SAFETY.CAT.COM™

C32 MARINE ENGINE (RXB)

Maintenance Intervals

Excerpted from Operation & Maintenance Manual (SEBU7908-09)

CATERPILLAR®

i03634432

Maintenance Interval Schedule (Engines Which Are Rated “B” and Engines Which Are Rated “C”)

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 installation of new components due to normal wear and aging. The performance of this product may be diminished if proper maintenance intervals and procedures are not followed. Components may experience accelerated wear if proper maintenance intervals and procedures are not followed.

Note: Use whichever of the following that occurs first in order to determine the maintenance intervals: fuel consumption, service hours, and calendar time . Before each consecutive interval is performed, all maintenance from the previous intervals must be performed.

Products that operate in severe operating conditions may require more frequent maintenance.

When Required

Daily

Initial 10 Service Hours

Every 50 Service Hours or Weekly

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

Every Year

Every 6000 Service Hours or 3 Years

Every 12 000 Service Hours or 6 Years

First 22 700 L (6000 US gal) of Fuel or 250 Service Hours

Every 22 700 L (6000 US gal) of Fuel or 250 Service Hours or 1 Year

Every 90 850 L (24 000 US gal) of Fuel or 1000 Service Hours

Every 272 550 L (72 000 US gal) of Fuel or 3000 Service Hours

Every 454 250 L (120 000 US gal) of Fuel or 5000 Service Hours

Overhaul

i03753401

Maintenance Interval Schedule (Engines Which Are Rated “E”)

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 installation of new components due to normal wear and aging. The performance of this product may be diminished if proper maintenance intervals and procedures are not followed. Components may experience accelerated wear if proper maintenance intervals and procedures are not followed.

Note: Use whichever of the following that occurs first in order to determine the maintenance intervals: fuel consumption, service hours, and calendar time . Before each consecutive interval is performed, all maintenance from the previous intervals must be performed.

Products that operate in severe operating conditions may require more frequent maintenance.

When Required

Daily

Initial 10 Service Hours

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

Every Year

Every 6000 Service Hours or 3 Years

Every 12 000 Service Hours or 6 Years

First 22 700 L (6000 US gal) of Fuel or 250 Service Hours

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Every 454 250 L (120 000 US gal) of Fuel or 5000 Service Hours

Overhaul

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 20 lists Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 20

Hydrosolv Liquid Cleaners(1)		
Part Number	**Description**	**Size**
1U-5490	Hydrosolv 4165	19 L (5 US gallon)
174-6854	Hydrosolv 100	19 L (5 US gallon)

(1) 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 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.

i02676048

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

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.

i02153996

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

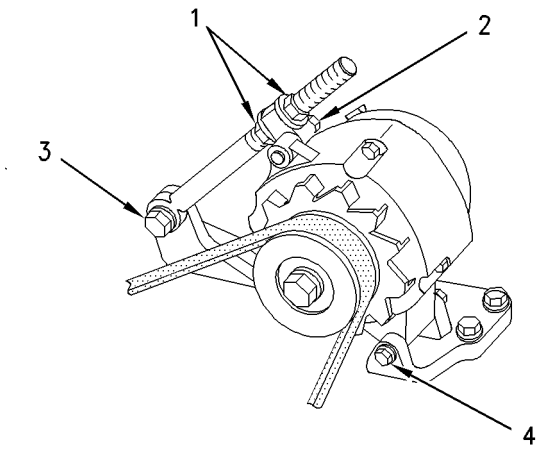

Illustration 24 g00960176

(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.

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Closed Crankcase Ventilation (CCV) Fumes Disposal Filter - Replace

SMCS Code: 1317-510-FI

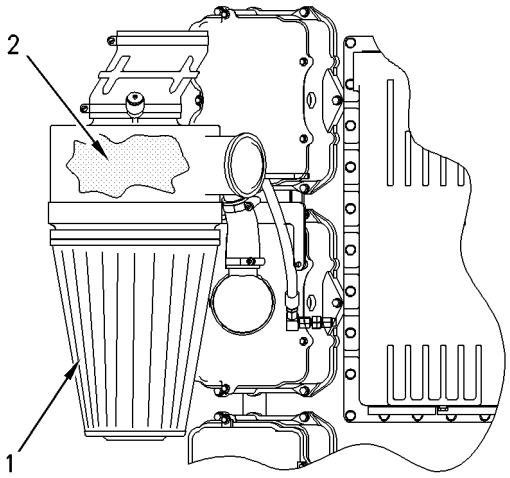

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Illustration 25

(1) Air cleaner element
(2) Fumes disposal filter

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

Use the following steps in order to ensure the proper replacement of the fumes disposal filter.

1. Remove air cleaner element (1).
2. Remove fumes disposal filter (2).
3. Install a new fumes disposal filter (2).
4. Install air cleaner element (1).

i02571689

Cooling System Coolant (DEAC) - Change

SMCS Code: 1350-070; 1395-044

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

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

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.

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

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 and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.
2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove one of the drain plugs.

   Allow the 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 Dealer Service Tools:

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. Install the drain plugs. Refer to the Specifications Manual for your particular engine for more specific information on the proper torques. Refer to the Specifications, SENR3130, “Torque Specifications” for more general 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 cooling system filler cap.

4. Start the engine and run the engine at low idle for a minimum of 30 minutes. The coolant temperature should be at least 82 °C (180 °F).

NOTICE
Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system 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. Install the drain plugs. Refer to the Specifications Manual for your particular engine for more specific information on the proper torques. Refer to the Specifications, SENR3130, “Torque Specifications” for more general 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. Install the drain plugs. Refer to the Specifications Manual for your particular engine for more specific information on the proper torques. Refer to the Specifications, SENR3130, “Torque Specifications” for more general 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 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity. Install the cooling system filler cap.

