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3208

MARINE ENGINE

Maintenance Intervals

Excerpted from Operation & Maintenance Manual (SEBU6090-03-01)

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Maintenance Interval Schedule

SMCS Code: 1000; 7500

Note: Ensure that the Safety Information, warnings, and instructions are read and understood before operation or maintenance procedures are performed.

Before each consecutive interval is performed, all of the maintenance requirements from the previous interval must also be performed.

Note: For engines that are equipped with AIRSEP® engine air cleaners, the turbocharger should be inspected every 1000 service hours.

When Required

Belt - Inspect/Adjust/Replace	59
Battery - Recycle	61
Battery or Battery Cable - Disconnect	62
Engine Oil Level Gauge - Calibrate	78
Fuel System - Prime	87

Daily

Cooling System Coolant Level - Check	66
Engine Air Cleaner Service Indicator - Inspect	75
Engine Oil Level - Check	77
Fuel System Water Separator - Drain	90
Marine Transmission Oil Level - Check	95
Walk-Around Inspection	102

Every 1900 L (500 US gal) of Fuel or 50 Service Hours

Aftercooler Drain Plug - Inspect	57
Engine Air Cleaner Element (Foam) - Clean/Replace	71
Zinc Rods - Inspect/Replace	104

Initial 9000 L (2400 US gal) of Fuel or 250 Service Hours or 1 Year

Engine Valve Lash - Inspect/Adjust	84
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Every 9000 L (2400 US gal) of Fuel or 250 Service Hours or Yearly

Auxiliary Water Pump - Inspect	59
Belt - Inspect/Adjust/Replace	59
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Cooling System Supplemental Coolant Additive (SCA) - Test/Add	67
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Fuel System Secondary Filter - Replace	89
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Hoses and Clamps - Inspect/Replace	93
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Sea Water Strainer - Clean/Inspect	100

Every 36 000 L (9000 US gal) of Fuel or 1000 Service Hours or 2 Years

Aftercooler Core - Clean/Test	57
Cooling System Coolant (DEAC) - Change	62
Cooling System Water Temperature Regulator - Replace	69
Engine - Clean	71
Governor Housing - Drain	92
Marine Transmission Oil Cooler - Clean/Inspect ..	94
PCV Valve - Inspect	99

Every 72 000 L (19 000 US gal) of Fuel or 2000 Service Hours

Alternator - Inspect	58
Crankshaft Vibration Damper - Inspect	70
Engine Mounts - Inspect	77
Engine Valve Lash - Inspect/Adjust	84
Fuel Injection Nozzles - Test/Exchange	86
Fuel Ratio Control - Inspect/Adjust	87
Heat Exchanger - Inspect	92
Starting Motor - Inspect	101
Turbocharger - Inspect	101

Every 108 000 L (28 500 US gal) of Fuel or 3000 Service Hours or 2 Years

Cooling System Coolant Extender (ELC) - Add	66
Water Pump - Inspect	103

Every 114 000 L (30 000 US gal) of Fuel

Overhaul Considerations	96
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Every 216 000 L (57 000 US gal) of Fuel or 6000 Service Hours or 4 Years

Cooling System Coolant (ELC) - Change	64
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Aftercooler Drain Plug - Inspect

SMCS Code: 1063-040

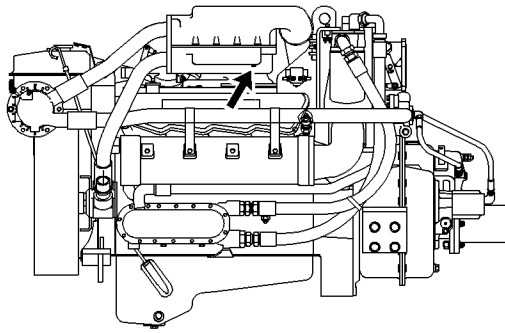


Illustration 15

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Typical location of aftercooler drain

Inspect the plug for the aftercooler drain (if equipped). Ensure that the plug is one of the following plugs:

- 101 - 3713 Tethered Plug
- 9x - 8406 Plug (stainless steel)

NOTICE

A failed aftercooler drain plug can cause the engine compartment to fill with sea water. Any plugs used in the aftercooler drain port, other than those recommended above, may corrode. Use only those recommended plugs.

Aftercooler Core - Clean/Test

SMCS Code: 1064-070; 1064-081

1. Remove the core. Refer to the Service Manual for the procedure.
2. Turn the aftercooler 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.

3. Back flush the core with cleaner.

Caterpillar recommends the use of Hydrosolv liquid cleaner. Table 23 lists Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 23

Hydrosolv Liquid Cleaners ⁽¹⁾	
Description	Container
1U-8812 Hydrosolv 4165	4 L (1 US gal)
1U-5490 Hydrosolv 4165	19 L (5 US gal)
8T-7570 Hydrosolv 4165	208 L (55 US gal)
1U-8804 Hydrosolv 100	4 L (1 US gal)
1U-5492 Hydrosolv 100	19 L (5 US gal)
8T-7571 Hydrosolv 100	208 L (55 US gal)

⁽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.

4. Steam clean the core in order to remove any residue. Flush the fins of the aftercooler core. Remove any other trapped debris.
5. Wash the core with hot, soapy water. Rinse the core thoroughly with clean water.

 **WARNING**

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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.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

6. Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.
7. 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.
8. Install the core. Refer to the Service Manual for the procedure.

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

Alternator - Inspect

SMCS Code: 1405-040

Note: This engine is equipped with an alternator circuit breaker. Note the location of the alternator circuit breaker for your particular application. If the alternator circuit breaker trips, you will need to reset the breaker in order for the charging system to operate. Refer to the information that is provided by the OEM for more information.

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. Refer to the Service Manual.

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.

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Auxiliary Water Pump - Inspect

SMCS Code: 1371-040

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

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

Check the following components for wear or damage:

- Bearings
- Cam
- Impeller
- Seals
- Wear plate

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

Belt - Inspect/Adjust/Replace

SMCS Code: 1357-039

Inspection

Belt tension should be checked initially between the first 20 to 40 hours of engine operation.

After the initial check, the belt tension should be checked at Every 250 Service Hours or Three Months.

To maximize the engine performance, inspect the belts for wear and for cracking. Replace belts that are worn or damaged.

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

If the belts are too loose, vibration causes unnecessary wear on the belts and pulleys. Loose belts may slip enough to cause overheating.

If the belts are too tight, unnecessary stresses are placed on the pulley bearings and on the belts. This may shorten the service life of the components.

Remove the belt guard. Inspect the condition and adjustment of the alternator belts and accessory drive belts (if equipped).

If the belts do not require replacement or adjustment, install the belt guard. If the belts require adjustment or replacement, perform the following procedure to adjust the belt tension.

Adjustment

Alternator Belt

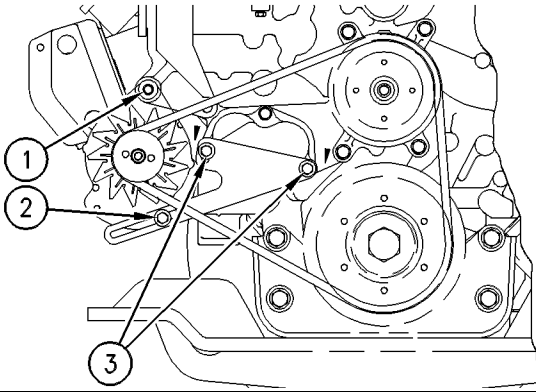


Illustration 16

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Typical illustration

- (1) Mounting bolt
- (2) Adjustment bolt
- (3) Bracket bolts

1. Slightly loosen mounting bolt (1) and adjusting bolt (2).
2. Move the alternator in order to adjust the belt tension. If the alternator will not adjust, it may be necessary to slightly loosen bracket bolts (3). Refer to the Specifications, "Belt Tension Chart" topic.
3. Tighten adjusting bolt (2) and mounting bolt (1). Tighten bracket bolts (3) if the bracket bolts were loosened. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section).
4. Install the belt guard.

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

Auxiliary Water Pump Belt

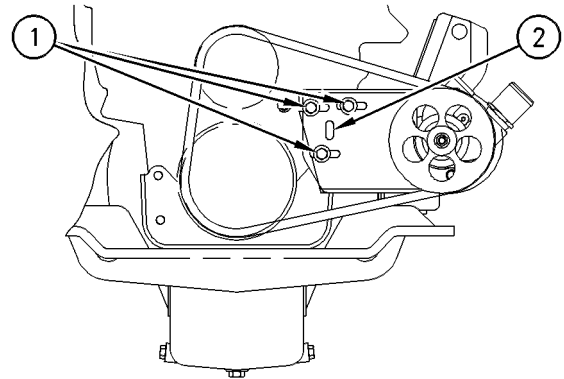


Illustration 17

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Typical illustration

- (1) Mounting bolts
- (2) Slotted hole

1. Slightly loosen mounting bolts (1).
2. Adjust the belt tension with a pry bar in slotted hole (2). Refer to the Specifications, "Belt Tension Chart" topic.
3. Tighten mounting bolts (2). Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section).
4. Install the belt guard.

