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MAINTENANCE INTERVALS

Operation and Maintenance
Manual Excerpt

CATERPILLAR®

CATERPILLAR®

SEBU6164-08
April 2012

Operation and Maintenance Manual

3116 and 3126 Marine Engines

4KG1-Up (3116 Marine Engine)
1ZJ1-Up (3126 Marine Engine)
1SK1-Up (3116 Marine Engine)
6MK1-Up (3126 MarineEngine)
8NM1-Up (3126 MarineEngine)
6SR1-Up (3126 MarineEngine)
NSW1-Up (3126 MarineEngine)
4EZ1-Up (3126 MarineEngine)

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Maintenance Interval Schedule

SMCS Code: 1000; 4450; 7500

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed. The user is responsible for the performance of all maintenance including the following procedures: all adjustments, the use of proper lubricants, fluids, filters, and the installation of new components due to normal wear and aging . The performance of this product may be diminished if proper maintenance intervals and procedures are not followed. Components may experience accelerated wear if proper maintenance intervals and procedures are not followed.

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

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

When Required

Daily

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

Every Year

Every 1500 L (400 US gal) of Fuel or 50 Service Hours

First 7500 L (2000 US gal) of Fuel or 250 Service Hours

Every 7500 L (2000 US gal) of Fuel or 250 Service Hours or 1 Year

Every 30 000 L (8000 US gal) of Fuel or 1000 Service Hours or 2 Years

Every 60 000 L (16 000 US gal) of Fuel or 2000 Service Hours

Every 91 000 L (24 000 US gal) of Fuel or 3000 Service Hours or 2 Years

Overhaul

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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 hot Hydrosolv 100 liquid cleaner at a concentration of 30% and at a temperature of 66° to 82°C (150° to 180°F). Table 11 lists the recommended Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 11

Hydrosolv Liquid Cleaners[1]	
Description	**Container**
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) 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

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.

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Auxiliary Water Pump (Rubber Impeller) - Inspect

SMCS Code: 1371-040

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

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

Check the following components for wear or damage:

- Bearings
- Impeller
- Seals
- Wear plate
- Key

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 Manual for more information on servicing the auxiliary water pump.

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Battery - Recycle

SMCS Code: 1401-005; 1401-510; 1401-535; 1401-561; 1401

Always recycle a battery. Never discard a battery.

Always return used batteries to one of the following locations:

- A battery supplier

- An authorized battery collection facility
- Recycling facility

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Battery Electrolyte Level - Check

SMCS Code: 1401-535-FLV

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

⚠ WARNING

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

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

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

2. Check the condition of the electrolyte with the 245-5829 Coolant Battery Tester Refractometer.

3. Keep the batteries clean.

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

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

   Thoroughly rinse the battery case with clean water.

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

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Battery or Battery Cable - Disconnect

SMCS Code: 1401; 1402-029

⚠ WARNING

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

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

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.

2. Disconnect the negative battery terminal at the battery that goes to the start switch. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, the negative side of two batteries must be disconnected.

3. Tape the leads in order to help prevent accidental starting.

4. Proceed with necessary system repairs. Reverse the steps in order to reconnect all of the cables.

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Belts - Inspect/Adjust/Replace

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

Inspection

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

Check the belt tension. Refer to the Operation and Maintenance Manual, “Maintenance Interval Schedule” topic (Maintenance Section) for the proper intervals.

To check the belt tension, apply 110 N (25 lb ft) of force midway between the pulleys. A correctly adjusted belt will deflect 9 mm (0.35 inch) to 15 mm (0.59 inch).

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. These stresses 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 belt does not require replacement or adjustment, install the belt guard. If the belt requires adjustment or replacement, perform the following procedure to adjust the belt tension.

- If the engine is equipped with a refrigerant compressor (air conditioner), the belts for the following components will have automatic belt tensioners: the alternator, the fan drive, and the accessories
- If the engine is not equipped with a refrigerant compressor, the alternator is used to adjust the belt tension.