4. Start the engine and run the engine at low idle for a minimum of 90 minutes. The coolant temperature should be at least 82 °C (180 °F).

NOTICE
Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system 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. Install the drain plugs. Refer to the Specifications Manual for your particular engine for more specific information on the proper torques. Refer to the Specifications, SENR3130, “Torque Specifications” for more general information on the proper torques.

Fill

Refer to Special Publication, SEBU6251, “Commercial Diesel Engine Fluids Recommendations” for information regarding acceptable water, antifreeze/coolant, and supplemental coolant additive requirements.

Engines that are Equipped with a Coolant Recovery Tank

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

1. Fill the cooling system with antifreeze/coolant. Refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” for additional information on cooling system specifications. Do not install the cooling system filler cap.

2. Start the engine and run the engine at low idle. Increase the engine rpm to high idle. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Return the engine to low idle. Stop the engine.

3. Add coolant to the cooling system until the cooling system is full.

4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.

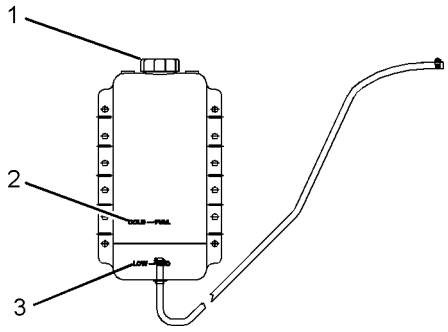

Illustration 26 g01268104

(1) Recovery tank filler cap
(2) “COLD FULL” mark
(3) “LOW ADD” mark

5. Loosen the cap for the coolant recovery tank slowly in order to relieve any pressure. Remove the cap for the coolant recovery tank.

6. Pour coolant into the coolant recovery tank until the coolant reaches the “COLD FULL” mark. DO NOT fill the coolant recovery tank above the “COLD FULL” mark.

Note: Pleasure craft that are cooled by a heat exchanger may require the coolant recovery tank to be overfilled approximately 102 mm (4 inch) above the CODE FULL mark.

7. Clean the cap for the coolant recovery tank. Install the cap for the coolant recovery tank.

8. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

9. Stop the engine and allow the engine to cool. Verify the coolant level in the coolant recovery tank.

Note: If necessary, refer to step8 through step 9 in order to purge air from the cooling system.

Engines that are Not Equipped with a Coolant Recovery Tank

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

1. Fill the cooling system with antifreeze/coolant. Refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” for additional information on cooling system specifications. Do not install the cooling system filler cap.

2. Start the engine and run the engine at low idle. Increase the engine rpm to high idle. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Return the engine to low idle. 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 cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.

5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i02555261

Cooling System Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

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

⚠ 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 and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove the cooling system drain plugs.

   Allow the 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 Dealer Service Tools:

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. Install the drain plugs. Refer to the Specifications Manual for your particular engine for more specific information on the proper torques. Refer to the Specifications, SENR3130, “Torque Specifications” for more general 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 clean water. Install the cooling system filler cap.

4. Start the engine and run the engine at low idle until the temperature reaches 49 to 66 °C (120 to 150 °F).

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system 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. Install the drain plugs. Refer to the Specifications Manual for your particular engine for more specific information on the proper torques. Refer to the Specifications, SENR3130, “Torque Specifications” for more general information on the proper torques.

Fill

Engines that are Equipped with a Coolant Recovery Tank

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

1. Fill the cooling system with Extended Life Coolant (ELC). Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.

2. Start the engine and operate the engine at low idle. Increase the engine rpm to high idle. Operate the engine at high idle for one minute in order to purge air from the cavities of the engine block. Return the engine to low idle. Stop the engine.

3. Pour more ELC into the cooling system until the cooling system is full.

4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.

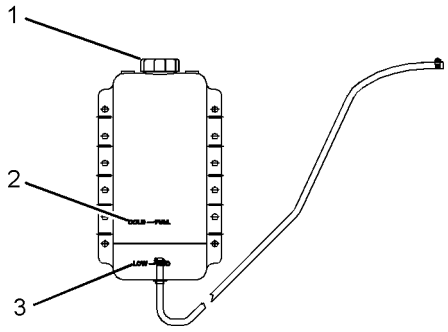

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Illustration 27
(1) Recovery tank filler cap
(2) “COLD FULL” mark
(3) “LOW ADD” mark

5. Loosen the cap for the coolant recovery tank slowly in order to relieve any pressure. Remove the cap for the coolant recovery tank.

6. Pour Extended Life Coolant (ELC) into the coolant recovery tank until the coolant reaches the “COLD FULL” mark. DO NOT fill the coolant recovery tank above the “COLD FULL” mark.

Note: Pleasure craft that are cooled by a heat exchanger may require the coolant recovery tank to be overfilled approximately 102 mm (4 inches) above the “COLD FULL” mark.

7. Clean the cap for the coolant recovery tank. Install the cap for the coolant recovery tank.

8. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

9. Stop the engine and allow the engine to cool. Verify the coolant level in the coolant recovery tank.

Note: If necessary, refer to step 8 through step 9 in order to purge air from the cooling system.

Engines that are NOT Equipped with a Coolant Recovery Tank

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

1. Fill the cooling system with Extended Life Coolant (ELC). Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.

2. Start the engine and operate the engine at low idle. Increase the engine rpm to high idle. Operate the engine at high idle for one minute in order to purge air from the cavities of the engine block. Return the engine to low idle. Stop the engine.