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

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Battery - Recycle

SMCS Code: 1401-561

1. Always recycle a battery. Never discard a battery.
2. Always return used batteries to one of the following locations.
 - A battery supplier
 - An authorized battery collection facility
 - Recycling facility

Battery Electrolyte Level - Check

SMCS Code: 1401-081

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. If batteries are properly charged, ammeter reading should be very near zero.

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 1U-7298 Coolant/Battery Tester (°C) or the 1U-7297 Coolant/Battery Tester (°F).

3. Keep the batteries clean.

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

- A mixture of 0.1 L (.12 qt) of baking soda and 1 L (1 qt) of clean water
- A mixture of 0.1 L (.12 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 Lubrication Compound, petroleum jelly or MPGM grease.

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Battery or Battery Cable - Disconnect

SMCS Code: 1402-029

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.

Cooling System Coolant (DEAC) - Change

SMCS Code: 1350-070; 1395-044

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

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

NOTICE

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

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

Drain

WARNING

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

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

Allow the coolant to drain.

NOTICE

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

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

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

Flush

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

NOTICE

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

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .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. The coolant temperature should be at least 82 °C (180 °F).
-

NOTICE

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

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

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) 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 the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for more information on the proper torques.
-

NOTICE

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

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .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).
-

NOTICE

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

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

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) 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.

1. Fill the cooling system with coolant/antifreeze. Refer to the Operation and Maintenance Manual, "Cooling System Specifications" topic (Maintenance Section) 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 high idle 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 that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

Cooling System Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

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

- The engine overheats frequently.
- Foaming 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.

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

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

Drain

WARNING

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

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

Allow the coolant to drain.

NOTICE

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

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

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

Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) 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.
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 the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) 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.

1. Fill the cooling system with Extended Life Coolant (ELC). Refer to the Operation and Maintenance Manual, "Cooling System Specifications" topic (Maintenance Section) 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 high idle. Run the engine at high idle 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 that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

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Cooling System Coolant Extender (ELC) - Add

SMCS Code: 1352-045; 1395-081

Caterpillar Extended Life Coolant (ELC) does not require the frequent Supplemental Coolant Additive (SCA) additions associated with the present conventional coolants. The Extender only needs to be added once.

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

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 Extender.
3. Add Extender according to the requirements for your engine's cooling system capacity. Refer to the Operation and Maintenance Manual, "Refill Capacities" in the Maintenance Section for the capacity of the cooling system for your engine. Refer to the Operation and Maintenance Manual, "Cooling System Specifications" information for the Caterpillar ELC Extender additions.
4. Clean the cooling system filler cap. Inspect the cooling system filler cap gaskets. Replace the cooling system filler cap if the cooling system filler cap gaskets are damaged. Install the cooling system filler cap.

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

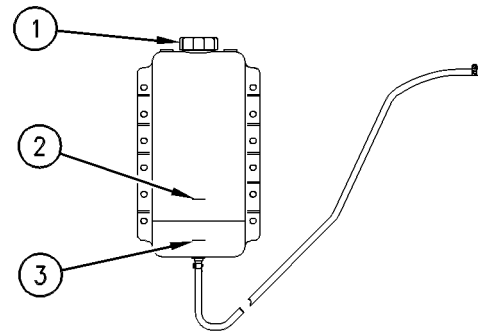


Illustration 18

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(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 the coolant specifications in the maintenance information for your product. 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.

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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 (.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.

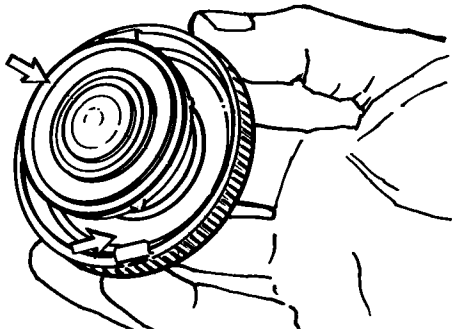


Illustration 19

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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.

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

SMCS Code: 1352-045; 1395-081

WARNING

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

Note: Test the concentration of the Supplemental Coolant Additive (SCA) or test the SCA concentration as part of an S·O·S Coolant Analysis.

Test for SCA Concentration

Coolant/Antifreeze and SCA

NOTICE

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

Use the 8T-5296 Coolant Conditioner Test Kit or use the 4C-9301 Coolant Conditioner Test Kit in order to check the concentration of the SCA. Refer to the Operation and Maintenance Manual for more information on conventional coolant/antifreeze cooling system maintenance.

Water and SCA

NOTICE

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

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Refer to the Operation and Maintenance Manual, "Water/Supplemental Coolant Additive (SCA)" topic (Maintenance Section). Refer to the Operation and Maintenance Manual, "Conventional Coolant/Antifreeze Cooling System Maintenance" topic (Maintenance Section).

S·O·S Coolant Analysis

S·O·S coolant samples can be analyzed at your Caterpillar dealer. S·O·S Coolant Analysis is a program that is based on periodic samples.

Level 1

Level 1 is a basic analysis of the coolant. The following items are tested:

- Glycol Concentration
- Concentration of SCA
- pH
- Conductivity

The results are reported, and recommendations are made according to the results. Consult your Caterpillar dealer for information on the benefits of managing your equipment with an S·O·S Coolant Analysis.

Add the SCA, If Necessary

NOTICE

Do not exceed the recommended amount of supplemental coolant additive concentration. 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 radiator tube blockage, overheating, and/or accelerated water pump seal wear. Never use both liquid supplemental coolant additive and the spin-on element (if equipped) at the same time. The use of those additives together could result in supplemental coolant additive concentration exceeding the recommended maximum.

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. Slowly loosen the cooling system filler cap in order to relieve the pressure. Remove the cooling system filler cap.

Note: Always discard drained fluids according to local regulations.

2. If necessary, drain some coolant from the cooling system into a suitable container in order to allow space for the extra SCA.

3. Add the proper amount of SCA. Refer to the Operation and Maintenance Manual for more information on SCA requirements.
4. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets are damaged, replace the old cooling system filler cap with a new cooling system filler cap. Install the cooling system filler cap.

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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.

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 the Service Manual 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.

i00894991

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.

Rubber Damper

Your engine may be equipped with a rubber damper. The rubber damper uses a ring which is mounted in rubber in order to reduce vibrations in the crankshaft.

Inspect the damper and repair or replace the damper for any of the following reasons:

- There is deterioration and cracking of the rubber.
- There is slippage of the outer ring from the original position.
- The engine has had a failure because of a broken crankshaft.
- Analysis of the oil has revealed that the front main bearing is badly worn.
- There is a large amount of gear train wear that is not caused by lack of oil.

Refer to the Service Manual or consult your Caterpillar dealer for information about damper replacement.

Visconic Damper

Your engine may be equipped with a visconic damper. The visconic damper has a weight that is located inside a fluid filled case. The weight moves in the case in order to limit torsional vibration.

Inspect the damper for evidence of fluid leaks. If a fluid leak is found, determine the type of fluid. The fluid in the damper is silicone. Silicone has the following characteristics: transparent, viscous, smooth, and difficult to remove from surfaces.

If the fluid leak is oil, inspect the crankshaft seals for leaks. If a leak is observed, replace the crankshaft seals.

Inspect the damper and repair or replace the damper for any of the following reasons:

- The damper is dented, cracked, or leaking.
- The paint on the damper is discolored from heat.
- The engine has had a failure because of a broken crankshaft.
- Analysis of the oil has revealed that the front main bearing is badly worn.
- There is a large amount of gear train wear that is not caused by a lack of oil.

Refer to the Service Manual or consult your Caterpillar dealer for information about damper replacement.

i00737417

i00911444

Engine - Clean

SMCS Code: 1000-070

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.

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

Engine Air Cleaner Element (Foam) - Clean/Replace

SMCS Code: 1054-070; 1054-510

NOTICE

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

NOTICE

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

1. Remove the air cleaner cover and the element.
2. Cover the air inlet opening with a clean cloth, or seal with tape in order to prevent dirt and debris from entering the engine.
3. Clean the inside of the air cleaner cover and the body with a clean, dry cloth.
4. Wash the element in warm water and mild nonsudsing household detergent. Rinse the element after washing.
5. Inspect the element for deterioration. Replace the element if the element is deteriorated or torn.
6. Remove the seal from the air inlet opening. Install the element and the air cleaner cover.

i00912642

Engine Air Cleaner Element - Clean/Replace

SMCS Code: 1054-070; 1054-510

AIRSEP®

NOTICE

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

NOTICE

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

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

1. Remove the vacuum limiter element and the AIRSEP® element.
 2. Cover the air inlet opening with a clean cloth, or seal with tape in order to prevent dirt and debris from entering the engine.
 3. Tap the element in order to dislodge dirt particles. Gently brush the element with a soft bristle brush.
-

NOTICE

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

4. Spray the element with the cleaning solution. Allow the element to stand for 20 minutes.
5. 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.

6. 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.