Adjustment

Alternator Belt

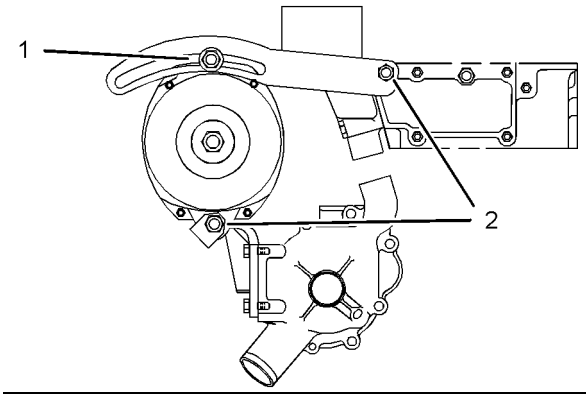

Illustration 22 g01075759

(1) Adjusting bolt
(2) Mounting bolts

1. Slightly loosen mounting bolts (2) and adjusting bolt (1).
2. Move the pulley in order to adjust the belt tension.
3. Tighten adjusting bolt (1) and mounting bolts (2). For the proper torque, refer to the Specifications Manual, SENR3130, “Torque Specifications”.
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.

Water Pump Belt

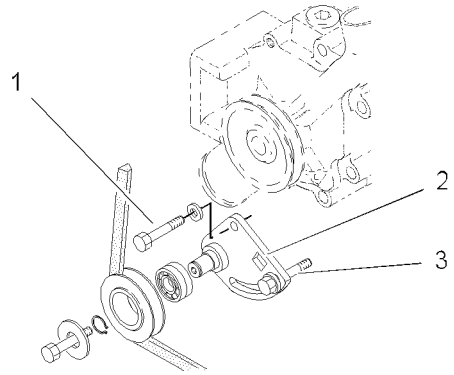

Illustration 23 g01075753

Exploded view of the drive assembly for a water pump belt

(1) Mounting bolt
(2) Square hole
(3) Adjusting bolt

1. Slightly loosen mounting bolts (1) and adjusting bolt (3).
2. Adjust the belt tension with a square drive in square hole (2).
3. Tighten adjusting bolt (3) and mounting bolt (1). For the proper torque, refer to the Specifications Manual, SENR3130, “Torque Specifications”.
4. Install the belt guard.

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

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Coolant - Change

SMCS Code: 1350-044; 1352; 1395-044; 1395

Refer to this Operation and Maintenance Manual, “Fluid Recommendations” for the correct intervals for changing the coolant.

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.

Drain the Cooling System

⚠ 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.

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

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

Dispose of all fluids according to local regulations and mandates.

1. Stop the engine and allow the engine to cool. Ensure that the engine will not start when the cooling system is drained.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.
3. 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.

Note: If equipped, be sure to drain the heater and any related supply and return lines.

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 Cat dealer or consult Cat Dealer Service Tool Group:

Inside USA: 1-800-542-TOOL
Inside Illinois: 1-800-541-TOOL
Canada: 1-800-523-TOOL
International: 1-309-578-7372

Flush

Systems Filled with Cat ELC, Cat ELI, or a Conventional Coolant that Meets the Cat EC-1 Requirements and the Standards of ASTM D6210

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

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

3. Fill the cooling system with clean water. Install the cooling system filler cap.
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 Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

Systems Filled with Cat DEAC, Conventional Coolant which does not Meet the Cat EC-1 Requirements, or Supplemental Coolant Additive (SCA) and Water

3. Flush the cooling system with clean water in order to remove any debris.

4. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

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

5. Fill the cooling system with a mixture of clean water and Cat Fast Acting Cooling System Cleaner.

6. Choose 1 of the following options.

   - Add 0.5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity.
   - For cooling systems with heavy deposits or plugging, add 0.5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity.

7. Install the cooling system filler cap.

8. Start and run the engine at low idle for a minimum of 30 minutes. For cooling systems with heavy deposits or plugging, run the engine for 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.

9. 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. If equipped, be sure to flush the heater and any related supply and return lines. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

Fill the Cooling System

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

1. Fill the cooling system. Refer to this Operation and Maintenance Manual, “Fluid Recommendations” for more information on cooling system specifications Refer to this Operation and Maintenance Manual, “Refill Capacities” for information about the capacity of the cooling system. 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 1 minute in order to purge the air from the cavities of the engine block. Stop the engine.

3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).

4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. Only install the used filler cap if the gasket is not damaged. Use a 9S-8140 Pressurizing Pump to pressure test a reinstalled 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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Coolant Extender (ELC) - Add

SMCS Code: 1352-544-NL

Note: Refer to this Operation and Maintenance Manual, “Fluid Recommendations” (Cooling System) for the maintenance interval for the addition of the coolant extender.