3. Check the coolant level. Maintain the coolant level within 13 mm (.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (.5 inch) to the proper level on the sight glass (if equipped).

4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.

5. Start the engine. Inspect the cooling system for 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.

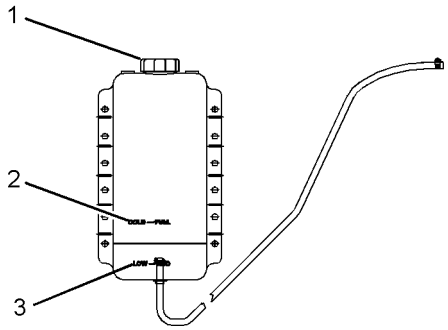
i02538100

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



g01268104

Illustration 28

(1) Recovery tank 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.

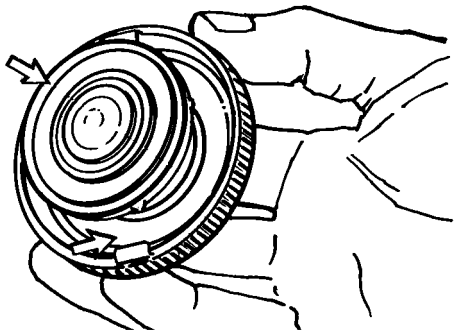
Engines That Are Not Equipped with a Coolant Recovery Tank

⚠ 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.



g00103639

Illustration 29

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.

i02837191

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 21

Recommended Interval		
Type of Coolant	**Level 1**	**Level 2**
Cat DEAC	Every 250 Hours(1)	Yearly(1)(2)
Cat ELC	Optional(2)	Yearly(2)

(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.

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.

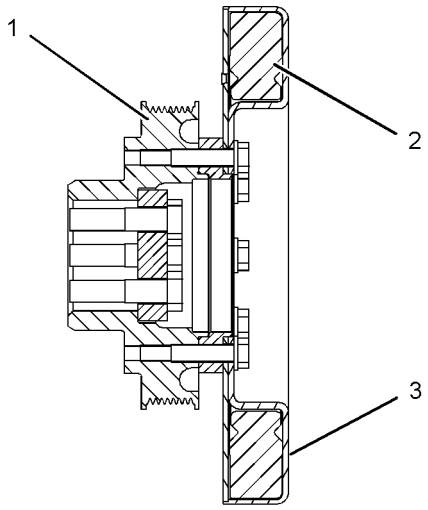


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Illustration 30

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.

i01646701

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.

i01727320

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.

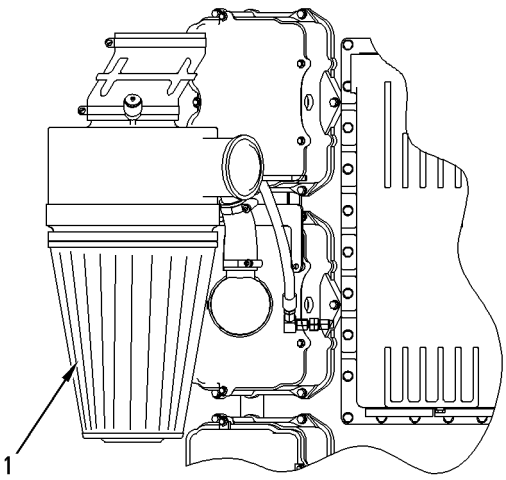


Illustration 31 g00887344

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

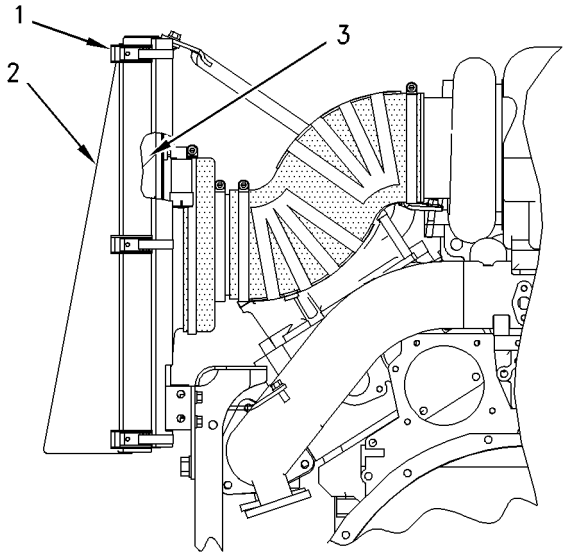


Illustration 32 g00888130

1. Disconnect latches (1).

2. Remove cover (2).

3. Remove air cleaner element (3).

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 (3).

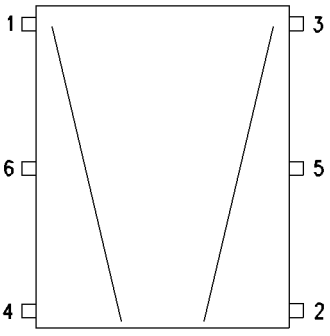


Illustration 33 g00888209

Sequence for latches

6. Install cover (2). Fasten cover (2) with latches(1) in the sequence that is shown in Illustration 33.

Type 3

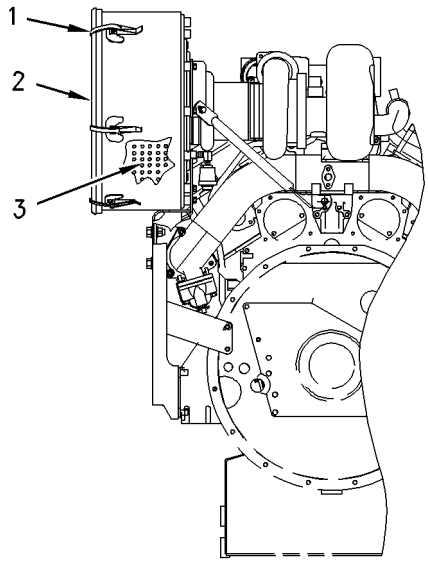


Illustration 34 g00888128

1. Disconnect latches (1).

2. Remove cover (2).

3. Remove air cleaner element (3).

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 (3).

