

SAFETY.CAT.COM™

C-12 and C12 MARINE ENGINES

Maintenance Intervals

Excerpted from Operation & Maintenance Manual (SEBU7599-07)

i03634261

Maintenance Interval Schedule

SMCS Code: 1000; 7500

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed. The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, filters, and the 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

Battery - Replace	69
Battery or Battery Cable - Disconnect	70
Engine - Clean	83
Engine Oil Level Gauge - Calibrate	86
Engine Storage Procedure - Check	91
Fuel System - Prime	92
Heat Exchanger - Inspect/Clean	96
Maintenance Recommendations	99
Sea Water Strainer - Clean/Inspect	103
Zinc Rods - Inspect/Replace	107

Daily

Closed Crankcase Ventilation (CCV) Filter Service Indicator - Inspect	71
Cooling System Coolant Level - Check	79
Engine Air Cleaner Service Indicator - Inspect	84
Engine Oil Level - Check	86
Fuel System Primary Filter/Water Separator - Drain	94
Walk-Around Inspection	106

Initial 20 to 40 Service Hours

Belts - Inspect/Adjust/Replace	70
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Every 50 Service Hours or Weekly

Aftercooler Condensate Drain Valve - Inspect/Clean	67
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Sea Water Strainer - Clean/Inspect	103
Zinc Rods - Inspect/Replace	107

Every 250 Service Hours

Cooling System Coolant Sample (Level 1) - Obtain	79
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Initial 500 Hours (for New Systems, Refilled Systems, and Converted Systems)

Cooling System Coolant Sample (Level 2) - Obtain	80
--	----

Every Year

Cooling System Coolant Sample (Level 2) - Obtain	80
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Every 6000 Service Hours or 3 Years

Cooling System Coolant Extender (ELC) - Add	78
--	----

Every 12 000 Service Hours or 6 Years

Cooling System Coolant (ELC) - Change	75
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First 12 750 L (3375 US gal) of Fuel or 250 Service Hours

Engine Valve Lash - Inspect/Adjust	91
Engine Valve Rotators - Inspect	91
Fuel Injector - Inspect/Adjust	92

Every 12 750 L (3375 US gal) of Fuel or 250 Service Hours or Yearly

Auxiliary Water Pump (Rubber Impeller) - Inspect/Replace	69
Battery Electrolyte Level - Check	70
Belts - Inspect/Adjust/Replace	70
Cooling System Supplemental Coolant Additive (SCA) - Test/Add	81
Engine - Clean	83
Engine Air Cleaner Element - Clean/Replace	83
Engine Crankcase Breather - Clean	85
Engine Oil Sample - Obtain	88
Engine Oil and Filter - Change	89
Fuel System Primary Filter (Water Separator) Element - Replace	93
Fuel System Secondary Filter - Replace	94
Fuel Tank Water and Sediment - Drain	95
Hoses and Clamps - Inspect/Replace	98
Marine Transmission Oil Cooler - Clean/Inspect ..	101

Every 36 900 L (9750 US gal) of Fuel or 750 Service Hours

Closed Crankcase Ventilation (CCV) Fumes Disposal Filter - Replace	72
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**Every 49 210 L (13 000 US gal) of Fuel or
1000 Service Hours or 2 Years**

Aftercooler Core - Clean/Test	67
Engine Valve Lash - Inspect/Adjust	91
Engine Valve Rotators - Inspect	91
Fuel Injector - Inspect/Adjust	92
Heat Exchanger - Inspect/Clean	96
Turbocharger - Inspect/Clean	104

**Every 147 630 L (39 000 US gal) of Fuel or
3000 Service Hours or 3 Years**

Auxiliary Water Pump (Bronze Impeller) - Inspect/Replace	68
Cooling System Coolant (DEAC) - Change	73
Cooling System Water Temperature Regulator - Replace	81
Crankshaft Vibration Damper - Inspect	82
Engine Mounts - Inspect	86
Engine Speed/Timing Sensor - Clean/Inspect	90

**Every 246 050 L (65 000 US gal) of Fuel or
5000 Service Hours or 5 Years**

Alternator - Inspect	68
Starting Motor - Inspect	103
Water Pump - Inspect	107

**Every 378 540 L (100 000 US gal) of Fuel or
8500 Service Hours**

Maintenance Recommendations	99
Overhaul (Major)	101

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Aftercooler Condensate Drain Valve - Inspect/Clean

SMCS Code: 1063-042-DN, VL

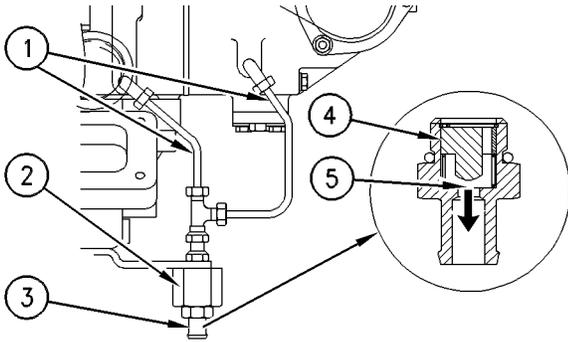


Illustration 31

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(1) Drain lines. (2) Adapter. (3) Valve. (4) Plunger. (5) Valve seat.

The turbocharger boost pressure forces plunger (4) to move down to valve seat (5). The plunger must close against the seat at a pressure of 27.5 kPa (4 psi). When the engine is stopped, the absence of boost pressure allows the plunger to rise to the open position, which allows condensation from the aftercooler to drain out.

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

1. Remove valve (3) from adapter (2). Check the valve in order to determine if plunger (4) moves freely. If the plunger does not move easily, clean the valve with solvent.
2. Remove drain lines (1). Check the lines for plugging. Clean the lines, if necessary. Pressure air or a flexible rod with a small diameter can be used to clean the lines.
3. Reassemble the aftercooler condensate drain valve. Refer to the Specifications, SENR3130, "Torque Specifications" for the correct torque values .

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

Table 11

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.

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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.

i03091745

Auxiliary Water Pump (Bronze Impeller) - Inspect/Replace

SMCS Code: 1371-510

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).

Refer to Disassembly and Assembly, "Auxiliary Water Pump - Remove" in order to remove the auxiliary water pump. Refer to Disassembly and Assembly, "Auxiliary Water Pump - Disassemble" in order to disassemble the auxiliary water pump.

Inspect 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 Disassembly and Assembly, "Auxiliary Water Pump - Assemble" in order to assemble the auxiliary water pump. Refer to Disassembly and Assembly, "Auxiliary Water Pump - Install" in order to install the auxiliary water pump.

i03091750

Auxiliary Water Pump (Rubber Impeller) - Inspect/Replace

SMCS Code: 1371-510

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).