Cat ELC (Extended Life Coolant) and Cat ELI (Extended Life Inhibitor) do not require the frequent additions of any supplemental cooling additives. The Cat ELC Extender will only be added one time.

Note: Do not use conventional supplemental coolant additive (SCA) with Cat ELC or with Cat ELI.

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

⚠ WARNING

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

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

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

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

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

NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

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

2. If necessary, drain enough coolant from the cooling system in order to add the Cat ELC Extender.

3. Add Cat ELC Extender according to the requirements for the cooling system capacity. Refer to this Operation and Maintenance Manual, “Refill Capacities” for the coolant capacity.

4. Clean the cooling system filler cap. Inspect the gaskets on the cooling system filler cap. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.

For further information, refer to this Operation and Maintenance Manual, , “Fluid Recommendations”.

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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

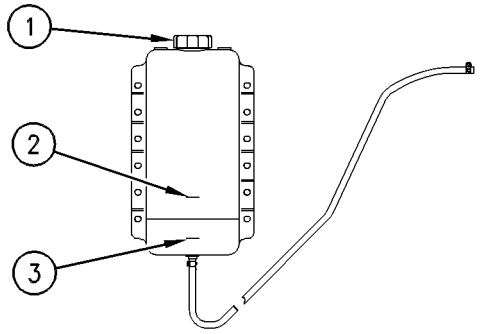

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Illustration 24

(1) Filler cap
(2) “COLD FULL” mark
(3) “LOW ADD” mark

1. Observe the coolant level in the coolant recovery tank. Maintain the coolant level to “COLD FULL” mark (2) on the coolant recovery tank.

2. Loosen filler cap (1) slowly in order to relieve any pressure. Remove the filler cap.

3. Pour the proper coolant mixture into the tank. Refer to this Operation and Maintenance Manual, “Refill Capacities” for information about coolants. Do not fill the coolant recovery tank above “COLD FULL” mark (2).

4. Clean filler cap (1) and the receptacle. Reinstall the filler cap and inspect the cooling system for leaks.

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

Engines That Are Not Equipped with a Coolant Recovery Tank

⚠ WARNING

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

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

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

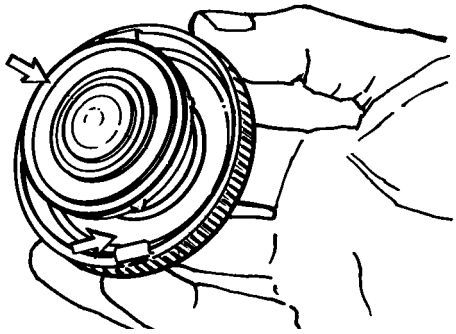

Illustration 25 g00103639

Typical filler cap gaskets

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

4. Inspect the cooling system for leaks.

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Coolant Sample (Level 1) - Obtain

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

Testing the engine coolant is important to ensure that the engine is protected from internal cavitation and corrosion. The analysis also tests the ability of the coolant to protect the engine from boiling and freezing. S·O·S Systems Coolant Analysis can be done at your Cat dealer. Cat S·O·S coolant analysis is the best way to monitor the condition of your coolant and your cooling system. S·O·S coolant analysis is a program that is based on periodic samples.

Note: Obtaining a Coolant Sample (Level 1) is optional if the cooling system is filled with one of the following coolants: Cat ELC (Extended Life Coolant)., Cat ELI (Extended Life Inhibitor), and Conventional Heavy-Duty Coolant.

Note: Obtain a Coolant Sample (Level 1) if the cooling system is filled with any of the following coolants: Cat DEAC, Cat SCA, and Conventional Heavy-Duty Coolants.

For additional information about coolant analysis and about other coolants, see this Operation and Maintenance Manual, “Fluid Recommendations” or consult your Cat dealer.

Sampling Conditions

If the engine is equipped with a sampling port, the engine should be running at operating temperature when the sample is obtained.

If the engine is not equipped with a sampling port, the coolant should be warm.