6. Install cover (2).

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

i01900118

Engine Air Cleaner Service Indicator - Inspect (If Equipped)

SMCS Code: 7452-040

Some engines may be equipped with a different service indicator.

Some engines are equipped with a differential gauge for inlet air pressure. The differential gauge for inlet air pressure displays the difference in the pressure that is measured before the air cleaner element and the pressure that is measured after the air cleaner element. As the air cleaner element becomes dirty, the pressure differential rises. If your engine is equipped with a different type of service indicator, follow the OEM recommendations in order to service the air cleaner service indicator.

The service indicator may be mounted on the air cleaner housing or in a remote location.

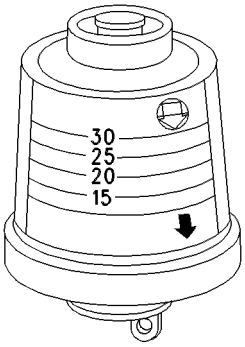


Illustration 35 g00103777

Typical service indicator

Observe the service indicator. The air cleaner element should be cleaned or the air cleaner element should be replaced when one of the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.

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 speed. 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 hole for the service indicator may be plugged.

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).

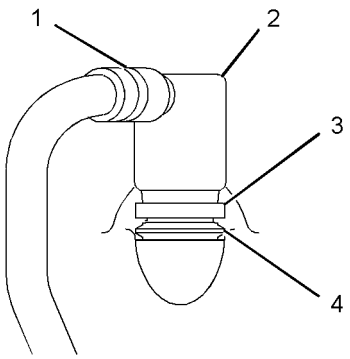
i02263740

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.



g01136454

Illustration 36

Typical example

(1) Hose clamp
(2) Breather assembly
(3) Retaining clamp
(4) Seal

1. Loosen hose clamp (1) and remove the hose from breather assembly (2).
2. Loosen retaining clamp (3). Remove the breather assembly and seal (4).
3. Wash the breather element in solvent that is clean and nonflammable. Allow the breather element to dry before installation.
4. Install a breather element that is clean and dry. Install the seal, the breather assembly, and the clamp. Refer to the Specifications, SENR3130 in order to locate the proper torques.
5. Install the hose. Install the hose clamp. Refer to the Specifications, SENR3130 in order to locate the proper torques.

i02456872

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.

i03709060

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

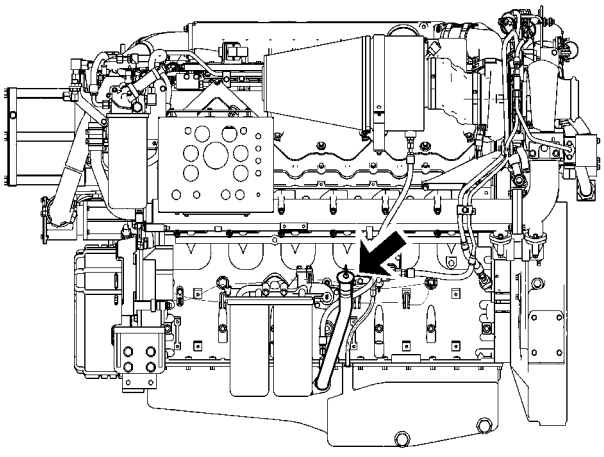


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Illustration 37

Typical C32 Marine Engine

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

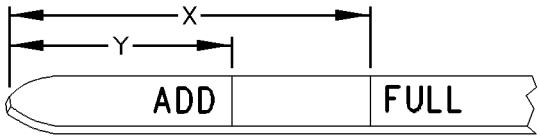

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Illustration 38

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.

i02776578

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 type of sump:

   - **Standard Oil Sump**: Fill the crankcase with 75.7 L (80 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 sump:

   - **Standard Oil Sump**: Fill the crankcase with 75.7 L (80 qt) of the recommended oil.

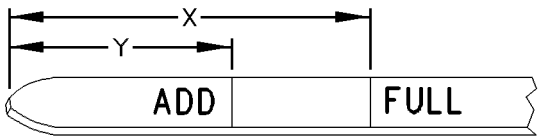
8. Start the engine. Ensure that the lubrication system and the new engine oil filter are filled. Inspect the lubrication system for leaks.

9. Stop the engine and allow the engine oil to drain into the engine crankcase for approximately twenty 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 9.5 L (10 qt) of the recommended oil grade and weight of engine oil to the crankcase with a standard sump. Allow the oil to drain into the sump for approximately 20 minutes.

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.



g00110310

Illustration 39

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.

i02107152

Engine Oil and Filter - Change

SMCS Code: 1318-510; 1348-044

⚠ WARNING

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

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

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

Drain the Engine Oil

After the engine has been run at the normal operating temperature, stop the engine. Use one of the following methods to drain the engine crankcase oil:

- If the engine is equipped with a drain valve, turn the drain valve knob counterclockwise in order to drain the oil. After the oil has drained, turn the drain valve knob clockwise in order to close the drain valve.
- If the engine is not equipped with a drain valve, remove the oil drain plug in order to allow the oil to drain. If the engine is equipped with a shallow sump, remove the bottom oil drain plugs from both ends of the oil pan.

After the oil has drained, the oil drain plugs should be cleaned and installed.