Refer to Disassembly and Assembly, "Auxiliary Water Pump - Remove" in order to remove the auxiliary water pump. Refer to Disassembly and Assembly, "Auxiliary Water Pump - Disassemble" in order to disassemble the auxiliary water pump.

Inspect 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 Disassembly and Assembly, "Auxiliary Water Pump - Assemble" in order to assemble the auxiliary water pump. Refer to Disassembly and Assembly, "Auxiliary Water Pump - Install" in order to install the auxiliary water pump.

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.

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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.

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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

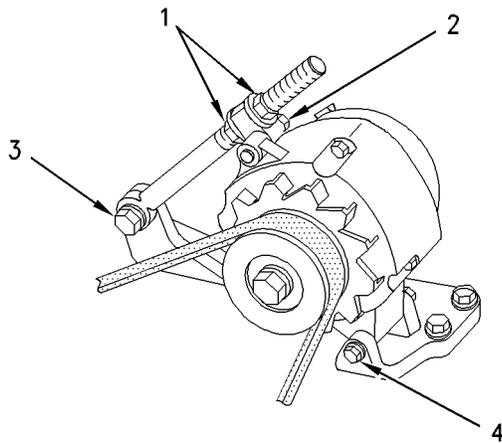


Illustration 32

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- (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) Filter Service Indicator - Inspect

SMCS Code: 1317-040-FI

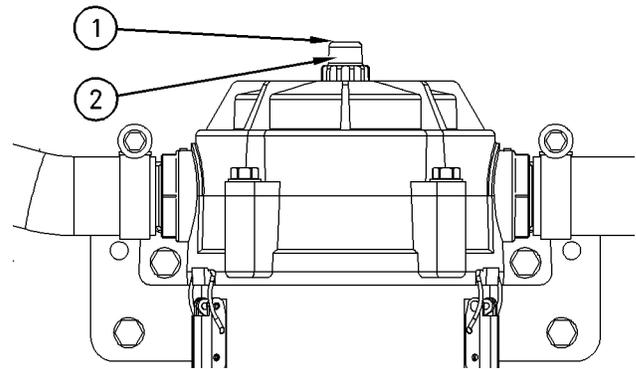


Illustration 33

g00744250

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

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

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

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Closed Crankcase Ventilation (CCV) Fumes Disposal Filter - Replace

SMCS Code: 1317-510-FI

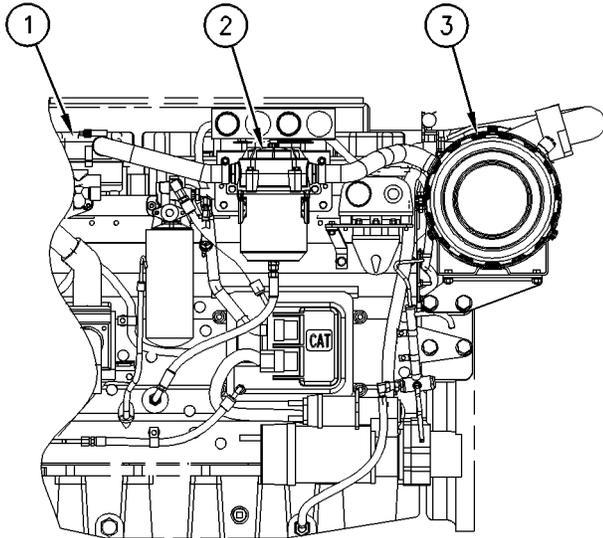


Illustration 34

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Typical example of the Closed Crankcase Ventilation system (CCV)

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

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

- Engine load
- Soot concentration
- Condition of the engine

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

Resetting the Service Indicator

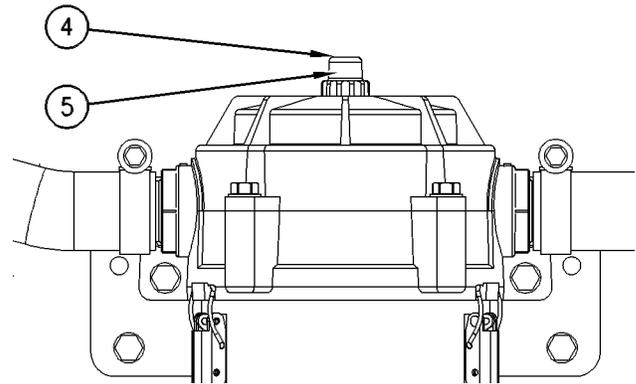


Illustration 35

g00585674

1. Remove the plastic cover (4).
2. Push down on the service indicator (5).
3. Replace the cover (4).
4. Replace the fumes disposal filter by using the following procedure:

Replacing the Fumes Disposal Filter

WARNING

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

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

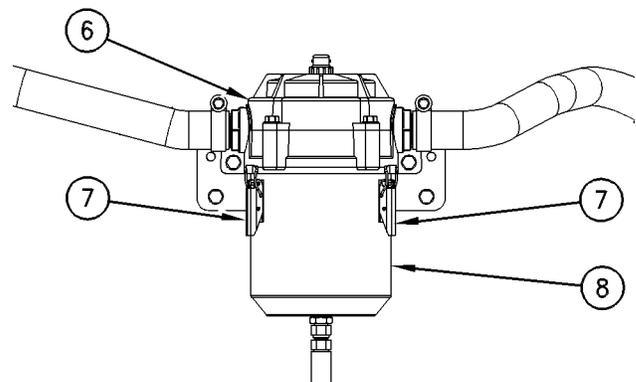


Illustration 36

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1. Release the latches (7) that hold the canister to the filter base assembly (6).

Note: The canister (8) may be difficult to remove while the engine is operating. The canister has negative air pressure while the engine is operating. This creates a vacuum.

2. Lower the canister (8) in order to expose the element. There may be oil in the bottom of the canister. Avoid spilling the oil.
3. Remove the filter element by pulling down. Dispose of the used element properly.
4. Remove the O-ring assembly on the top end cap of the used element.
5. Replace the O-ring seal on the bottom of the filter base assembly.
6. Install the new O-ring on the top end cap of the element. Install the element into the correct place.
7. Replace the canister (8) and align the canister with the boss on the filter base assembly (6).
8. Clamp the latches (7) in the closed position.

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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.

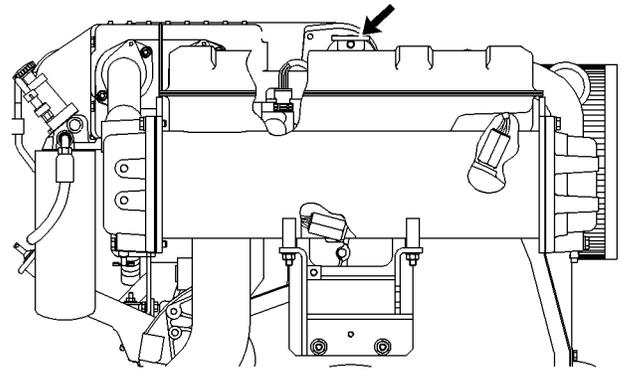


Illustration 37
Cooling System Filler Cap

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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.