Use the following guidelines for proper sampling of the coolant:

- Complete the information on the label for the sampling bottle before you begin to take the samples.
- Keep the unused sampling bottles stored in plastic bags.
- Obtain coolant samples directly from the coolant sample port. You should not obtain the samples from any other location.
- Keep the lids on empty sampling bottles until you are ready to collect the sample.

- Place the sample in the mailing tube immediately after obtaining the sample in order to avoid contamination.
- Never collect samples from expansion bottles.
- Never collect samples from the drain for a system.

Timing of the Sampling

Table 12

Recommended Interval		
Type of Coolant	**Level 1**	**Level 2**
Cat DEAC Cat SCA Conventional Heavy-Duty Coolants	Every 250 hours	Yearly(1)
Cat ELC Cat ELI Commercial EC-1 Coolants	Optional(1)	Yearly(1)

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

Note: Check the SCA (Supplemental Coolant Additive) of the conventional coolant at every oil change or at every 250 hours. Perform this check at the interval that occurs first.

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

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

Submit the sample for Level 1 analysis.

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

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Coolant Sample (Level 2) - Obtain

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

An S·O·S Coolant Analysis (Level 2) is a comprehensive chemical evaluation of the coolant. This analysis is also a check of the overall condition of the cooling system. The S·O·S Coolant Analysis (Level 2) has the following features:

- Full coolant analysis (Level 1)
- Identification of metal corrosion and contaminants
- Identification of buildup of the impurities that cause corrosion and scaling
- Determination of the possibility of electrolysis within the cooling system of the engine

The results are reported and appropriate recommendations are made.

Obtaining the Sample

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

Submit the sample for Level 2 analysis.

For further information, refer to this Operation and Maintenance Manual, “Fluid Recommendations”.

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Coolant Temperature Regulator - Replace

SMCS Code: 1355-510

Replace the water temperature regulator before the water temperature regulator fails. 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 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.

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.

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.

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

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

Dispose of all fluids according to local regulations and mandates.

Note: If replacing only the water temperature regulator, only drain the coolant to a level that is below the water temperature regulator housing.

Refer to two articles in the Disassembly and Assembly Manual, “Water Temperature Regulator - Remove and Water Temperature Regulator - Install” for the replacement procedure or consult your Cat dealer.

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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 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 this Operation and Maintenance Manual, “Refill Capacities and Recommendations” for more information.

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 Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” for more information.

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.

Level 2

This level coolant analysis is recommended when the engine is overhauled. Refer to this Operations and Maintenance Manual, “Overhaul Considerations” for further information.

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 Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engines Fluids Recommendations” 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.

i04441631

Engine Air Cleaner Element (Single Element) - Inspect/Clean/Replace

SMCS Code: 1051; 1054-040; 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.

If the air cleaner element becomes plugged, the air can split the material of the air cleaner element. Unfiltered air will drastically accelerate internal engine wear. Your Cat dealer has the proper air cleaner elements for your application. Consult your Cat dealer for the correct air cleaner element.

- Check the precleaner (if equipped) daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.
- Operating conditions (dust, dirt, and debris) may require more frequent service of the air cleaner element.
- The air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Cleaning the Air Cleaner Element

Use a clean air cleaner element 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 air cleaner elements before cleaning. Inspect the air cleaner elements for damage to the seal, the gaskets, and the outer cover. Inspect the filter material for rips and for tears. Discard any damaged air cleaner elements.

There are two common methods that are used to clean air cleaner elements:

- Pressurized air
- Vacuum cleaning

Pressurized Air

⚠ WARNING

Personal injury can result from air pressure.

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

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

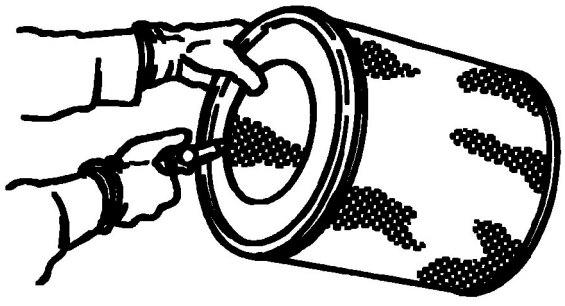


Illustration 26 g02633318
Typical air cleaner element

Note: When the 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 towards the inside of the element along the length of the filter to help prevent damage to the paper pleats. Do not aim the stream of air directly at the air cleaner element. Dirt could be forced further into the pleats.