7. The dry element should be oiled before installation. Apply small amounts of oil across the top of each pleat. Allow the oil to soak into the element for 20 minutes. Oil any remaining "white" spots.
8. Inspect the housing and the clamp for the element. Replace the housing and the clamp, if necessary.
9. Remove the seal from the air inlet opening. Install the clean, oiled element. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section).

Paper 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 airborne 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.

1. Remove the cover. Remove the element.
2. Cover the air inlet opening with a clean cloth, or seal with tape in order to prevent dirt from entering the engine.
3. Clean the inside of the air cleaner cover and body with a clean, dry cloth.

4. Clean the element and inspect the element. Replace the element, if necessary. Refer to "Cleaning Paper Air Cleaner Elements".
5. Remove the seal from the air inlet opening. Install an element that is new or cleaned.

Cleaning Paper Air Cleaner Elements

The element can be used up to six times if the element is properly cleaned and inspected. When the element is cleaned, check for rips or tears in the filter material. The element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Use clean elements while dirty elements are being cleaned.

NOTICE

Do not clean the air cleaner elements by bumping or tapping. This could damage the seals. Do not use elements with damaged pleats, gaskets or seals. Damaged elements will allow dirt to pass through. Engine damage could result.

Visually inspect the element before cleaning. Inspect the element for damage to the seal, the gaskets, and the outer cover. Discard any damaged elements.

There are four common methods that are used to clean elements:

- Pressurized water
- Pressurized air
- Vacuum cleaning
- Washing with nonsudsing detergent

Pressurized Water

Pressurized water will clean the element unless carbon and oil have accumulated on the surface of the element. The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi). Do not use a spray nozzle.

Note: When the element is cleaned, always begin with the clean side (inside) in order to force dirt particles toward the dirty side (outside).

Aim the hose so that the water flows inside the element along the length of the filter in order to help prevent damage to the paper pleats. Do not aim the stream of water directly at the element. Dirt could be forced further into the pleats.

Note: Refer to "Drying the Paper Air Cleaner Elements". Refer to "Inspecting the Paper Air Cleaner Elements".

Pressurized Air

Pressurized air can be used to clean elements that have not been cleaned more than two times. Pressurized air will not remove deposits of carbon and oil. Use filtered, dry air with a maximum pressure of 207 kPa (30 psi).

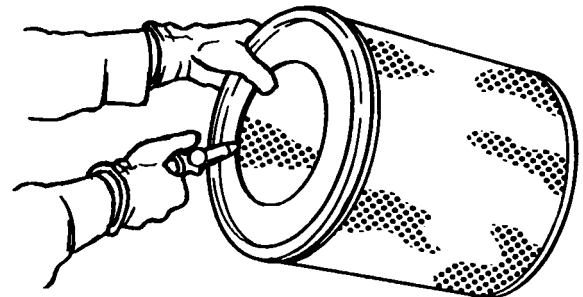


Illustration 20

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Note: When the paper air cleaner elements are cleaned, always begin with the clean side (inside) in order to force dirt particles toward the dirty side (outside).

Aim the hose so that the air flows inside the element along the length of the filter in order to help prevent damage to the paper pleats. Do not aim the stream of air directly at the element. Dirt could be forced further into the pleats.

Note: Refer to "Inspecting the Paper Air Cleaner Elements".

Vacuum Cleaning

Vacuum cleaning is a good method for cleaning paper air cleaner elements which require daily cleaning because of a dry, dusty environment. Cleaning with pressurized air is recommended prior to vacuum cleaning. Vacuum cleaning will not remove deposits of carbon and oil.

Note: Refer to "Inspecting the Paper Air Cleaner Elements".

Washing the Paper Air Cleaner Elements with Nonsudsing Detergent

WARNING

Do not wash air cleaner elements in any flammable solution such as diesel fuel or gasoline. Doing so can cause fire or an engine runaway and can result in personal injury.

Washing with nonsudsing detergent is effective for cleaning elements that have deposits of carbon or oil. Use a cleaning agent that is specifically manufactured for cleaning paper air cleaner elements. Cleaning with pressurized water, pressurized air, or vacuum cleaning is recommended prior to washing with nonsudsing detergent.

1. Place the element into a wash tank so that the gasket is up. The wash tank should be equipped with a rack so that the element does not sit on the bottom of the wash tank.

Note: Caterpillar does not recommend a process for washing the element which includes vigorously shaking. By vigorously shaking the element, carbon particles may be distributed.

2. Fill the wash tank with the cleaning agent and warm water to a maximum temperature of 60 °C (140 °F). Follow the manufacturers recommendations for the cleaning agent. Allow the element to soak for six hours.
3. Drain the wash tank. Do not use the cleaning agent more than one time. Remove the element from the wash tank. Rinse the element by performing the method for cleaning with pressurized water.

Note: Refer to “Drying the Paper Air Cleaner Elements”. Refer to “Inspecting the Paper Air Cleaner Elements”.

Drying the Paper Air Cleaner Elements

The oven method may be used in order to dry the elements. If an oven is used, do not expose the elements to temperatures that exceed 82 °C (160 °F).

Note: Do not use compressed air in order to dry the elements.

The elements may be allowed to air dry. Allow two days for the elements to air dry before the elements are inspected and installed.

Inspecting the Paper Air Cleaner Elements

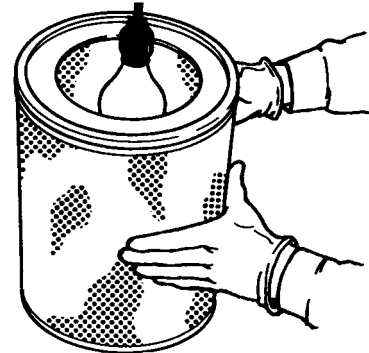


Illustration 21

g00281693

Inspect the clean, dry element. Use a 60 watt blue light in a dark room or in a similar facility. Place the blue light in the element. Rotate the element. Inspect the element for tears and/or holes. Inspect the filter material for light that may show through the filter material. If it is necessary in order to confirm the result, compare the element to a new element that has the same part number.

Do not use an element that has any tears and/or holes in the filter material. Do not use an element with damaged pleats, gaskets or seals. Discard damaged elements.

Storing Paper Air Cleaner Elements

If an element that passes inspection will not be used, the element can be stored for future use.

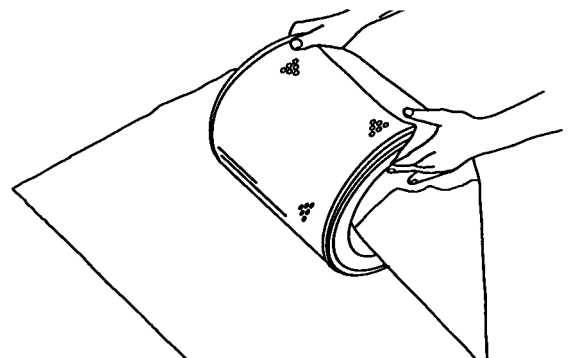


Illustration 22

g00281694

Do not use paint, a waterproof cover, or plastic as a protective covering for storage. Restricted air flow may result. To protect against dirt and damage, wrap the elements in Volalite Corrosion Inhibited (VCI) paper.

Place the element into a box for storage. For identification, mark the outside of the box and mark the element. Include the following information:

- Date of the cleaning
- Number of cleanings

Store the box in a dry location.

For more detailed information on cleaning the paper air cleaner element, refer to Special Publication, SEBF8062, "Procedure to Inspect and Clean Air Filters".

Engine Air Cleaner Service Indicator - Inspect

SMCS Code: 7452-040

Some engines may be equipped with a different service indicator.

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

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

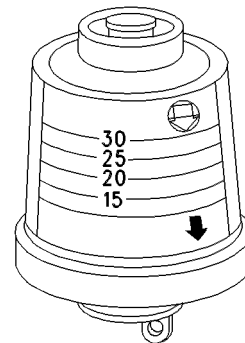


Illustration 23

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, if necessary. Replace the service indicator annually regardless of the operating conditions. Replace the service indicator when the engine is overhauled, and whenever major engine components are replaced.

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

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

NOTICE

Perform this maintenance with the engine stopped.

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

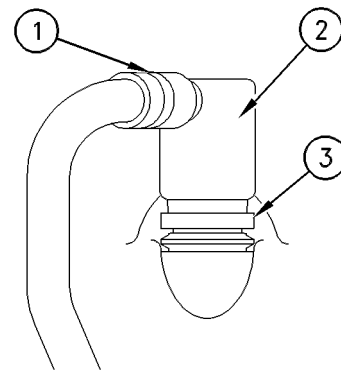


Illustration 24

g00463048

Typical example

- (1) Hose clamp
- (2) Breather assembly
- (3) Retaining clamp

1. Loosen hose clamp (1) and remove the hose from breather assembly (2).
2. Loosen the retaining clamp (3). Remove breather assembly (2) and the seal.
3. Wash the breather element in solvent that is clean and nonflammable. Allow the breather element to dry before installation.
4. Install a breather element that is clean and dry. Install breather assembly and seal (2) and install clamp (3). Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for the proper torques.
5. Install the hose. Install hose clamp (1). Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for the proper torques.

i00259257

i00908787

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 the Service Manual for the recommended torques. Refer to the OEM recommendations for more information.