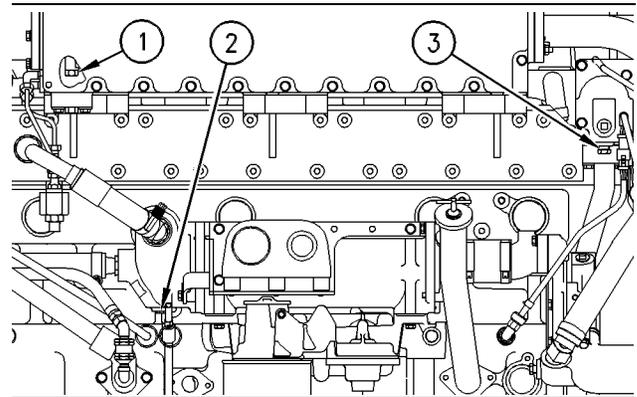


Illustration 38
(1) Aftercooler drain plug. (2) Oil cooler drain plug. (3) Drain Plug for the water temperature regulator.

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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.

Remove the drain plug from the bottom of the water cooled exhaust manifold. Remove the drain plug for the water temperature regulator (3), aftercooler drain plug (1) and oil cooler drain plug (2). 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 Service Technology Group:

Outside Illinois: 1-800-542-8665
Inside Illinois: 1-800-541-8665
Canada: 1-800-523-8665

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, SENR3130, "Torque Specifications" for more information on the proper torques.
3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .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 and run the engine at low idle for a minimum of 30 minutes with a coolant temperature of 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 Specifications, SENR3130, "Torque Specifications" for more information on the proper torques.

Cooling Systems with Heavy Deposits or Plugging

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

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to Specifications, SENR3130, "Torque Specifications" for more information on the proper torques.
3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .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 and run the engine at low idle for a minimum of 90 minutes. The coolant temperature should be at least 82°C (180°F).
5. Stop the engine and allow the engine to cool. Loosen the 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 Specifications, SENR3130, "Torque Specifications" for more information on the proper torques.

Fill

NOTICE

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

Engines That Are Equipped with a Coolant Recovery Tank

1. Fill the system to the top with the mixture of coolant that is recommended. Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" for more information on cooling system specifications. Do not install the cooling system filler cap.
2. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at 1500 rpm for one minute in order to purge the air from the cavities of the engine block. Stop the engine.

3. Check the coolant level. Maintain the coolant level within 13 mm (.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 for 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 for 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.

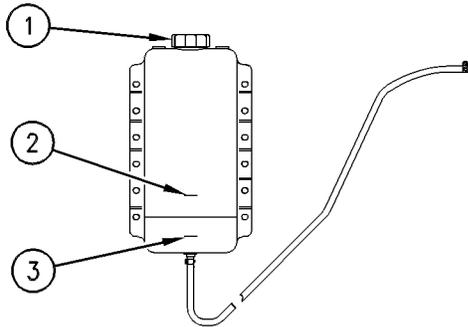


Illustration 39

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(1) Filler cap for the recovery tank. (2) "COLD FULL" mark. (3) "LOW ADD" mark.

5. Pour coolant into the recovery tank until the coolant reaches "COLD FULL" mark (2). Do not fill the recovery tank above "COLD FULL" mark (2).
6. Clean the filler cap for the recovery tank. Install the filler cap for the recovery tank. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

Engines That Are Not Equipped with a Coolant Recovery Tank

1. Fill the cooling system with coolant. Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" for more information on cooling system specifications. Do not install the cooling system filler cap.
2. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at 1500 rpm for one minute in order to purge the air from the cavities of the engine block. Stop the engine.

3. Check the coolant level. Maintain the coolant level within 13 mm (.5 inch) below the bottom of the pipe for filling. Maintain the coolant level at the proper level on the sight glass (if equipped).
4. Clean the cooling system filler cap. Inspect the gasket for the cooling system filler cap. If the gasket for 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 for 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.

i02456377

Cooling System Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

WARNING

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

At operating temperature, engine coolant is hot and under pressure. The 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.

Use only clean water to flush the cooling system when Extended Life Coolant (ELC) is drained and replaced.

Drain

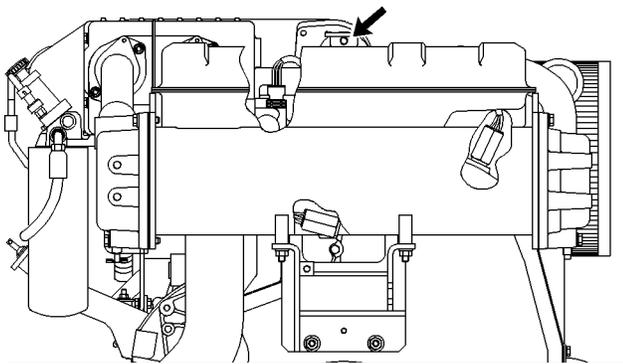


Illustration 40
g00105134
Filler Cap for the Cooling System

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

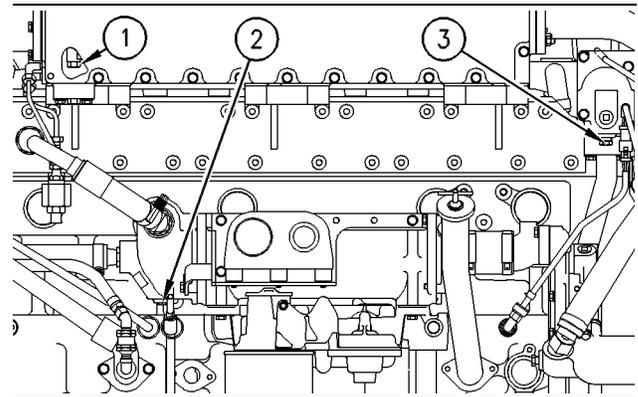


Illustration 41
g00105135

(1) Aftercooler drain plug. (2) Oil cooler drain plug. (3) Drain plug for the water temperature regulator.

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.

Remove the drain plug from the bottom of the water cooled exhaust manifold. Remove the drain plug for the water temperature regulator (3), aftercooler drain plug (1) and oil cooler drain plug (2). Allow the coolant to drain.

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

Outside U.S.A.: (309) 675-6277
Inside U.S.A.: 1-800-542-TOOL
Inside Illinois: 1-800-541-TOOL
Canada: 1-800-523-TOOL
CSTG COSA Geneva, Switzerland:
41-22-849 40 56

Clean the Cooling System

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 Specifications, SENR3130, "Torque Specifications" for more information on the proper torques.