Vacuum Cleaning

Vacuum cleaning is a good method for cleaning 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.

Inspecting the Air Cleaner Element

Illustration 27 g02633320
Typical air cleaner element

Inspect the clean, dry air cleaner element. Use a 60 W blue light in a dark room or in a similar facility. Place the blue light in the air cleaner element. Rotate the air cleaner element. Inspect the air cleaner element for tears and/or holes. Inspect the air cleaner element for light that may show through the filter material. , Compare the air cleaner element to a new air cleaner element that has the same part number to determine if the filter is clean.

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

Replacing the Air Cleaner Element

Note: Replace an old air cleaner element with a new air cleaner element after the old element has been cleaned six times.

Storing the Air Cleaner Elements

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

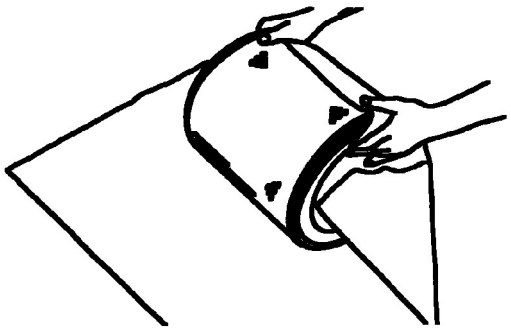


Illustration 28 g02633322

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

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

- Date of cleaning
- Number of cleanings

Store the box in a dry location.

i01900118

Engine Air Cleaner Service Indicator - Inspect (If Equipped)

SMCS Code: 7452-040

Some engines may be equipped with a different service indicator.

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

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

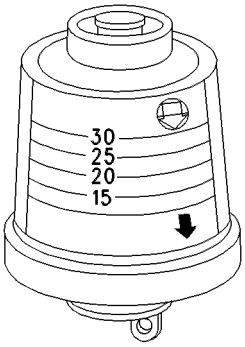


Illustration 29 g00103777

Typical service indicator

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

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

Test the Service Indicator

Service indicators are important instruments.

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

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

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

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

i01007514

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.

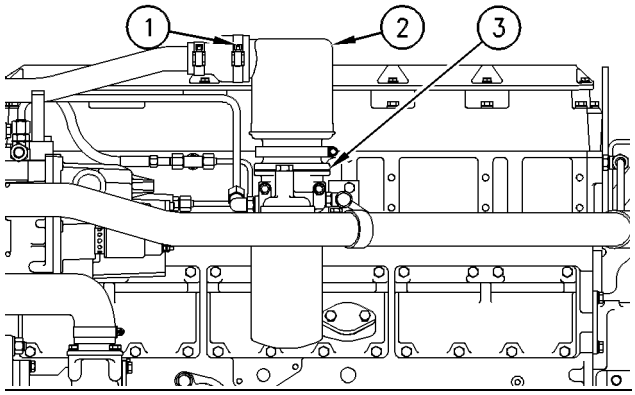


Illustration 30 g00516808

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

1. Loosen hose clamp (1) and remove the hose from breather assembly (2).
2. Remove breather assembly (2) and seal (3).
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 seal (3) and breather assembly (2).
5. Install the hose. Install hose clamp (1). Refer to the Operation and Maintenance Manual, “Torque Specifications” topic (Maintenance Section) for the proper torque.

i02456872

Engine Mounts - Inspect

SMCS Code: 1152-040; 1152

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

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

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

i01007363

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

Check the oil level after the engine has stopped. This maintenance procedure must be performed on a level surface.

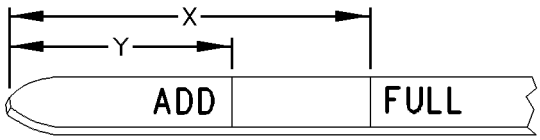


Illustration 31 g00110310

(Y) “ADD” mark
(X) “FULL” mark

1. Maintain the oil level between the “ADD” mark (Y) and the “FULL” mark (X) on the oil level gauge. Do not fill the crankcase above “FULL” mark (X).

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

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

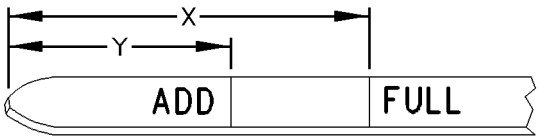
i01139872

Engine Oil Level Gauge - Calibrate

SMCS Code: 1326-524; 1326

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 installation can be different for each engine. The angle of installation will affect the “ADD” mark (Y) and the “FULL” mark (X) that is engraved on the engine oil level gauge.