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

WARNING

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

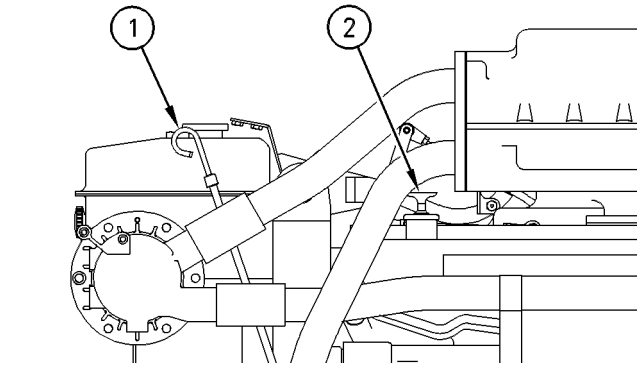


Illustration 25

g00463731

Typical example

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

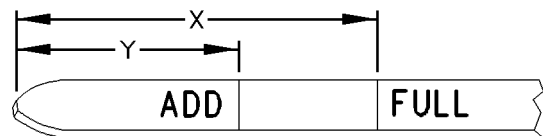


Illustration 26

g00110310

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

NOTICE

Perform this maintenance with the engine stopped.

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

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

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

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

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

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

Engine Oil Level Gauge - Calibrate

SMCS Code: 1326-524

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

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

Tables 24 through 27 list the installation angles (front to rear) and the corresponding oil level marks. Use a marking pen in order to engrave "ADD" mark (Y) and "FULL" mark (X) on the engine oil level gauge according to the information in Tables 24 through 27.

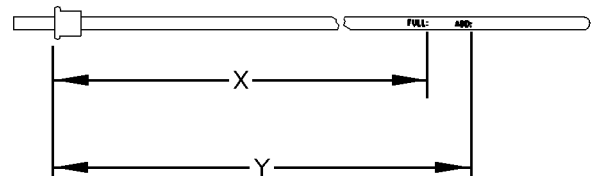


Illustration 27

g00468470

Oil level gauge
(X) "FULL" mark
(Y) "ADD" mark

Table 24

3208 Marine Engine (75V1-Up) Oil Level Gauge Calibration Left Hand Service		
Angle ⁽¹⁾	(X) "FULL" Mark	(Y) "ADD" Mark
15 degrees	759 mm (29.9 inch)	773 mm (30.4 inch)
14 degrees	755 mm (29.7 inch)	769 mm (30.3 inch)
13 degrees	751 mm (29.6 inch)	766 mm (30.2 inch)
12 degrees	748 mm (29.4 inch)	762 mm (30.0 inch)
11 degrees	743 mm (29.6 inch)	758 mm (29.8 inch)
10 degrees	739 mm (29.1 inch)	755 mm (29.7 inch)
9 degrees	735 mm (28.9 inch)	752 mm (29.6 inch)
8 degrees	732 mm (28.8 inch)	748 mm (29.4 inch)
7 degrees	728 mm (28.7 inch)	748 mm (29.4 inch)
6 degrees	723 mm (28.5 inch)	740 mm (29.1 inch)
5 degrees	719 mm (28.3 inch)	736 mm (29.0 inch)
4 degrees	714 mm (28.1 inch)	732 mm (28.8 inch)
3 degrees	711 mm (28.0 inch)	728 mm (28.7 inch)
2 degrees	707 mm (27.8 inch)	725 mm (28.5 inch)
1 degree	702 mm (27.6 inch)	720 mm (28.3 inch)
0 degrees	698 mm (27.5 inch)	716 mm (28.2 inch)
-1 degree	693 mm (27.3 inch)	713 mm (28.1 inch)
-2 degrees	689 mm (27.1 inch)	710 mm (28.0 inch)
-3 degrees	683 mm (26.9 inch)	707 mm (27.8 inch)
-4 degrees	679 mm (26.7 inch)	704 mm (27.7 inch)
-5 degrees	676 mm (26.6 inch)	702 mm (27.6 inch)
-6 degrees	671 mm (26.4 inch)	700 mm (27.6 inch)
-7 degrees	669 mm (26.3 inch)	698 mm (27.5 inch)
-8 degrees	665 mm (26.2 inch)	695 mm (27.4 inch)
-9 degrees	661 mm (26.0 inch)	693 mm (27.3 inch)
-10 degrees	659 mm (25.9 inch)	692 mm (27.3 inch)

(1) A positive angle indicates the number of degrees that the front of the engine is raised. A negative angle indicates the number of degrees that the front of the engine is lowered.

Table 25

3208 Marine Engine (75V1-Up) Oil Level Gauge Calibration Right Hand Service		
Angle ⁽¹⁾	(X) "FULL" Mark	(Y) "ADD" Mark
15 degrees	756 mm (29.8 inch)	771 mm (30.4 inch)
14 degrees	752 mm (29.6 inch)	768 mm (30.2 inch)
13 degrees	749 mm (29.5 inch)	763 mm (30.0 inch)
12 degrees	745 mm (29.3 inch)	760 mm (29.9 inch)
11 degrees	741 mm (29.2 inch)	757 mm (29.8 inch)
10 degrees	737 mm (29.0 inch)	752 mm (29.6 inch)
9 degrees	733 mm (28.9 inch)	749 mm (29.5 inch)
8 degrees	730 mm (28.7 inch)	746 mm (29.4 inch)
7 degrees	726 mm (28.6 inch)	742 mm (29.2 inch)
6 degrees	722 mm (28.4 inch)	738 mm (29.1 inch)
5 degrees	718 mm (28.3 inch)	735 mm (28.9 inch)
4 degrees	714 mm (28.1 inch)	730 mm (28.7 inch)
3 degrees	710 mm (28.0 inch)	726 mm (28.6 inch)
2 degrees	706 mm (27.8 inch)	723 mm (28.5 inch)
1 degree	702 mm (27.6 inch)	719 mm (28.3 inch)
0 degrees	697 mm (27.4 inch)	715 mm (28.1 inch)
-1 degree	692 mm (27.2 inch)	712 mm (28.0 inch)
-2 degrees	689 mm (27.1 inch)	710 mm (28.0 inch)
-3 degrees	685 mm (27.0 inch)	707 mm (27.8 inch)
-4 degrees	680 mm (26.8 inch)	704 mm (27.7 inch)
-5 degrees	677 mm (26.7 inch)	702 mm (27.6 inch)
-6 degrees	673 mm (26.5 inch)	700 mm (27.6 inch)
-7 degrees	670 mm (26.4 inch)	698 mm (27.5 inch)
-8 degrees	670 mm (26.4 inch)	696 mm (27.4 inch)
-9 degrees	663 mm (26.1 inch)	694 mm (27.3 inch)
-10 degrees	662 mm (26.1 inch)	693 mm (27.3 inch)

(1) A positive angle indicates the number of degrees that the front of the engine is raised. A negative angle indicates the number of degrees that the front of the engine is lowered.

Table 26

3208 Marine Engines (01Z1-Up) Oil Level Gauge Calibration Left Hand Service		
Angle⁽¹⁾	(X) "FULL" Mark	(Y) "ADD" Mark
15 degrees	743 mm (29.3 inch)	759 mm (29.9 inch)
14 degrees	738 mm (29.1 inch)	755 mm (29.7 inch)
13 degrees	734 mm (28.9 inch)	752 mm (29.6 inch)
12 degrees	733 mm (28.8 inch)	748 mm (29.4 inch)
11 degrees	737 mm (28.6 inch)	743 mm (29.2 inch)
10 degrees	723 mm (28.4 inch)	739 mm (29.1 inch)
9 degrees	719 mm (28.3 inch)	735 mm (29.0 inch)
8 degrees	715 mm (28.2 inch)	732 mm (28.8 inch)
7 degrees	713 mm (28.1 inch)	728 mm (28.7 inch)
6 degrees	707 mm (27.8 inch)	723 mm (28.5 inch)
5 degrees	703 mm (27.6 inch)	719 mm (28.3 inch)
4 degrees	697 mm (27.5 inch)	715 mm (28.1 inch)
3 degrees	694 mm (27.3 inch)	711 mm (28.0 inch)
2 degrees	690 mm (27.2 inch)	707 mm (27.8 inch)
1 degree	684 mm (26.9 inch)	702 mm (27.6 inch)
0 degrees	679 mm (26.7 inch)	698 mm (27.5 inch)
-1 degree	673 mm (26.5 inch)	693 mm (27.3 inch)
-2 degrees	667 mm (26.3 inch)	689 mm (27.1 inch)
-3 degrees	660 mm (25.7 inch)	683 mm (26.9 inch)
-4 degrees	655 mm (25.8 inch)	679 mm (26.7 inch)
-5 degrees	650 mm (25.6 inch)	676 mm (26.6 inch)
-6 degrees	643 mm (25.3 inch)	671 mm (26.4 inch)
-7 degrees	640 mm (25.2 inch)	669 mm (26.3 inch)
-8 degrees	635 mm (25.0 inch)	665 mm (26.2 inch)
-9 degrees	629 mm (24.8 inch)	661 mm (26.0 inch)
-10 degrees	627 mm (24.7 inch)	659 mm (26.0 inch)

(1) A positive angle indicates the number of degrees that the front of the engine is raised. A negative angle indicates the number of degrees that the front of the engine is lowered.