NOTICE

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

3. Fill the cooling system with clean water. Install the cooling system filler cap. Operate the engine until the temperature reaches 49 °C (120 °F) to 66 °C (150 °F).

4. Start 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 Specifications, SENR3130, "Torque Specifications" for more information on the proper torques.

Fill the Cooling System

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 to the top with Cat ELC. Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" for more information on coolant specifications. Do not install the filler cap for the recovery tank.
2. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at 1500 rpm for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
3. Check the coolant level. Maintain the coolant to the proper level on the sight gauge (if equipped). If a sight gauge is not equipped, maintain the coolant within 13 mm (.5 inch) below the bottom of the filler pipe.
4. Clean the cooling system filler cap. Inspect the filler cap gasket. If the filler cap gasket is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the filler cap gasket 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.

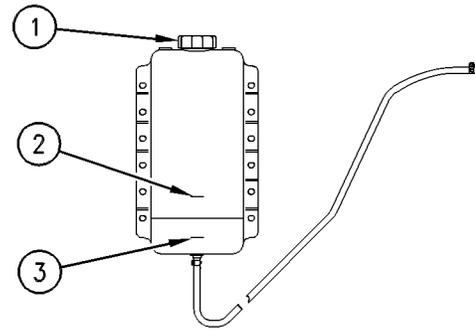


Illustration 42

g00103638

(1) Filler cap for the recovery tank. (2) "COLD FULL" mark. (3) "LOW ADD" mark.

5. Pour Cat ELC into the recovery tank until the coolant reaches "COLD FULL" mark (2). Do not fill the tank above "COLD FULL" mark (2).
6. Clean the filler cap. Install the filler cap. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

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 to the top with Cat ELC. Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" for more information on cooling system specifications. Do not install the cooling system filler cap.
2. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at 1500 rpm for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
3. Check the coolant level. Maintain the coolant level within 13 mm (.5 inch) below the bottom of the pipe for filling. Maintain the coolant level at the proper level on the sight glass (if equipped).

4. Clean the filler cap. Inspect the gasket for the filler cap for the cooling system. If the gasket is damaged, discard the old filler cap for the cooling system and install a new filler cap. If the gasket for 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. Inspect the cooling system for proper operating temperature.

i02482066

Cooling System Coolant Extender (ELC) - Add

SMCS Code: 1352-045; 1395-081

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

NOTICE

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

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

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

WARNING

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

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

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

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

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

NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

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

i02456586

Cooling System Coolant Level - Check

SMCS Code: 1395-082

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

Engines That Are Equipped with a Coolant Recovery Tank

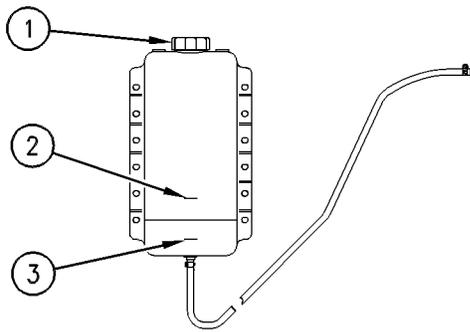


Illustration 43

g00103638

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

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

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

Engines That Are Not Equipped with a Coolant Recovery Tank

WARNING

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

1. Remove the cooling system filler cap slowly in order to relieve pressure.
2. Maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level to the proper level in the sight glass.

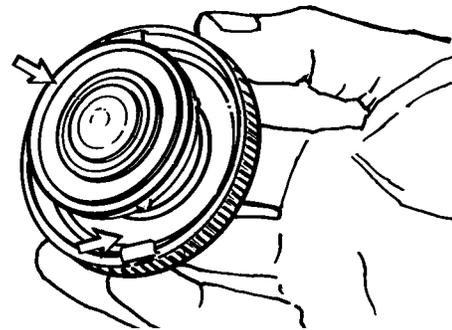


Illustration 44

g00103639

Typical filler cap gaskets

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

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 12

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.

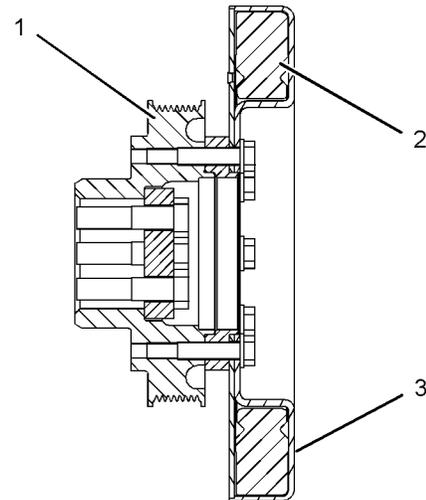


Illustration 45

g01134779

Viscous vibration damper

Typical example

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

Inspection

Inspect the damper for the following conditions:

- The damper is dented, cracked, or fluid is leaking from the damper.
- The paint on the damper is discolored from excessive heat.
- The damper is bent.
- The bolt holes are worn or there is a loose fit for the bolts.

- The engine has had a crankshaft failure due to torsional forces.

Replace the damper if any of these conditions exist.

Removal and Installation

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

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.

i01708992

Engine Air Cleaner Element - Clean/Replace

SMCS Code: 1054-070; 1054-510

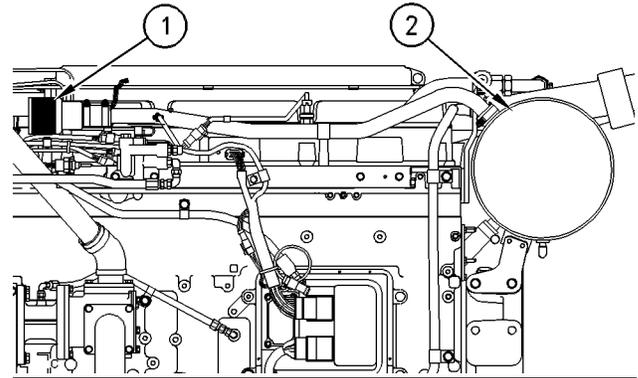


Illustration 46

g00105025

- (1) Vacuum regulator filter element
(2) Air cleaner element

Note: The air cleaner element should be replaced after three cleanings.

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.

1. Remove the vacuum regulator filter element (1) and the air cleaner element (2).

Note: The same procedure is used for cleaning both the air filter element and the vacuum regulator filter element.

2. Tap the element in order to dislodge dirt particles. Gently brush the element with a soft bristle brush.

Note: The element may be oiled and the element may be reinstalled, if complete cleaning is not practical at this time. Refer to step 6.

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.