Replace the Oil Filter

NOTICE
Caterpillar oil filters are built to Caterpillar specifications. Use of an oil filter not recommended by Caterpillar could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

1. Remove the oil filter with a 1U-8760 Chain Wrench.
2. 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 oil filter element. Ferrous metals may indicate wear on the steel and cast iron parts of the engine. Nonferrous metals may indicate wear on the aluminum parts, brass parts or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

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

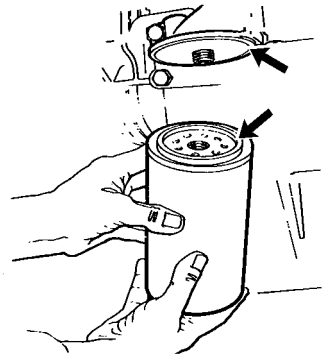


Illustration 40 g00103713
Typical filter mounting base and filter gasket

3. Clean the sealing surface of the filter mounting base. Ensure that all of the old oil filter gasket is removed.
4. Apply clean engine oil to the new oil 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.

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

Fill the Engine Crankcase

1. Remove the oil filler cap. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” for more information.

NOTICE
If equipped with an auxiliary oil filter system or a remote oil filter system, follow the OEM or filter manufacturer's recommendations. Under filling or overfilling the crankcase with oil can cause engine damage.

NOTICE
To prevent crankshaft bearing damage, crank the engine with the fuel OFF. This will fill the oil filters before starting the engine. Do not crank the engine for more than 30 seconds.

2. Start the engine and run the engine at “LOW IDLE” for two minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.

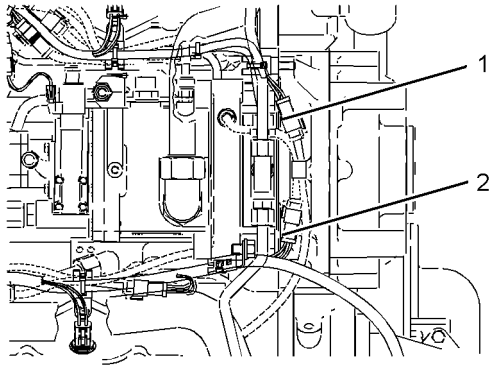
3. Stop the engine and allow the oil to drain back to the sump for a minimum of ten minutes.

4. Remove the oil level gauge in order to check the oil level. Maintain the oil level between the “ADD” and “FULL” marks on the oil level gauge.

i03709240

Engine Speed/Timing Sensors - Check/Clean/Calibrate

SMCS Code: 1912-040; 1912-070; 1912-524



g01996333

Illustration 41

Top view

(1) Secondary speed/timing sensor
(2) Primary speed/timing sensor

1. Remove the speed/timing sensors from the front housing. Check the condition of the plastic end of the speed/timing sensors for wear and/or contaminants.

2. Clean the metal shavings and other debris from the face of the speed/timing sensors. Use the procedure in the Troubleshooting Manual, “Speed/Timing Sensor - Calibrate” in order to calibrate the speed/timing sensors.

i01458399

Engine Storage Procedure - Check

SMCS Code: 1000-535

The oil change interval may be extended to 12 months for a vehicle that is operated seasonally and placed in storage for the remainder of the year by using the required storage procedures and the required start-up procedures. This extension is permitted if the following categories for oil change intervals in the Operation and Maintenance Manual, “Maintenance Interval Schedule” have not been reached:

- Mileage
- Operating hours
- Fuel consumption

If an engine is out of operation and if use of the engine is not planned, special precautions should be made. If the engine will be stored for more than three months, a complete protection procedure is recommended. For more detailed information on engine storage, see Special Instruction, SEHS9031, “Storage Procedure For Caterpillar Products”.

If the engine will not be started for several weeks, the lubricating oil will drain from the cylinder walls and from the piston rings. Rust can form on the cylinder liner surface. Rust on the cylinder liner surface will cause increased engine wear and a reduction in engine service life. Caterpillar recommends the use of volatile corrosion inhibitor (VCI) oil in order to prevent internal engine damage due to moisture during storage. These inhibitors in the VCI oil act by evaporating inside the engine. The inhibitors then condense over the inside surfaces of the engine. The evaporation process and the condensing process offers full protection to surfaces that cannot be reached with preservatives. 0.9 L (1.0 qt) of 4C-6792 VCI oil will treat 28.4 L (30.0 qt) of engine oil. This will give a 3 percent concentration of VCI oil. The engine must be completely sealed when the engine is stored in order for the VCI oil to function properly. The VCI oil is easily cleaned from the engine when you remove the engine from storage. The volatile vapors are removed by simply running the engine to operating temperature. A mineral oil base is left behind after the volatile vapors are removed.

i00869628

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 adjustment is necessary due to the initial wear of the valve train components and to the 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.

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.

Ensure that the engine is stopped before measuring the valve lash. To obtain an accurate measurement, allow the valves to cool before this maintenance is performed.

Refer to the Service Manual for more information.

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.

i02553422

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.

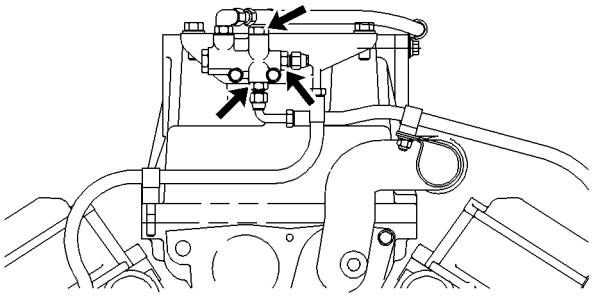


Illustration 42 g00395938

Fuel supply connections

The fuel system should be primed after a unit injector is changed or when the fuel system is totally dry.