Table 27

3208 Marine Engines (01Z1-Up) Oil Level Gauge Calibration Right Hand Service		
Angle⁽¹⁾	(X) "FULL" Mark	(Y) "ADD" Mark
15 degrees	743 mm (29.3 inch)	757 mm (29.8 inch)
14 degrees	739 mm (29.1 inch)	754 mm (29.7 inch)
13 degrees	734 mm (28.9 inch)	748 mm (29.4 inch)
12 degrees	730 mm (28.8 inch)	745 mm (29.3 inch)
11 degrees	725 mm (28.5 inch)	741 mm (29.2 inch)
10 degrees	721 mm (28.4 inch)	737 mm (29.0 inch)
9 degrees	717 mm (28.2 inch)	749 mm (28.8 inch)
8 degrees	714 mm (28.1 inch)	730 mm (28.7 inch)
7 degrees	711 mm (28.0 inch)	726 mm (28.6 inch)
6 degrees	706 mm (27.8 inch)	722 mm (28.4 inch)
5 degrees	701 mm (27.6 inch)	718 mm (28.3 inch)
4 degrees	697 mm (27.4 inch)	714 mm (28.1 inch)
3 degrees	693 mm (27.3 inch)	710 mm (28.0 inch)
2 degrees	689 mm (27.1 inch)	706 mm (27.8 inch)
1 degree	684 mm (26.9 inch)	702 mm (27.6 inch)
0 degrees	679 mm (26.7 inch)	697 mm (27.4 inch)
-1 degree	673 mm (26.5 inch)	692 mm (27.3 inch)
-2 degrees	668 mm (26.3 inch)	689 mm (27.1 inch)
-3 degrees	664 mm (26.1 inch)	685 mm (27.0 inch)
-4 degrees	657 mm (25.8 inch)	680 mm (26.8 inch)
-5 degrees	652 mm (25.7 inch)	677 mm (26.6 inch)
-6 degrees	646 mm (25.4 inch)	673 mm (26.5 inch)
-7 degrees	643 mm (25.3 inch)	670 mm (26.4 inch)
-8 degrees	638 mm (25.1 inch)	666 mm (26.2 inch)
-9 degrees	633 mm (24.9 inch)	663 mm (26.1 inch)
-10 degrees	631 mm (24.9 inch)	662 mm (26.1 inch)

(1) A positive angle indicates the number of degrees that the front of the engine is raised. A negative angle indicates the number of degrees that the front of the engine is lowered.

i00978513

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.

Obtain the Sample and the Analysis

WARNING

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

Before taking the sample, complete the Label, PEEP5031 for identification of the sample. To help obtain the most accurate analysis, provide the following information:

- Engine model
- Service hours on the engine
- The oil's hours of use
- 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 8T-9190 Fluid Sampling Bottle Group is recommended for use with the sampling valve. The bottle group includes the parts that are needed for obtaining oil samples. Instructions are also provided.

NOTICE

Do not use the same vacuum sampling pump for extracting oil samples that is used for extracting coolant samples.

A small residue of either type sample may remain in the pump and may cause a false positive analysis for the sample being taken.

Always use a designated pump for oil sampling and a designated pump for coolant sampling.

Failure to do so may cause a false analysis which could lead to customer and dealer concerns.

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, PEHP6001, "How To Take A Good Oil Sample". Consult your Caterpillar dealer for complete information and assistance in establishing an S·O·S program for your engine.

i00652130

Engine Oil and Filter - Change

SMCS Code: 1318-510; 1348-044

WARNING

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

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

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

Drain the Engine Oil

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

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

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

Replace the Oil Filter

NOTICE

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

1. Remove the oil filter with a 1U-8760 Chain Wrench.

2. Cut the oil filter open with a 4C-5084 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.

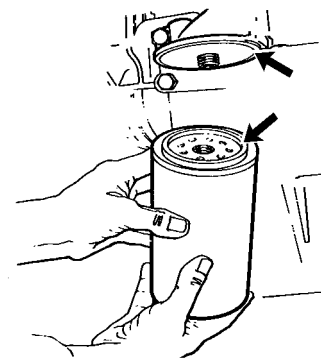


Illustration 28

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 for more information on lubricant specifications. Fill the crankcase with the proper amount of oil. Refer to the Operation and Maintenance Manual for more information on refill capacities.

NOTICE

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

NOTICE

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

2. Start the engine and run the engine at "LOW IDLE" for two minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.
3. Stop the engine and allow the oil to drain back to the sump for a minimum of ten minutes.
4. Remove the oil level gauge in order to check the oil level. Maintain the oil level between the "ADD" and "FULL" marks on the oil level gauge.

Engine Protective Devices - Check

SMCS Code: 7400-535

Alarms and shutoffs must function properly. Alarms provide timely warning to the operator. Shutoffs help to prevent damage to the engine. It is impossible to determine if the engine protective devices are in good working order during normal operation. Malfunctions must be simulated in order to test the engine protective devices.

A calibration check of the engine protective devices will ensure that the alarms and shutoffs activate at the setpoints. Ensure that the engine protective devices are functioning properly.

NOTICE

During testing, abnormal operating conditions must be simulated.

The tests must be performed correctly in order to prevent possible damage to the engine.

To prevent damage to the engine, only authorized service personnel or your Caterpillar dealer should perform the tests.

Visual Inspection

Visually check the condition of all gauges, sensors and wiring. Look for wiring and components that are loose, broken, or damaged. Damaged wiring or components should be repaired or replaced immediately.

i00869628

i00915472

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

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

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

NOTICE

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

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

WARNING

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

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

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

Refer to the Service Manual for more information.

Exhaust Restrictor - Inspect/Adjust

SMCS Code: 1061-025; 1061-040

Your engine may be equipped with an exhaust restrictor in order to reduce white smoke during engine warm-up.

Inspect Exhaust Back Pressure

NOTICE

If the exhaust restrictor opens too slow, the result is power loss and increased black smoke. If the exhaust restrictor opens too fast, cold starting will produce more white smoke. Avoid these problems by keeping the exhaust restrictor properly adjusted.

Before adjusting the linkage, perform the following steps:

1. Start the engine. Run the engine at low idle rpm.
2. Ensure that the restrictor is in the CLOSED position. Adjust the low idle screw in order to obtain 650 rpm.
3. Measure the exhaust back pressure before the restrictor. No adjustment is needed if the exhaust back pressure is at least 34 kPa (5 psi). Perform the adjustment procedure if the exhaust back pressure is too low.

Note: Set the low idle operating rpm to the desired rpm after adjusting the linkage.

Linkage Adjustment

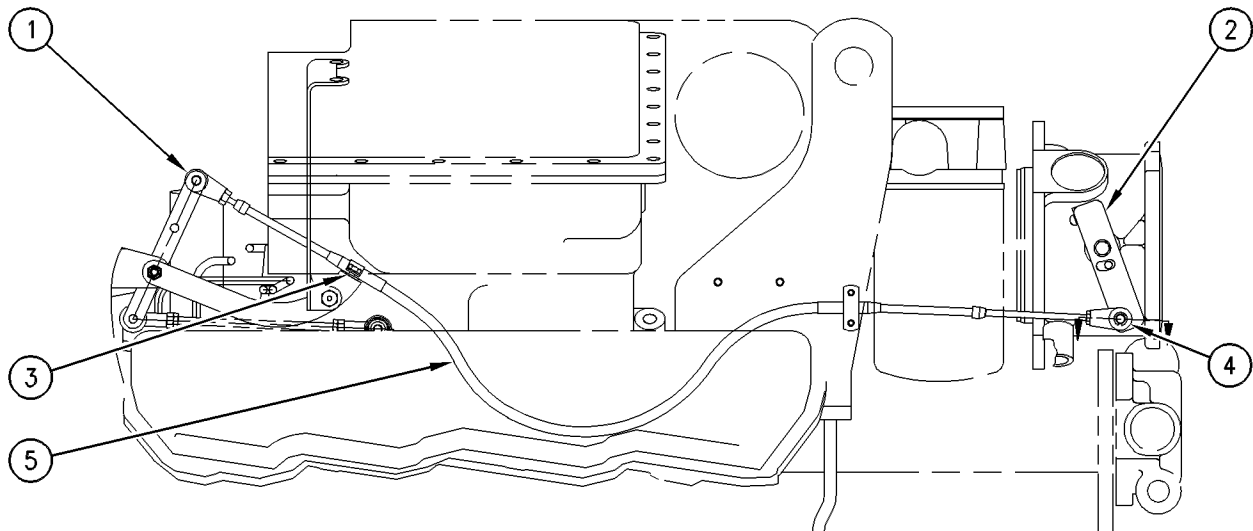


Illustration 29

g00467629

(1) 7E - 8660 Cable End
(2) Lever

(3) Lever assembly
(4) 7E - 8660 Cable End

(5) 7E - 8661 Cable

1. Install the 7E - 8671 Terminal Eye Pin Assembly in lever (2). Install four 4B - 4276 Washers over the threaded end of the pin. Install the threaded end of the pin through the lever. Install the star washer and the nut. Tighten the nut.
2. Install two 7E - 8660 Cable Ends (1) and (4) on the 7E - 8661 Cable (5). Put a 1 mm (0.04 inch) shim between the governor lever and the low idle stop bolt. Place the restrictor in the CLOSED position. Adjust the cable ends. Connect the cable ends to the levers. Remove the shim.