3. Spray the element with the cleaning solution. Allow the element to stand for 10 minutes.

4. Rinse the 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 element from the clean side (inside). Next, clean the dirty side (outside) in order to flush out dirt. Inspect the element for tears and/or holes after the element is cleaned. Do not reuse damaged 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.

5. Shake excess water off the element and allow the element to air dry. Drying the 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.

6. The dry element should be oiled before installation. Apply small amounts of oil across the top of each pleat. Allow the oil to wick into the element for 20 minutes. Oil any remaining "white" spots.
7. Inspect the housing and the clamp for air cleaner element (2). Replace the housing and the clamp, if necessary. Install the clean, oiled air cleaner element. Refer to the Torque Specifications, SENR3130 for more information on the proper torques.
8. Install the vacuum regulator filter element (1) on the vacuum regulator filter.

i02456843

Engine Air Cleaner Service Indicator - Inspect

SMCS Code: 7452-040

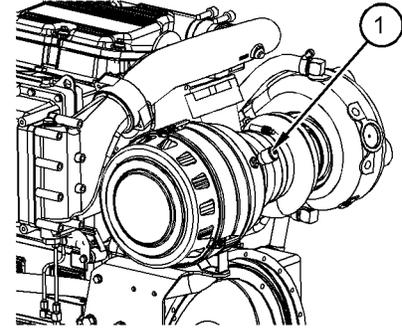


Illustration 47

g01045984

Typical example

(1) Service indicator

Some engines may be equipped with a different service indicator.

Some engines are equipped with a differential gauge for inlet air pressure. The gauge indicates the pressure differential between the inlet side of the air cleaner element and the outlet side of 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 recommendations for the vessel or follow the recommendations in the air cleaner OEM in order to service the air cleaner element.

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

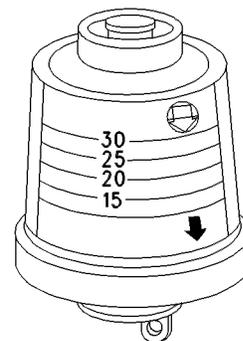


Illustration 48

g00103777

Typical Service Indicator

Observe the service indicator. The air cleaner element should be cleaned or replaced when the yellow diaphragm enters the red zone or the red piston locks in the visible position. If the service indicator appears red at any time, clean the air cleaner element or install a new air cleaner element.

Test the Service Indicator

Service indicators are important instruments.

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

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

The service indicator may need to be replaced frequently in environments that are severely dusty. 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).

Service the Air Cleaner Element

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 air-borne debris from entering the air inlet.

NOTICE

Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

If the air cleaner element becomes plugged, the air can split the filter material. Unfiltered air will drastically accelerate internal engine wear. Your Caterpillar dealer has air filter elements in order to service this unit. Consult your Caterpillar dealer for the correct air cleaner element.

If the service indicator appears red at any time, clean the air cleaner element or install a new air cleaner element. Clean the air cleaner element or replace the air cleaner element at 250 hour intervals.

i02027506

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

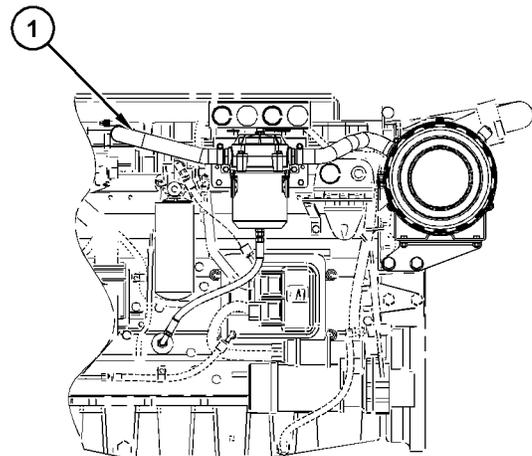


Illustration 49

g01046003

Typical example

(1) Crankcase breather

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.

1. Loosen the hose clamp and remove the hose from the breather cover.
2. Loosen the four bolts for the breather cover and remove the breather cover.
3. Remove the breather element and wash the breather element in solvent that is clean and nonflammable. Allow the breather element to dry.
4. Install a breather element that is clean and dry. Install the breather cover and install the bolts. Refer to the Specifications, SENR3130, "Torque Specifications Module" for the proper torques.

5. Install the hose. Install hose clamp. Refer to the Specifications, SENR3130, "Torque Specifications Module" for 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.

i00573217

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

Check the oil level after the engine has stopped.

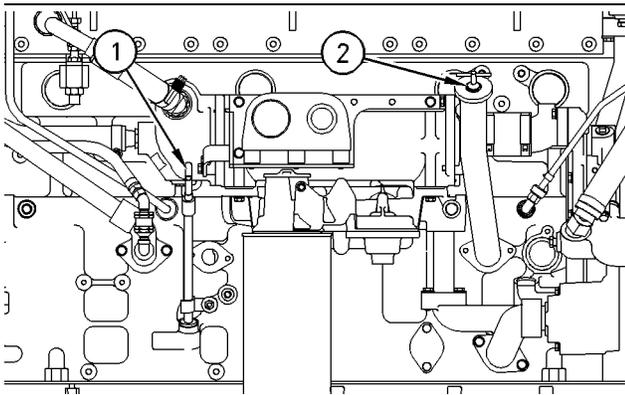


Illustration 50

g00105043

(1) Oil level gauge. (2) Oil filler cap.

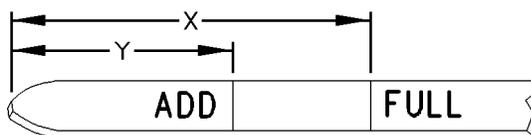


Illustration 51

g00110310

(Y) "ADD" mark. (X) "FULL" mark.

1. Maintain the oil level between "ADD" mark (Y) and "FULL" mark (X) on oil level gauge (1). 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.

2. Remove oil filler cap (2) and add oil, if necessary. Clean the oil filler cap. Reinstall the oil filler cap.

i03163760

Engine Oil Level Gauge - Calibrate

SMCS Code: 1326-524

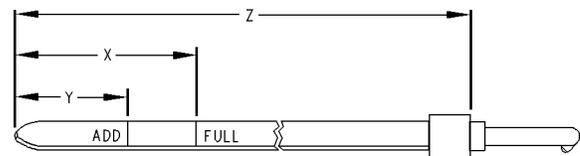


Illustration 52

g00882677

(Y) "ADD" mark. (X) "FULL" mark. (Z) "Effective Length".

(Z-LH Service Engines) 642 mm (25.3 inch)

(Z-RH Service Engines) 479 mm (18.9 inch)

The engine is shipped with an engine oil level gauge that is not marked. The engine oil level gauge is not marked because the angle of the installation and the side for servicing the engine oil can be different for each engine. The angle of the installation and the side for servicing the engine oil will affect "ADD" mark (Y) and "FULL" mark (X) that is engraved on the engine oil level gauge.