Note: The fuel system does not typically need to be primed when the primary fuel filters or secondary fuel filters are changed or when an Electronic Control Module (ECM) is replaced. When the engine is started under these circumstances, the engine may momentarily run rough until the air is purged from the system.

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 any disconnected fuel system components.

1. Loosen a fuel supply connection to the regulating valve, as shown.

Note: The fuel priming pump is located on the secondary fuel filter. Operating the fuel priming pump without loosening a fuel connection upstream of the regulating valve can cause a failure of the fuel transfer pump seal.

2. Open the fuel priming pump and operate the pump until air is purged and the fuel appears at the fuel connection. Tighten the fuel connection.

3. Crank the engine after pressurizing the 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. If the engine does not start, repeat Steps 1 through 3 in order to start the engine.

i02927282

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. If a vacuum gauge is installed, the primary filter/water separator should be changed at 50 to 70 kPa (15 to 20 inches Hg).

Replace the Element

⚠ 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” 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.

1. Close the main fuel supply valve.

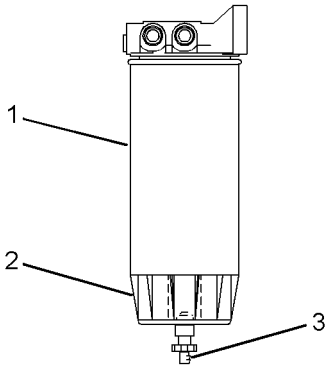


Illustration 43 g01453091

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

2. Remove element (1) from the element mounting base while bowl (2) is attached.

3. Dispose of the contents of the filter. Remove bowl (2) from element (1). The bowl is reusable. Do not discard the bowl. Dispose of the used element.

4. Remove the O-ring from the gland of the bowl. Clean the following components:

- Bowl
- O-ring
- Mounting base

Inspect the O-ring for damage and for deterioration. Replace the O-ring, if necessary.

5. Lubricate the O-ring with clean diesel fuel.

6. Install bowl (2) on a new element. Tighten the bowl by hand. Do not use tools in order to tighten the bowl.

NOTICE
The primary filter/water separator may be prefilled with fuel to avoid rough running/stalling of the engine due to air. Do not fill the secondary filter with fuel before installation. The fuel would not be filtered and could be contaminated. Contaminated fuel will cause accelerated wear to fuel system parts.

7. Lubricate the top seal of element (1) with clean diesel fuel. The element may be filled with fuel at this time. Install the new element on the mounting base. Tighten the element by hand.

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.

8. Open the main fuel supply valve.

9. Start the engine and check for leaks. Run the engine for one minute. Stop the engine and check for leaks again.

Detecting leaks is difficult while 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.

i01463757

Fuel System Primary Filter/Water Separator - Drain

SMCS Code: 1260-543; 1263-543

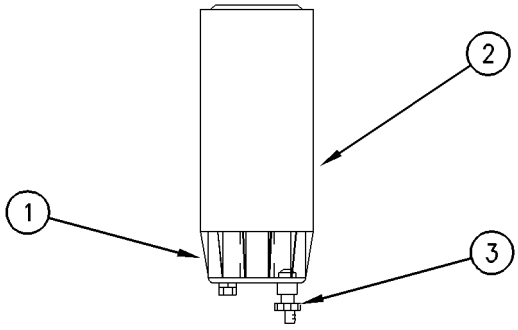


Illustration 44 g00668636

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

Bowl (1) 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.

i00823807

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. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

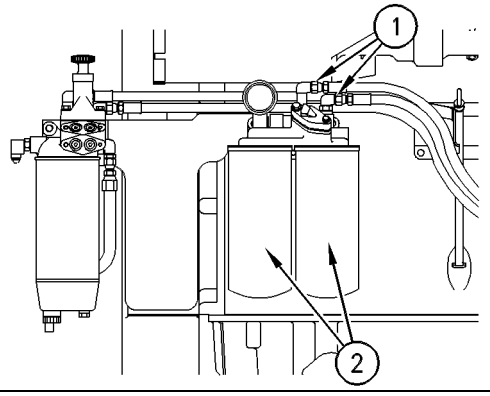


Illustration 45 g00396257

(1) Fuel supply connections
(2) Fuel filters

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 any disconnected fuel system components.

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

1. It may be necessary to relieve residual fuel pressure from the fuel system before removing the fuel filter.

   Loosen one of the fuel supply connections (1) in order to purge any residual pressure.

NOTICE
Do not loosen fuel lines or fittings at the fuel manifold or ECM. The engine components may be damaged.

2. Remove the used fuel filter.

3. Clean the gasket sealing surface of the fuel filter base. Ensure that all of the old gasket is removed.

4. 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.

5. Install the new fuel filter. 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.

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 Durablity”.

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.

i03712080

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” 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.

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.

Cleaning Procedure

Removal and Disassembly of the Heat Exchanger

Drain the heat exchanger. Refer to the Disassembly and Assembly Manual, “Heat Exchanger - Remove” for the removal procedure.

Refer to the Disassembly and Assembly Manual, “Heat Exchanger - Disassemble” for the disassembly procedure. **Keep the plates in order.**.

Cleaning the Heat Exchanger

Refer to “Choosing the Correct Cleaning Fluid” for the correct cleaning fluid for your heat exchanger. 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.

Choosing the Correct Cleaning Fluid

Refer to 22 for the correct cleaning fluid for the heat exchanger.