The engine oil level gauge must be calibrated after the engine is installed in the vessel. Table 13 and Table 14 list the corresponding “ADD” mark, “FULL” mark and the angle of installation. 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 Table 13 or Table 14.



g00110310

Illustration 32

Oil Level Gauge

(Y) “ADD” mark
(X) “FULL” mark

Calibration of Oil Level Gauge

Table 13

Engine Oil Level Gauge 4KG1-05782 1SK1-01724 8NM1-01465		
Angle[1]	**“FULL” Mark (X)**	**“ADD” Mark (Y)**
15 degrees	156 mm (6.14 inch)	137 mm (5.39 inch)
14 degrees	151 mm (5.95 inch)	133 mm (5.24 inch)
13 degrees	148 mm (5.83 inch)	129 mm (5.08 inch)
12 degrees	144 mm (5.67 inch)	125 mm (4.92 inch)
11 degrees	139 mm (5.47 inch)	119 mm (4.69 inch)
10 degrees	136 mm (5.35 inch)	115 mm (4.53 inch)
9 degrees	130 mm (5.12 inch)	114 mm (4.49 inch)
8 degrees	128 mm (5.04 inch)	113 mm (4.45 inch)
7 degrees	121 mm (4.76 inch)	114 mm (4.49 inch)
6 degrees	117 mm (4.61 inch)	107 mm (4.21 inch)
5 degrees	113 mm (4.45 inch)	100 mm (3.94 inch)
4 degrees	112 mm (4.41 inch)	93 mm (3.66 inch)
3 degrees	111 mm (4.37 inch)	88 mm (3.47 inch)
2 degrees	109 mm (4.29 inch)	81 mm (3.19 inch)
1 degree	102 mm (4.02 inch)	76 mm (2.99 inch)
0 degrees	96 mm (3.78 inch)	70 mm (2.76 inch)

(1) The angle indicates the number of degrees that the front of the engine is raised.

Table 14

Engine Oil Level Gauge 4KG05783-UP 1SK01725-UP 8NM01466-UP 6SR1-UP 1ZJ1-UP 6MK1-UP		
Angle[1]	**“FULL” Mark (X)**	**“ADD” Mark (Y)**
10 degrees	125 mm (4.92 inch)	114 mm (4.49 inch)
9 degrees	124 mm (4.89 inch)	106 mm (4.17 inch)
8 degrees	122 mm (4.80 inch)	102 mm (4.02 inch)
7 degrees	120 mm (4.72 inch)	96 mm (3.78 inch)
6 degrees	115 mm (4.53 inch)	89 mm (3.50 inch)
5 degrees	110 mm (4.33 inch)	81 mm (3.19 inch)
4 degrees	101 mm (3.98 inch)	71 mm (2.80 inch)
3 degrees	94 mm (3.70 inch)	66 mm (2.60 inch)
2 degrees	90 mm (3.54 inch)	59 mm (2.32 inch)
1 degree	82 mm (3.23 inch)	52 mm (2.05 inch)
0 degrees	76 mm (2.99 inch)	46 mm (1.81 inch)
-1 degree	65 mm (2.56 inch)	39 mm (1.54 inch)
-2 degrees	59 mm (2.32 inch)	33 mm (1.30 inch)
-3 degrees	53 mm (2.09 inch)	26 mm (1.02 inch)
-4 degrees	46 mm (1.81 inch)	20 mm (0.79 inch)
-5 degrees	39 mm (1.54 inch)	12 mm (0.47 inch)

(1) The 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.

Verifying the Calibration of the Oil Level Gauge

Caterpillar recommends verifying the calibration of the oil level gauge at the first oil change. Use the following procedure to verify the “FULL” mark on the oil level gauge:

Note: The vessel must be level in order to perform this procedure.

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

2. Remove the used engine oil filter. Install the new engine oil filter. Install the crankcase drain plug and tighten the crankcase drain plug.

3. Add 25 L (26.5 qt) of the recommended oil grade and weight of engine oil to the crankcase.

Note: The engine may be equipped with auxiliary engine oil filters which require additional oil. Refer to the OEM specifications.