Note: Do not force lever (2) to override the spring during the adjustment of the cable ends (1) and (4).

3. Ensure that the throttle will go into the Low Idle position. The governor lever should be against the low idle stop bolt. Ensure that the throttle will go into the High Idle position. Slight spring tension should be felt when the governor lever goes over center.
4. Use the circlip from the pin assembly in order to attach cable end (4) to the pin on lever (2).
5. Use one 4B - 4276 Washer and one 7H - 9737 Cotter Pin in order to connect cable end (1) to the right side of lever assembly (3), as shown.

Adjust Throttle Cable

Adjust the throttle cable so that there is a slight compressive force in the Low Idle position.

i00626014

Fuel Injection Nozzles - Test/Exchange

SMCS Code: 1254-013; 1254-081

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.

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.

Fuel injection nozzles are subject to tip wear. Tip wear is a result of fuel contamination. Tip wear can cause the following problems:

- Increased fuel consumption
- Black smoke
- Misfire
- Rough running

Fuel Injection nozzles should be cleaned, inspected, tested, and replaced, if necessary. Refer to Special Instruction, SEHS7292 for using the 8S-2245 Injection Cleaning Tool Group. Consult your Caterpillar dealer about cleaning the fuel injection nozzle and testing the fuel injection nozzle.

NOTICE

Never wire brush or scrape a fuel injection nozzle. Wire brushing or scraping a fuel injection nozzle will damage the finely machine orifice. Proper tools for cleaning and testing the fuel injection nozzles can be obtained from Caterpillar dealers.

The following items are symptoms of a malfunction of the fuel injection nozzle:

- Abnormal engine operation
- Smoke emission
- Engine knock

Each fuel injection nozzle must be isolated one at a time in order to determine the malfunctioning fuel injection nozzle.

1. Start the engine.

2. Loosen each fuel line nut one at a time at the fuel injection pump. A cloth or similar material must be used in order to prevent fuel from spraying on the hot exhaust components. Tighten each nut before loosening the next nut.

3. A defective fuel injection nozzle may be identified when a fuel line nut is loosened and the following conditions are present:

- The exhaust smoke is partially eliminated or the exhaust smoke is completely eliminated.
- Engine performance is not affected.

A fuel injection nozzle that is suspected of being defective should be removed. A new fuel injection nozzle should be installed in the cylinder in order to determine if the removed fuel injection nozzle is defective.

Removal and Installation of the Fuel Injection Nozzles

For the removal and the installation of fuel injection nozzles, special tooling is required. Refer to the Service Manual for more information. Consult your Caterpillar dealer for assistance.

i00908934

i00909629

Fuel Ratio Control - Inspect/Adjust

SMCS Code: 1278-025; 1278-040

Slow engine response and low power may indicate a need for adjustment or repair of the fuel ratio control. Refer to the Service Manual or your Caterpillar dealer for the complete adjustment procedure on the fuel ratio control.

Fuel System - Prime

SMCS Code: 1258; 1280-045

Priming the fuel system fills the fuel filter. Priming the fuel system removes air bubbles from the fuel system. Prime the fuel system under the following conditions:

- Fuel system that is run dry
- Storage
- Fuel filter maintenance
- Disconnecting fuel lines and installing fuel lines
- Repair of leaks in the fuel lines

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

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

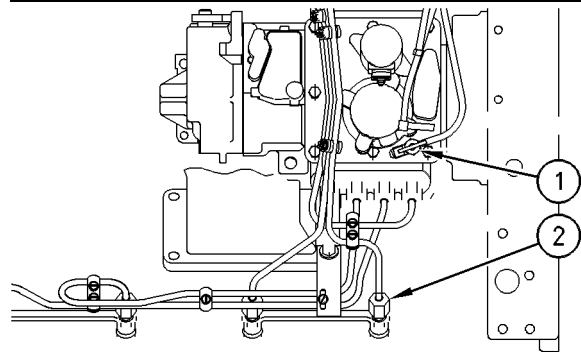


Illustration 30

g00464247

Top view

- (1) Vent valve
- (2) Fuel injection line nuts

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. Open vent valve (1) on the fuel injection pump and turn on the fuel tank supply valve.
2. Unlock and operate the priming pump plunger until the flow of fuel from the vent valve is continuous and free of air bubbles.
3. Close vent valve (1) and lock the priming pump plunger. Ensure that any spilled fuel is cleaned up.

NOTICE

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

4. Start the engine. The engine may run rough. Run the engine at low idle until the engine runs smoothly. If the engine will not start, further priming may be necessary. If the engine starts and the engine continues to misfire or smoke, further priming may be necessary.

If further priming is necessary, perform Steps 5 through 9.

NOTICE

Do not let the tops of fuel nozzles turn when the fuel line nuts are loosened or tightened.

The nozzles will be damaged if the top of the nozzle turns in the body.

The engine will be damaged if a defective fuel injection nozzle is used because the shape of fuel (spray pattern) that comes out of the nozzles will not be correct.

5. Loosen fuel injection line nuts (2) at the cylinder head.
6. Unlock and operate the priming pump plunger until the flow of fuel from the fuel injection lines is continuous and free of air bubbles.
7. Lock the priming pump plunger.
8. Tighten the fuel injection line nuts (2). Refer to Specifications for more information on the proper torques. Ensure that any spilled fuel is cleaned up.

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.

9. Start the engine.

Fuel System Primary Filter/Water Separator Element - Replace

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

Water in the fuel can cause the engine to run rough. Water in the fuel may cause fuel system components 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. The primary filter/water separator should be changed when the vacuum gauge (if equipped) registers 50 to 70 kPa (15 to 20 In 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.

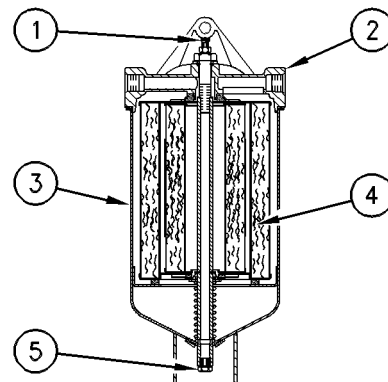


Illustration 31

g00467033

- (1) Vent valve
- (2) Base
- (3) Can
- (4) Element
- (5) Drain plug

1. Close the main fuel supply valve.
2. Remove drain plug (5). Depress vent valve (1) in order to start the flow of fuel. Allow the fuel to drain into a suitable container. Dispose of the fuel properly.
3. Install the drain plug.

i00908585

4. Remove can (3) from base (2).
5. Remove element (4) from the can. Dispose of the used element.
6. Remove the gasket. Clean the following components:

- Can
- Gasket
- Base

Inspect the gasket for damage and for deterioration. Replace the gasket, if necessary.

7. Install the gasket. Lubricate the gasket with clean diesel fuel.

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.

8. Install a new element in the can. The can may be filled with fuel at this time.
 9. Install the can on the base. Tighten the can by hand. Do not use tools in order to tighten the can.
-

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.

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

Leaks are difficult to detect 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, ensure that all components are properly tightened.

Fuel System Secondary Filter - Replace

SMCS Code: 1261-510-SE

WARNING

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

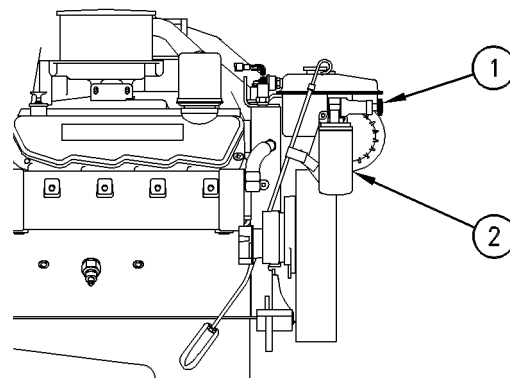


Illustration 32

g00463611

NOTICE

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

1. Stop the engine.
 2. Shut off the fuel tank supply valve.
-

NOTICE

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

3. Remove fuel filter (2).
 4. Clean the gasket sealing surface of the fuel filter base. Ensure that all of the old gasket is removed.
 5. 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.

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

Fuel System Water Separator - Drain

SMCS Code: 1263-543

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.

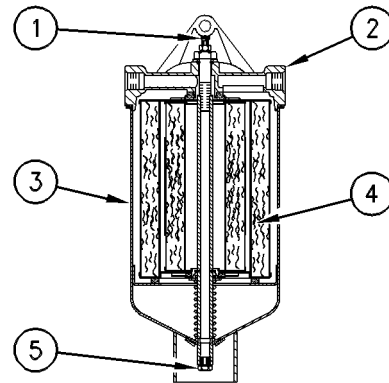


Illustration 33

g00467033

- (1) Vent valve
- (2) Base
- (3) Can
- (4) Element
- (5) Drain plug

Water in the fuel can cause fuel system components to fail. Drain the water separator daily. Drain the water separator more frequently when a large concentration of water is present in the fuel system.