Table 22

Problem	Source	Cleaners[1][2][3][4]
Scaling	Calcium carbonate Calcium sulfate Silicates	Nitric acid Sulfamic acid Citric acid Phosphoric acid Complexing agents Sodium polyphosphates
Sediment[5]	Corrosion products Metal oxides Silt Diatomic organisms	
Gross fouling	Seaweed Chips of wood and fibers Mussels Barnacles	
Biological growth	Bacteria Nematodes Protozoa	
Residue	Oily films Asphalt Fats	Paraffinic or Naphtha based solvent such as Kerosene.[6][7]

(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) Do not use water that contains more than 300 ppm of chlorine in the preparation of cleaning solutions.

(3) Do not use hydrochloric acid to clean stainless steel plates. Do not use hydrofluoric acid to clean titanium plates.

(4) Do not use a type of ketone such as acetone and methyletyketone. Do not use aromatics such as benzene and toluene. Do not use esters such as ethylacetate and butylacetate. Do not use halogenated hydrocarbons such as chlorothene and carbon tetrachloride.

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

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

(7) 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.

Assembly and Installation of the Heat Exchanger

Refer to the Disassembly and Assembly Manual, “Heat Exchanger - Assemble” for the assembly procedure.

Refer to the Disassembly and Assembly Manual, “Heat Exchanger - Install” for the installation procedure.

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.

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.

i03753503

Maintenance Recommendations (Engines Which Have “E” Ratings)

SMCS Code: 1000

Overhaul Considerations

Some factors that are important for determining the overhaul intervals include the following considerations:

- Performance of preventive maintenance
- Use of recommended lubricants
- Use of recommended coolants
- Use of recommended fuels
- Proper installation
- Operating conditions
- Operation within acceptable limits
- Engine load
- Engine speed
- Use of S·O·S Services Fluids Analyses

Generally, engines that are operated at a reduced load and/or speed achieve more service life before an overhaul. However, this is for engines that are properly operated and maintained.

Other factors must also be considered for determining a major overhaul:

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

Overhaul Intervals Which are Based on Fuel Consumption

Experience has shown that the interval for an overhaul is most accurately based on fuel consumption. Fuel consumption corresponds more accurately to the engine load.

Table 23

Overhaul Intervals		
Top End Overhaul	Fuel Consumption	454250 L (120000 US gal)
Major Overhaul	Fuel Consumption	757100 L (200000 US gal)

Overhaul Intervals Which are Based on Oil Consumption

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.

Overhaul Options

Before Failure Overhaul

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 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, 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

Coolant Analysis

The concentration of supplemental coolant additive (SCA) should be checked regularly with test kits or with S·O·S Coolant Analysis (Level 1). Further coolant analysis is recommended when the engine is overhauled.

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 can be obtained by consulting your local water utility company or an agricultural agent. Private laboratories are also available for water analysis.

Caterpillar Inc. recommends an S·O·S Coolant Analysis (Level 2).

S·O·S Coolant Analysis (Level 2)

An S·O·S Coolant Analysis (Level 2) is a comprehensive coolant analysis which completely analyzes the coolant and the effects on the cooling system. An S·O·S Coolant Analysis (Level 2) provides the following information:

- Complete S·O·S Coolant Analysis (Level 2)
- Visual inspection of properties
- Identification of metal corrosion
- Identification of contaminants
- Identification of built up impurities (corrosion and scale)

S·O·S Coolant Analysis (Level 2) provides a report of the results of both the analysis and the maintenance recommendations.

For more information, refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” or contact your Caterpillar dealer.

Engine Components

Refer to this Operation and Maintenance Manual, “Overhaul (Top End)” for a list of components which are affected by a top end overhaul. Refer to this Operation and Maintenance Manual, “Overhaul (Major)” for a list of components which are affected by a major overhaul.

Severe Service Applications

Severe service operation can accelerate component wear. An engine which operates in a severe service application may need more frequent maintenance intervals for the following reasons:

- Maximum reliability
- Retention of full service life

A severe service application is an application which exceeds the current published standards for that 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.

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.

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 coolant

i03718161

Maintenance Recommendations (Engines Which Are Rated “B” and Engines Which Are Rated “C”)

SMCS Code: 1000

Overhaul Considerations

Some factors that are important for determining the overhaul intervals include the following considerations:

- Performance of preventive maintenance
- Use of recommended lubricants
- Use of recommended coolants
- Use of recommended fuels
- Proper installation
- Operating conditions
- Operation within acceptable limits
- Engine load
- Engine speed
- Use of S·O·S Services Fluids Analyses

Generally, engines that are operated at a reduced load and/or speed achieve more service life before an overhaul. However, this is for engines that are properly operated and maintained.

Other factors must also be considered for determining a major overhaul:

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

Overhaul Intervals Which are Based on Fuel Consumption

Experience has shown that the interval for an overhaul is most accurately based on fuel consumption. Fuel consumption corresponds more accurately to the engine load.

Table 24

Maintenance Interval for Overhauls		
Engine Rating	B	C
Major Overhaul	1400600 L (370000 US gal)	757100 L (200000 US gal)

Overhaul Intervals Which are Based on Oil Consumption

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.

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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.

Overhaul Options

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

- Costly unplanned downtime can be avoided.
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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
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Coolant Analysis

The concentration of supplemental coolant additive (SCA) should be checked regularly with test kits or with S·O·S Coolant Analysis (Level 1). Further coolant analysis is recommended when the engine is overhauled.

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 can be obtained by consulting your local water utility company or an agricultural agent. Private laboratories are also available for water analysis.

Caterpillar Inc. recommends an S·O·S Coolant Analysis (Level 2).

