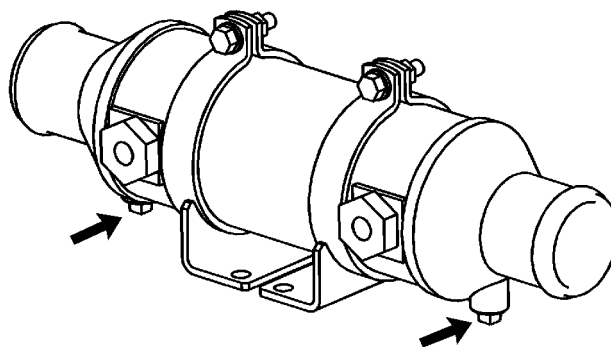


Illustration 87

g01937139

One or two zinc rods may be located in the oil cooler.

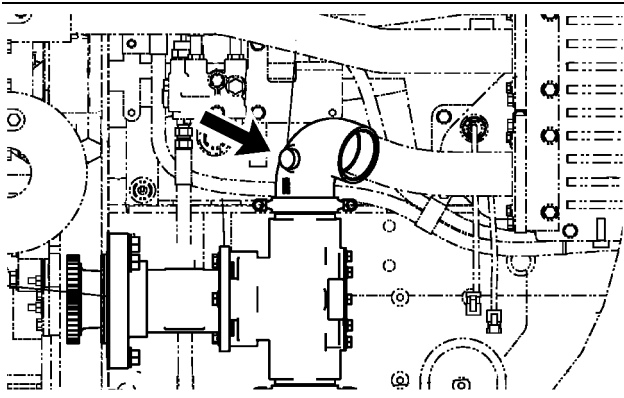


Illustration 88

g01937142

One zinc rod is located on top of the auxiliary water pump.

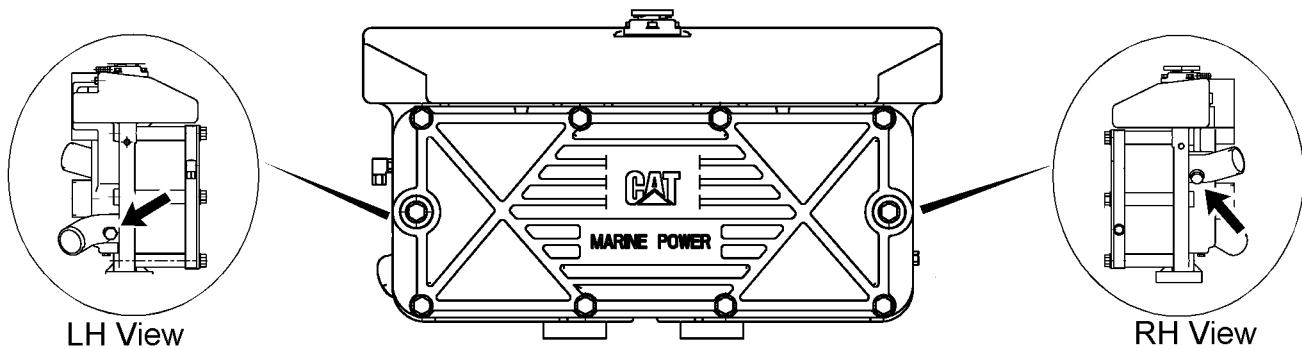


Illustration 89

g01937141

One zinc rod is located in the intake for the heat exchanger. One zinc rod is located in the outlet for the heat exchanger.

## Inspect the Zinc Rods

1. Remove the zinc rod.

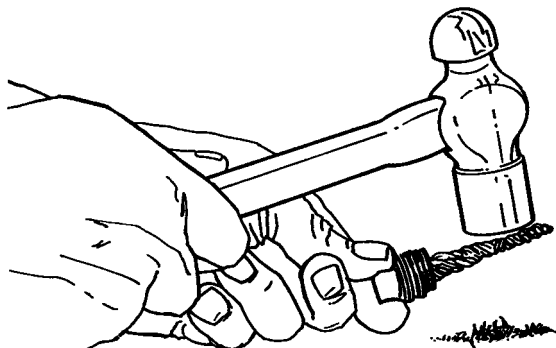


Illustration 90

g00104048

2. Tap the zinc rod lightly with a hammer. If the zinc rod has deteriorated, or if the zinc rod flakes, install a new zinc rod.

## Replace the Zinc Rods

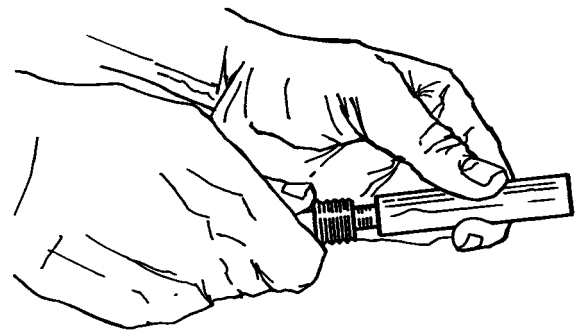


Illustration 91

g00104049

1. Unscrew the old zinc rod or drill the old zinc rod from the plug. Clean the plug.
2. Apply 9S-3263 Compound to the shoulder of a new zinc rod. Apply the compound only to the shoulder of the zinc rod. Install the zinc rod into the plug.

3. Coat the external threads of the plug with 5P - 3413 Pipe Sealant. Install the zinc rod. Refer to the Specifications Manual for more information on torque specifications.