1. Close the fuel supply valve.
-

NOTICE

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

2. Remove drain plug (5). Depress vent valve (1) in order to start the flow. Allow the water to drain into a suitable container. Allow the water to flow until fuel flows from the drain.
 3. Install the drain plug. Dispose of the liquid properly.
 4. Open the fuel supply valve.
-

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.

i00073301

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive fuel system wear. 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.

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.

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.

Governor Housing - Drain

SMCS Code: 1287-543

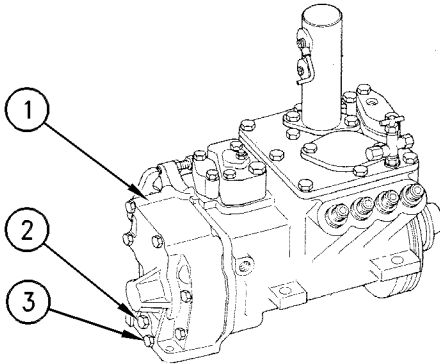


Illustration 34

g00463489

- (1) Governor housing
- (2) Bolt
- (3) Plug

The governor housing (1) is mounted on the rear of the fuel injection pump. Condensation can collect over time in the governor housing. There are two drains which are located at the rear (bottom) of the governor housing. Perform the following procedure in order to drain the water from the governor housing:

1. Remove bolt (2) and plug (3).
2. Allow the water and sediment to drain.
3. Install bolt (2) and plug (3). Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for the proper torques.
4. Prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" topic (Maintenance Section) for more information on priming the fuel system.

Heat Exchanger - Inspect

SMCS Code: 1379-040

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

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

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

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

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

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

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

The procedure for cleaning the heat exchanger 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 heat exchanger, consult your Caterpillar dealer.

i00907072

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.

Note: For torques on hose clamps, see this Operation and Maintenance Manual, "Torque Specifications" (Maintenance Section).

7. Install the hose clamps with a torque wrench.

Note: For the proper coolant to use, see this Operation and Maintenance Manual, "Coolant Recommendations" (Maintenance Section).

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.

i00906366

i00916467

Magnetic Pickups - Clean/Inspect

SMCS Code: 7400-040; 7400-070

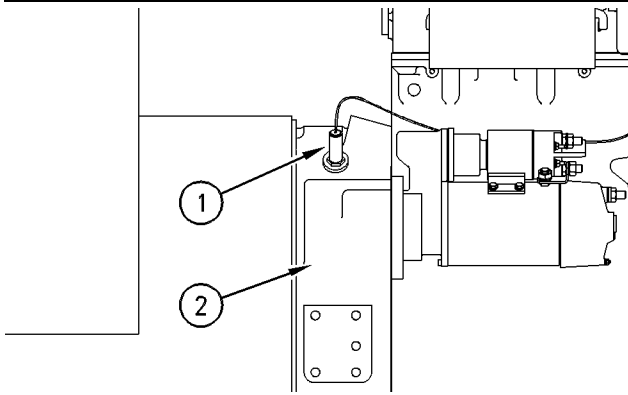


Illustration 35

g00293335

Typical example

- (1) Magnetic pickup
- (2) Flywheel housing

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.

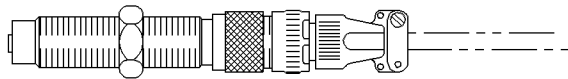


Illustration 36

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Typical magnetic pickup

1. Remove magnetic pickup (1) from flywheel housing (2). Check the condition of the end of the magnetic pickup. Check for signs of wear and contaminants.
2. Clean the metal shavings and other debris from the face of the magnet.
3. Install the magnetic pickup and adjust the magnetic pickup. Refer to the Service Manual for the installation procedure.

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Marine Transmission Oil Level - Check

SMCS Code: 3081-535

Marine Transmission Operation, Maintenance, Warranty, and Parts Support

Caterpillar Inc. encourages customers to refer to a Caterpillar dealer and/or to the OEM dealer for information on the following items:

- Marine transmission operation
- Maintenance of the marine transmission

All support for the warranty will be the responsibility of the OEM. All parts support for the marine transmission will be the responsibility of the OEM. This parts support includes both the installation of parts and the resolution of any service problems.

Refer to the OEM recommendations on the nameplate for the following information about the model of the marine transmission:

- Lubrication specifications
- Requirements for maintenance

Oil Fumes Filter - Replace

SMCS Code: 1317-510

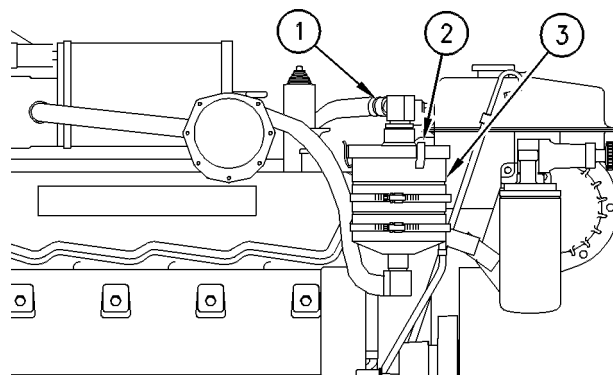


Illustration 37

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- (1) Hose clamp
- (2) Clip
- (3) Housing

1. Loosen hose clamp (1). Remove the hose.
2. Unfasten clips (2). Remove the cover and the seal from housing (3).

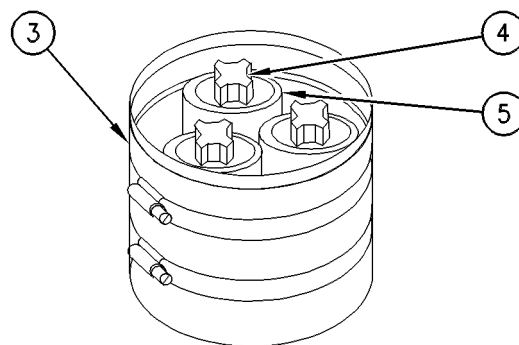


Illustration 38

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- (3) Housing
- (4) Nut
- (5) Filter element

3. Remove nuts (4). Remove filter elements (5) from housing (3). Discard the used elements.
4. Clean the inside of the filter housing with a clean cloth.
5. Install new elements (5) and tighten nuts (4).
6. Clean the cover and the seal with a clean cloth. Inspect the condition of the seal. Replace the seal, if necessary.
7. Install the seal and the cover. Fasten clips (2).

8. Install the hose. Tighten hose clamp (1). Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for more information on the proper torques.

Overhaul Considerations

SMCS Code: 7595-043

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:

- Need for preventive maintenance
- Quality of the fuel that is being used
- Operating conditions
- Results of the S-O-S analysis

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

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

- Avoid costly unplanned downtime.
- Reuse many original parts according to the standards for reusable parts.
- Extend the engine's service life without the risk of a major catastrophe due to engine failure.
- Attain the best cost/value relationship per hour of extended life.

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

Overhaul Recommendation

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.

If an overhaul is performed without overhaul service from your Caterpillar dealer, be aware of the following maintenance recommendations.

Rebuild or Exchange

Inspect the following components according to the instructions that are found in various Caterpillar reusability publications. The Special Publication, SEBF8029 lists the reusability publications that are needed for inspecting the engine parts.

- Cylinder head assembly
- Connecting rods

- Pistons
- Turbocharger
- Oil pump
- Fuel ratio control
- Cam followers
- Fuel Transfer pump
- Timing advance

If the parts comply with the established inspection specifications that are expressed in the reusable parts guideline, the parts should be reused.

Parts that are not within the established inspection specifications should be salvaged, repaired, or replaced.

Using out-of-spec parts can result in the following problems:

- Unscheduled downtime
- Costly repairs
- Damage to other engine parts
- Reduced engine efficiency
- Increased fuel consumption

Reduced engine efficiency and increased fuel consumption translates into higher operating costs. Therefore, Caterpillar Inc. recommends repairing out-of-spec parts or replacing out-of-spec parts.

Component Replacement

Replace the following components during the overhaul:

- Piston Rings
- Thrust bearings
- Main bearings
- Connecting rod bearings
- Gaskets and seals
- Engine mounts
- Hoses

Inspection

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
- Camshaft bearings
- Crankshaft
- Crankshaft vibration damper
- Gear train

Inspect the camshaft for damage to the journals and the lobes. Inspect the camshaft bearings for signs of wear and/or for signs of fatigue.