The engine oil level gauge should be calibrated after the engine is installed in the vessel. Use the following procedure in order to verify that "ADD" mark (Y) is correct. Use the following procedure in order to establish actual "FULL" mark (X) on the engine oil level gauge. Refer to table 13 and table 14 in order to determine the location for the "ADD" and "FULL" marks for a particular installation.

1. Operate the engine until normal operating temperature is achieved. Stop the engine. Remove one of the drain plugs for the engine crankcase. Allow the engine oil to drain.

- Remove the used engine oil filter. Install the new engine oil filter. Install the drain plug for the engine crankcase. See this Operation and Maintenance Manual, "Engine Oil and Filter - Change" for the procedure for replacing the filter. Tighten the drain plug for the engine crankcase to 70 ± 14 N·m (50 ± 10 lb ft).

Note: The engine may be equipped with auxiliary engine oil filters. Volumes that are different from the standard amounts may be required. Refer to the OEM specifications.

- Pour 24.6 L (26 qt) of engine oil into the engine crankcase. Allow enough time for the engine oil to drain into the engine crankcase. Approximately 20 minutes should be allowed. Check the engine oil level. Wait for a few minutes. Check the engine oil level again. Proceed after the engine oil level stops changing.
- Mark the engine oil level on the engine oil level gauge. Use a marking pen in order to engrave "ADD" mark (Y).
- Pour 3.8 L (4 qt) of engine oil into the engine crankcase. Allow enough time for the engine oil to drain into the engine crankcase.
- Mark the engine oil level on the engine oil level gauge. Use a marking pen in order to engrave "FULL" mark (X).
- Start the engine. Ensure that the lubrication system is filled. Inspect the lubrication system for leaks.
- Stop the engine and allow enough time for the engine oil to drain into the engine crankcase.
- Check the engine oil level on the engine oil level gauge. If the engine oil level is not at calibrated "FULL" mark (X), fill the sump to the calibrated "FULL" mark. Record the amount of oil that is added. Add both the 28.4 L (30 qt) of oil that was added to the engine before Step 9 and the amount of oil that was added in Step 9. Record this total amount of oil for future changes of the engine oil.

Markings on the Engine Oil Level Gauge for the C-12 Marine Engine

Note: Use the following tables if these conditions exist:

- The engine is installed with an angle in the tables.
- No auxiliary engine oil filters are used on the engine.

Table 13

C-12 Marine Engine Markings for the Engine Oil Level Gauge (mm) LH Service ⁽¹⁾		
Tilt Angle ⁽²⁾	LH Service "ADD" Mark Y	LH Service "FULL" Mark X
-15°	120 mm (4.7 inch)	133 mm (5.2 inch)
-13°	113 mm (4.4 inch)	125 mm (4.9 inch)
-11°	110 mm (4.3 inch)	124 mm (4.9 inch)
-9°	106 mm (4.2 inch)	118 mm (4.6 inch)
-7°	100 mm (3.9 inch)	110 mm (4.3 inch)
-5°	93 mm (3.7 inch)	106 mm (4.2 inch)
-3°	87 mm (3.4 inch)	99 mm (3.9 inch)
-1°	82 mm (3.2 inch)	93 mm (3.7 inch)
0°	79 mm (3.1 inch)	89 mm (3.5 inch)
1°	73 mm (2.9 inch)	85 mm (3.3 inch)
3°	68 mm (2.7 inch)	81 mm (3.2 inch)
5°	63 mm (2.5 inch)	74 mm (2.9 inch)
7°	54 mm (2.1 inch)	67 mm (2.6 inch)
9°	47 mm (1.9 inch)	61 mm (2.4 inch)
11°	38 mm (1.5 inch)	52 mm (2.0 inch)
13°	30 mm (1.2 inch)	43 mm (1.7 inch)
15°	19 mm (0.7 inch)	36 mm (1.4 inch)

⁽¹⁾ (Z-LH Service Engines) 642 mm (25.3 inch).

⁽²⁾ The tilt angles in this chart are the engine installation angles for the vessel. A positive angle indicates that the front of the engine is raised.

Table 14

C-12 Marine Engine Markings for the Engine Oil Level Gauge (mm) RH Service ⁽¹⁾		
Tilt Angle ⁽²⁾	RH Service "ADD" Mark Y	RH Service "FULL" Mark X
-15°	25 mm (1.0 inch)	44 mm (1.7 inch)
-13°	37 mm (1.5 inch)	55 mm (2.2 inch)
-11°	48 mm (1.9 inch)	65 mm (2.6 inch)
-9°	57 mm (2.2 inch)	73 mm (2.9 inch)
-7°	65 mm (2.6 inch)	81 mm (3.2 inch)
-5°	72 mm (2.8 inch)	88 mm (3.5 inch)
-3°	79 mm (3.1 inch)	96 mm (3.8 inch)
-1°	86 mm (3.4 inch)	102 mm (4.0 inch)
0°	89 mm (3.5 inch)	106 mm (4.2 inch)
1°	94 mm (3.7 inch)	110 mm (4.3 inch)
3°	101 mm (4.0 inch)	116 mm (4.6 inch)
5°	107 mm (4.2 inch)	122 mm (4.8 inch)
7°	115 mm (4.5 inch)	125 mm (4.9 inch)
9°	121 mm (4.8 inch)	136 mm (5.4 inch)
11°	127 mm (5.0 inch)	140 mm (5.5 inch)
13°	134 mm (5.3 inch)	145 mm (5.7 inch)
15°	135 mm (5.3 inch)	150 mm (5.9 inch)

(1) (Z-RH Service Engines) 479 mm (18.9 inch).

(2) The tilt angles in this chart are the engine installation angles for the vessel. A positive angle indicates that the front of the engine is raised.

NOTICE

Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engines Fluids Recommendations".

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



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.

i02456905

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.

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.

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 manual sump pump, turn the drain valve knob counterclockwise in order to pump the oil out of the oil pan. 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. Tighten the oil drain plugs to 70 ± 14 N·m (50 ± 10 lb ft).

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. 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 53

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 on lubricant specifications. Fill the crankcase with the proper amount of oil.

NOTICE

If equipped with an auxiliary oil filter or system, extra oil must be added when filling the crankcase. Follow the OEM or filter manufacturer's recommendations. If the extra oil is not added, the engine may starve for oil.