S·O·S Coolant Analysis (Level 2)

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- Visual inspection of properties
- Identification of metal corrosion
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S·O·S Coolant Analysis (Level 2) provides a report of the results of both the analysis and the maintenance recommendations.

For more information, refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” or contact your Caterpillar dealer.

Engine Components

Refer to this Operation and Maintenance Manual, “Overhaul (Top End)” for a list of components which are affected by a top end overhaul. Refer to this Operation and Maintenance Manual, “Overhaul (Major)” for a list of components which are affected by a major overhaul.

Severe Service Application

Severe service operation can accelerate component wear. An engine which operates in a severe service application may need more frequent maintenance intervals for the following reasons:

- Maximum reliability
- Retention of full service life

A severe service application is an application which exceeds the current published standards for that 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.

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.

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 coolant

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Oil Cooler Core - Check/Clean/Test (Engines Which Are Rated “E”)

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

This procedure should only be performed on engines which are rated “E”. Perform this maintenance procedure together with the top end overhaul.

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 25 lists Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 25

Hydrosolv Liquid Cleaners(1)		
Part Number	**Description**	**Size**
1U-5490	Hydrosolv 4165	19 L (5 US gallon)
174-6854	Hydrosolv 100	19 L (5 US gallon)

(1) 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.

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Overhaul (Major)

SMCS Code: 7595-020-MJ

Refer to this Operation and Maintenance Manual, “Maintenance Recommendations” in order to determine the maintenance interval for a major overhaul.

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.

A major overhaul includes all of the work that is done for the top end overhaul. A major overhaul includes additional parts and labor. Additional parts and labor are required in order to completely rebuild the engine.

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:

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

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.

i03714880

Overhaul (Top End) (Engines Which are Rated “E”)

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:

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 26.

Table 26

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

i01556871

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. The sea water strainer protects the aftercooler from debris. The sea water strainer will catch pieces of the rubber impeller from the raw water pump due to a failure from debris.

1. Close the valve for the sea water. The location of the valve and the type of the valve may vary with each vessel.

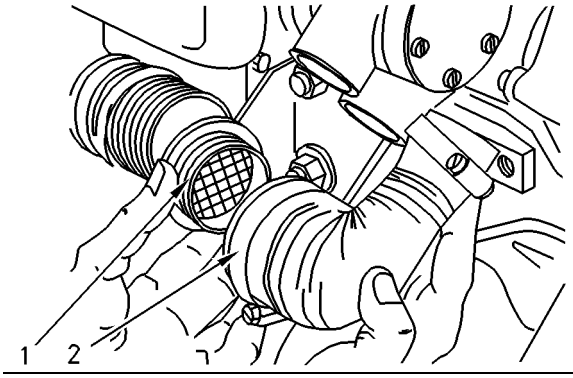

Illustration 46 g00752040

2. Remove the hose clamp (2) on each side of the sea water strainer. Remove the sea water strainer (1).

3. Use clean water to clean the sea water strainer (1). Remove any dirt and debris. If there is debris from the impeller, the impeller may need to be replaced. Refer to Operation and Maintenance Manual, “Auxiliary Water Pump (Rubber Impeller) - Inspect” for replacement information.

4. Install the sea water strainer (1). Install the hose and each hose clamp (2).

5. Open the valve for the sea water.

i00651416

Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

Caterpillar Inc. recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for proper operation. Check the electrical connections and clean the electrical connections. Refer to the Service Manual for more information on the checking procedure and for specifications or 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.

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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 used 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 you start 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 properly clamped. Check for leaks. Check the condition of all pipes.

- Check the marine transmission oil level. Refer to the OEM specification for the marine transmission or refer to the OEM specification for the vessel.

- 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.

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. Inspect the hose that goes from the unit injector hydraulic pump to the left side fluid manifold.
- 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 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. 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.

i01040881

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. A lack of zinc rods in the sea water system can cause corrosion in the sea water cooling system.

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

The zinc rods are red for easy identification. Table 27 shows the locations of the zinc rods and the quantities of the zinc rods.

Table 27

Locations of the Zinc Rods	
Location	**Quantity**
Inlet Elbow for Sea Water On the Heat Exchanger	1
Outlet Elbow for Sea Water On the Heat Exchanger	1

1. Remove the zinc rod.

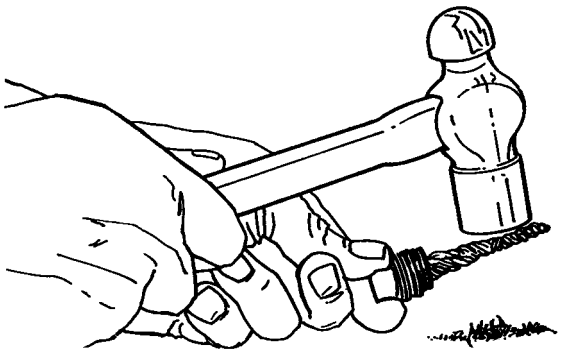

Illustration 47 g00104048

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

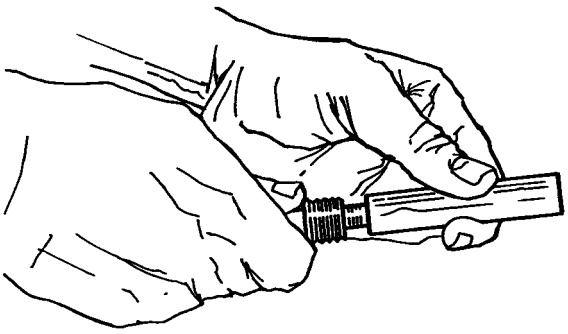

Illustration 48 g00104049

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 Operation and Maintenance Manual for more information on torque specifications.