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 rod bearings and 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 are found:

- Engine failure due to a broken crankshaft
- Excessive wear of the front main bearing
- Excessive wear of the gear train that is not caused by a lack of lubrication
- Visconic damper that is dented, cracked, or leaking
- Visconic damper that is discolored from heat
- Rubber damper that is deteriorated and cracked
- Rubber damper with slippage of the outer ring

Inspect the gear train for the following conditions:

- Worn gear teeth

- Unusual fit
- Unusual wear

Testing

Test the following components during the overhaul:

- Fuel injection nozzles
- Fuel injection pump
- Governor

Testing the fuel system during the overhaul will ensure that your engine operates at peak efficiency. Your Caterpillar dealer can provide these services and components in order to ensure that your fuel system is operating within the appropriate specifications.

Cleaning

The following components should be cleaned and pressure tested during the overhaul:

- Engine oil cooler
- Marine gear oil cooler
- Aftercooler
- Heat exchanger

Refer to the Operation and Maintenance Manual, "Aftercooler Core - Inpect/Clean" topic (Maintenance Section) for the cleaning procedure.

Obtain Coolant Analysis

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

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

Caterpillar Inc. recommends an S-O-S Coolant Analysis (Level II).

S-O-S Coolant Analysis (Level II)

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

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

S-O-S Coolant Analysis (Level II) provides a report of the results of both the analysis and the maintenance recommendations that are based on the analysis.

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

PCV Valve - Inspect

SMCS Code: 1074-040

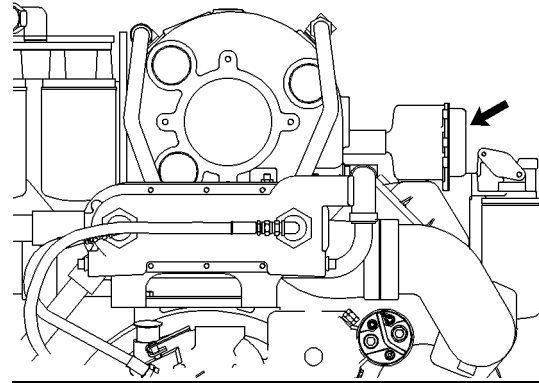


Illustration 39

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Typical PCV valve location

1. Clean the outside of the PCV valve and clean the area around the PCV valve.
2. Inspect the condition of the PCV hose. Replace the PCV hose, if necessary.

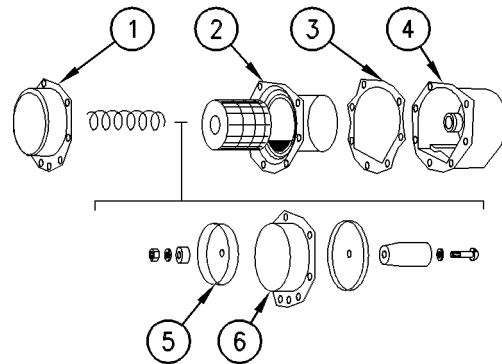


Illustration 40

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- (1) Cover
- (2) Inner sleeve
- (3) Gasket
- (4) Housing
- (5) Piston
- (6) Diaphragm

3. Remove the screws and washers that hold cover (1) in place.
4. Remove cover (1) and the spring.
5. Remove the diaphragm assembly, inner sleeve (2), and gasket (3) from housing (4).
6. Disassemble the diaphragm assembly.

7. Clean all of the parts. Inspect all of the parts. Replace any part that is worn or damaged. Always install a new gasket and a new diaphragm when the PCV valve is being serviced.
8. Assemble the diaphragm assembly. Use a new diaphragm (6).
9. Coat both flange sides of the diaphragm with gasket cement in order to prevent diaphragm (6) from distorting and cracking. Install the diaphragm so that the face of the diaphragm that is marked "piston face" faces piston (5).
10. Coat the new gasket (3) with gasket cement. Install the gasket against the rear face of inner sleeve (2).
11. Install the diaphragm assembly in housing (4).
12. Install the spring and cover (1). Install the screws and washers that hold the cover in place.

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.

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Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

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

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

Turbocharger - Inspect

SMCS Code: 1052-040

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

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

NOTICE

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

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

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

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

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

Removal and Installation

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

Cleaning and Inspecting

1. Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil.
2. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger must be reconditioned.
3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the wheel, there is a possibility of a failed turbocharger oil seal.

The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the inlet air (plugged air filters), which causes the turbocharger to slobber.

4. Use a dial indicator to check the end clearance on the shaft. If the measured end play is greater than the Service Manual specifications, the turbocharger should be repaired or replaced. An end play measurement that is less than the minimum Service Manual specifications could indicate carbon buildup on the turbine wheel. The turbocharger should be disassembled for cleaning and for inspection if the measured end play is less than the minimum Service Manual specifications.
5. Inspect the bore of the turbine housing for corrosion.
6. Clean the turbocharger housing with standard shop solvents and a soft bristle brush.
7. Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

Walk-Around Inspection

SMCS Code: 1000-040

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take 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 cooling lines are properly clamped and that cooling lines are tight. Check for leaks. Check the condition of all pipes.
- Check the marine transmission oil level. Refer to the OEM specification for the marine transmission or refer to the OEM specification for the vessel.
- Inspect the water pumps for coolant leaks.

Note: The water pump seal is lubricated by coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down 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.
- 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 or any gauges that can not be calibrated.

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

Visually inspect the water pump for leaks. If any leaking is observed, replace each water pump seal. Refer to the Service Manual for the disassembly and assembly procedure.

Inspect the water pump for any of the following conditions:

- Wear
- Cracks
- Pin holes
- Proper operation

Note: Refer to the Service Manual or consult your Caterpillar dealer if any repair is needed or any replacement is needed.

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Zinc Rods - Inspect/Replace

SMCS Code: 1388-040; 1388-510

Corrosion in sea water circuits can result in premature deterioration of cooling system components, leaks, and possible cooling system contamination. The corrosion may be caused by 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 oxidation that is caused by sea water. The reaction of the zinc to the sea water causes the zinc rods to oxidize rather than the cooling system components. Rapid deterioration of zinc rods may indicate the presence of uncontrolled electrical currents from improperly installed electrical attachments or from 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 28 shows the locations of the zinc rods and the quantities of the zinc rod:

Table 28

Locations of the Zinc Rods	
Location	Quantity
Right Heat Exchanger Bonnet	2
Left Heat Exchanger Bonnet	1
Transmission Oil Cooler ⁽¹⁾	2
Exhaust Elbow ⁽²⁾	2

(1) Zinc rods will only be located in marine transmission oil coolers that are cooled with sea water.

(2) Exhaust elbows that are aftermarket may or may not be equipped with zinc rods.

1. Remove the zinc rod.
2. Inspect the zinc rod.

Ensure that the zinc rod will remain effective until the next scheduled inspection.

- a. If the zinc rod has deteriorated excessively, install a new zinc rod.

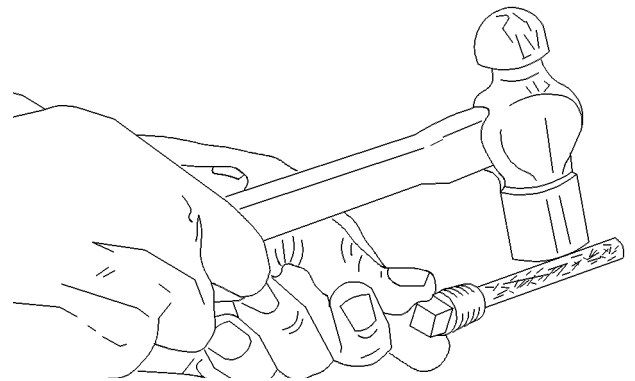


Illustration 41

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- b. Tap the zinc rod lightly with a hammer. If the zinc rod flakes, install a new zinc rod.
3. If the zinc rod will be reused, scrape the layer of oxidation from the zinc rod before installation. The layer of oxidation reduces the effectiveness of the zinc rod.

Replace the Zinc Rods

1. Unscrew the old zinc rod from the plug.

If not enough material remains or the zinc rod has broken off, drill the old zinc rod from the plug.

2. Clean the plug.

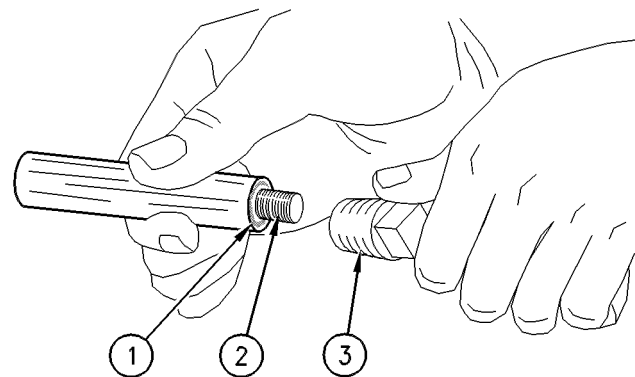


Illustration 42

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- (1) Shoulder of the zinc rod
- (2) Threads of the zinc rod
- (3) External threads of the plug

Note: DO NOT apply adhesive or sealant to threads (2) of the zinc rod .

3. Apply 9S-3263 Thread Lock Compound to shoulder (1) of a new zinc rod. Apply the compound ONLY to the shoulder of the zinc rod. Install the zinc rod onto the plug.

4. Coat external threads (3) of the plug with 5P - 3413 Pipe Sealant. Install the zinc rod. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section).