NOTICE

To help prevent crankshaft or bearing damage, crank engine to fill all filters before starting. Do not crank 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.

i03535100

Engine Speed/Timing Sensor - Clean/Inspect

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

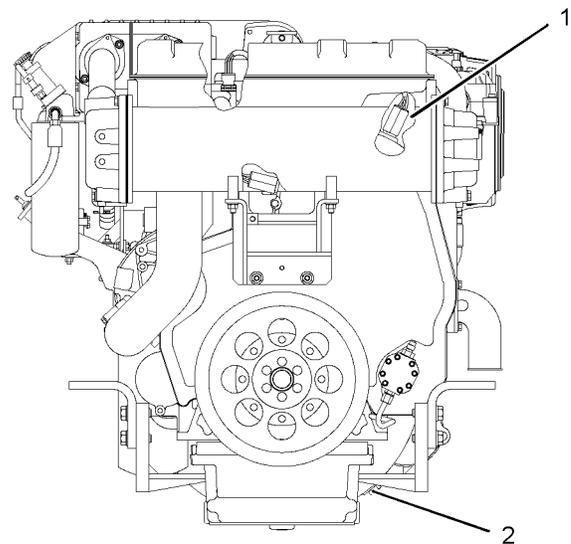


Illustration 54

g01863196

View of the front of a typical C12 Marine Engine

- (1) Speed/timing sensor (camshaft)
(2) Speed/timing sensor (crankshaft)

1. Remove the speed/timing sensors.
2. Inspect the condition of the plastic end of the speed/timing sensors for wear and/or contaminants.
3. Clean the metal shavings and other debris from the face of the speed/timing sensors.
4. Install the speed/timing sensors. Ensure that the sensor is seated before the bolt is tightened. Tighten each bolt to a torque of 28 ± 7 N·m (21 ± 5 lb ft).

i02703023

i01597115

Engine Storage Procedure - Check

SMCS Code: 1000-535

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

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

- Operating hours
- Fuel consumption

i03539022

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

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.

Note: Only qualified service personnel should perform this maintenance.

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.

Refer to Testing and Adjusting, "Engine Valve Lash - Inspect/Adjust" for the inspection and the adjustment procedures.

Engine Valve Rotators - Inspect

SMCS Code: 1109-040

WARNING

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

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

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

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

NOTICE

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

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

i03534881

Fuel Injector - Inspect/Adjust

SMCS Code: 1290-025

WARNING

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

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

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

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

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

i01645814

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.

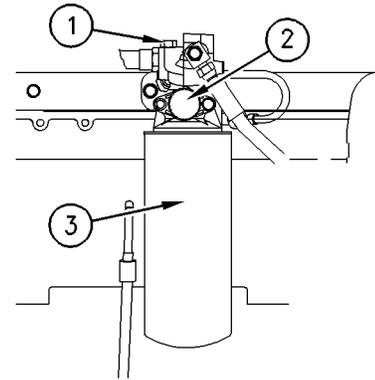


Illustration 55

g00850626

Priming the fuel system fills the fuel filters. Priming the fuel system also removes air from the fuel system. This procedure is used primarily when the engine runs out of fuel.

Note: DO NOT remove plug (1) in the fuel filter base in order to release air from the fuel system during periodic service of the fuel filter. Periodic removal of the plug will result in increased wear of the threads in the fuel filter base. This can lead to fuel leakage. However, the plug in the fuel filter base can be used to bleed air from the fuel system if the engine runs out of fuel.

1. Open fuel priming pump (2) and operate the fuel priming pump until a strong pressure is felt on the fuel priming pump and until the check valve "clicks". This procedure will require considerable strokes. Lock the fuel priming pump.
2. 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.

3. If the engine does not start, open fuel priming pump (2) and repeat Steps 1 and 2 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.

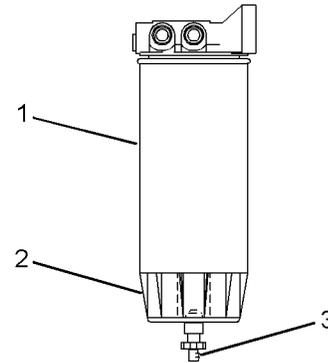


Illustration 56

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.

i02927285

Fuel System Primary Filter/Water Separator - Drain

SMCS Code: 1260-543; 1263-543

 **WARNING**

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

NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

NOTICE

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

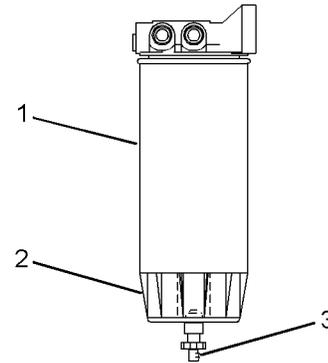


Illustration 57

g01453091

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

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

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

NOTICE

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

i03539225

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.

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

-
4. Unlock the fuel priming pump in order to relieve residual pressure in the fuel system.
-

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.

5. Remove the used fuel filter.
 6. Clean the gasket sealing surface of the fuel filter base. Ensure that all of the old gasket is removed.
-

NOTICE

In order to meet expected fuel system component life, 4 micron(c) absolute or less secondary fuel filtration is required for all Caterpillar diesel engines that are equipped with common-rail fuel systems, and for all Caterpillar diesel engines that are equipped with unit injected fuel systems. For all other Caterpillar diesel engines (mostly older engines with pump, line and nozzle type fuel systems), the use of 4 micron(c) absolute or less secondary fuel filtration is strongly recommended. Note that all current Caterpillar diesel engines are factory equipped with Caterpillar Advanced Efficiency 4 micron(c) absolute fuel filters.

7. Apply clean diesel fuel to the new fuel filter gasket.
-

NOTICE

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

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

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

9. Operate the fuel priming pump until a strong pressure is felt on the fuel priming pump and until the check valve "clicks". This procedure will require considerable strokes. Lock the fuel priming pump.

10. Open the fuel tank supply valve. If necessary, reconnect the battery to the starting motor.

11. Start the engine according to the normal operating procedures. Immediately increase the engine rpm between 1000 to 1200 rpm with no load. The engine will begin to misfire briefly until air from the fuel filter is purged. No damage to the engine will occur.
-

NOTICE

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

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

i03645042

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

Fuel Tank

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

Drain the Water and the Sediment

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

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

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

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

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

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

Fuel Storage Tanks

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

- Weekly
- Oil change
- Refill of the tank

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

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

i03538175

Heat Exchanger - Inspect/Clean

SMCS Code: 1379-040; 1379-070

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 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 tubes for the heat exchanger
- 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.

Inspect

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 and maintenance of the heat exchanger are required if the engine is overheating.

Clean

Remove the heat exchanger. Refer to the Disassembly and Assembly Manual, "Heat Exchanger - Remove" for the procedure.

1. Drain the heat exchanger.

2. Remove the heat exchanger.
3. Turn the heat exchanger core upside-down in order to remove debris.

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.

4. Back flush the core with cleaner.

Caterpillar recommends the use of Hydrosolv liquid cleaner. Table 15 lists Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 15

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.

5. Steam clean the core in order to remove any residue. Flush the tubes of the heat exchanger core. Remove any other trapped debris.
6. Wash the core with hot, soapy water. Rinse the core thoroughly with clean water.

⚠ 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.

7. Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.
8. Inspect the core in order to ensure cleanliness. Pressure test the core. Many shops that service radiators are equipped to perform pressure tests. If necessary, repair the core.

9. Install the heat exchanger. Refer to Disassembly and Assembly, "Heat Exchanger - Install" for the procedure.

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

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.

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Maintenance Recommendations

SMCS Code: 1000

Maintenance Information

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

Severe Operation

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

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

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

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

- Maximum reliability
- Retention of full service life

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

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

Environmental Factors

Extreme Ambient Temperatures

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

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

Cleanliness

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

Improper Operating Procedures

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

Improper Maintenance Practices

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

Overhaul Information

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

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

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

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

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

Oil Consumption as an Overhaul Indicator

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

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

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

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

Overhaul Options

Before Failure Overhaul

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

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

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

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

After Failure Overhaul

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

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

This lower cost can be attributed to three aspects:

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

i00916467

Marine Transmission Oil Cooler - Clean/Inspect

SMCS Code: 3320-040; 3320-070

The procedure for cleaning the marine transmission oil cooler is the same procedure that is used for cleaning the aftercooler core. Refer to the Operation and Maintenance Manual, "Aftercooler Core - Clean/Test" topic (Maintenance Section). For more information on servicing the marine transmission oil cooler, refer to the OEM recommendations or consult your Caterpillar dealer.

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Overhaul (Major)

SMCS Code: 7595-020-MJ

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

- An increase of oil consumption
- An increase of crankcase blowby
- The total amount of fuel consumption
- The service hours of the engine
- The wear metal analysis of the lube oil
- An increase in the levels of noise and vibration

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

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

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

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

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

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

Replacement of Components

Replace the following components during the major overhaul:

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

International Convention for Safety of Life at Sea (SOLAS)

Caterpillar recommends replacing the following:

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

Inspection, Reconditioning or Exchanging of Components

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

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

- Camshaft followers
- Camshaft thrust washers
- Connecting rods
- Crankshaft vibration damper
- Cylinder head assembly
- Cylinder liners
- Engine mounts
- Scavenge oil pump
- Engine wiring harness
- Exhaust manifold seals
- Exhaust manifold bellows
- Fuel pressure regulating valve
- Fuel priming pump
- Fuel transfer pump
- Inlet manifold gaskets
- Inlet manifold seals
- Oil cooler core
- Oil pump
- Pistons
- Piston pins
- Prelube pump
- Pushrods
- Rocker arms
- Spacer plate
- Software update
- Turbocharger

Inspection of Components

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

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

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

Inspect the crankshaft for any of the following conditions:

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

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

- rod bearing
- main bearings

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

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

- Engine failure due to a broken crankshaft
- Excessive wear of the front bearing for the crankshaft

- Excessive wear of the gear train that is not caused by a lack of lubrication

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

- Worn gear teeth
- Unusual fit
- Unusual wear

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

Cleaning of Components

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

Obtain a Coolant Analysis

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

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

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

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

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

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

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

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

i00905687

Sea Water Strainer - Clean/Inspect

SMCS Code: 1371-040; 1371-070

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

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

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

i02618737

Starting Motor - Inspect (If equipped)

SMCS Code: 1451-040; 1453-040

Air Starting Motor

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

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

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

WARNING

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

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

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

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

If damaged teeth are found, the air circuit for the starting motor must be examined in order to determine the cause of the problem.

Electric Starting Motor

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

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

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

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

Inspect the electrical system for the following conditions:

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

Removal and Installation of the Starting Motor

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

Consult your Caterpillar dealer for assistance and/or for options on replacement of the starting motor.

i03543183

Turbocharger - Inspect/Clean

SMCS Code: 1052-571

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.

WARNING

Disconnect batteries before performance of any service work.

⚠ WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

⚠ WARNING

Personal injury can result from rotating and moving parts.

Stay clear of all rotating and moving parts.

Never attempt adjustments while the machine is moving or the engine is running unless otherwise specified.

The machine must be parked on a level surface and the engine stopped.

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.

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.

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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Removal and Installation

Refer to Disassembly and Assembly, "Turbocharger - Remove" for the removal procedure. Refer to Disassembly and Assembly, "Turbocharger - Install" for the installation procedure. Consult with your Caterpillar dealer for further information.

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.
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 and clean the backing plate of the cartridge with standard shop solvents and a soft bristle brush.
7. Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

i02706582

Walk-Around Inspection

SMCS Code: 1000-040

Inspect the Engine for Leaks and for Loose Connections

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

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

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

NOTICE

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

NOTICE

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

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

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

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

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

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

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

i03543200

Water Pump - Inspect

SMCS Code: 1361-040; 1361

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

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

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

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

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

i02456923

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. The cause for the premature corrosion may be the lack of zinc rods in the sea water 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 16 shows the locations of the zinc rods and the quantities of the zinc rod:

Table 16

Locations of the Zinc Rods	
Location	Quantity
Right Heat Exchanger Bonnet	2
Left Heat Exchanger Bonnet	1
Transmission Oil Cooler	2
Fuel Cooler	2

1. Remove the zinc rod.

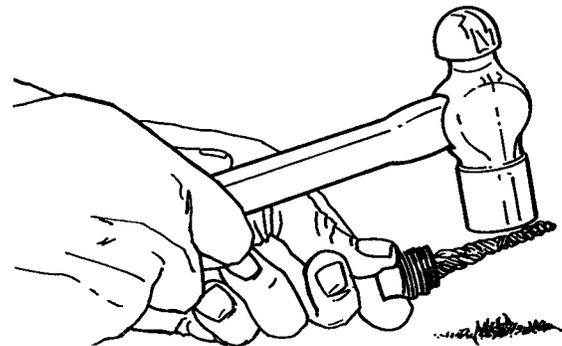


Illustration 58

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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

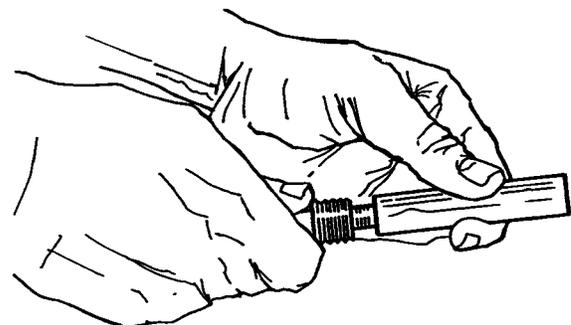


Illustration 59

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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 Special Publication, SENR3130, "Torque Specifications" for more information on torque specifications.