NOTICE
To help prevent crankshaft or bearing damage, crank engine to fill all filters before starting. Do not crank engine for more than 30 seconds.

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

Turbocharger (if equipped) damage can result, if the engine rpm is not kept low until the engine oil light/ gauge verifies the oil pressure is sufficient.

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

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

6. Check the engine oil level. If necessary, use a marking pen in order to correct the “FULL” mark (X).

i04237495

Engine Oil Sample - Obtain

SMCS Code: 1348-554-SM

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

Obtain the Sample and the Analysis

⚠ WARNING

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

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

- Engine model
- Service hours on the engine

- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

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

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

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

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

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

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

For instructions, see Special Publication, PEGJ0047, “How To Take A Good S·O·S Oil Sample”. Consult your Cat dealer for complete information and assistance in establishing an S·O·S program for your engine.

i02107152

Engine Oil and Filter - Change

SMCS Code: 1318-510

⚠ WARNING

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

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

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

Drain the Engine Oil

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

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

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

Replace the Oil Filter

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

1. Remove the oil filter with a 1U-8760 Chain Wrench.
2. Cut the oil filter open with a 175-7546 Oil Filter Cutter Gp. Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

   Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the oil filter element. Ferrous metals may indicate wear on the steel and cast iron parts of the engine.

Nonferrous metals may indicate wear on the aluminum parts, brass parts or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

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

g00103713

Illustration 33

Typical filter mounting base and filter gasket

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

4. Apply clean engine oil to the new oil filter gasket.

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

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

Fill the Engine Crankcase

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

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

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

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

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

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

i00626013

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.

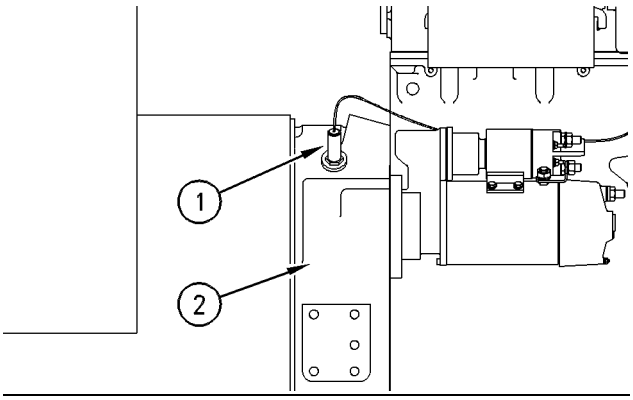
Visual Inspection

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.

i04748255

Engine Speed/Timing Sensor - Clean/Inspect (Magnetic Pick-ups)

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

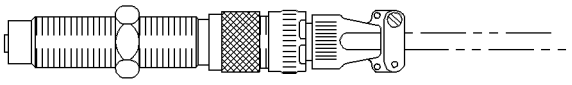


g00293335

Illustration 34

Typical example

(1) Magnetic pickup
(2) Flywheel housing



g00293337

Illustration 35

Typical magnetic pickup

1. Remove magnetic pickup from flywheel housing. 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. Contact your Cat dealer for further information.

i04242309

Engine Valve Lash - Check

SMCS Code: 1105-535

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.

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

Note: Only qualified service personnel should perform this maintenance. For procedures on adjusting the valve lash and adjusting the valve bridge, see System Systems Operation/Testing and Adjusting, “Engine Valve Lash - Inspect/Adjust”. Consult your Cat dealer for assistance.

⚠ 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.

i00850658

Fuel Injection Timing - Check

SMCS Code: 1251-036-TM; 1290-036-TM

Note: The correct fuel timing specification is found on the Engine Information Plate. Fuel timing specifications may vary for different engine applications and/or for different power ratings.

A qualified mechanic should adjust the fuel injector timing because special tools and training are required.

Refer to your Caterpillar dealer for the complete adjustment procedure for the fuel injector timing.

i01007661

Fuel System - Prime

SMCS Code: 1250-548; 1258-548

⚠ WARNING

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

Prime the fuel system in order to fill the fuel filter. Prime the fuel system in order to purge trapped air. The fuel system should be primed under the following conditions:

- Running out of fuel
- Storage
- Replacement of the fuel filter

Engines that are Equipped with a Fuel Priming Pump

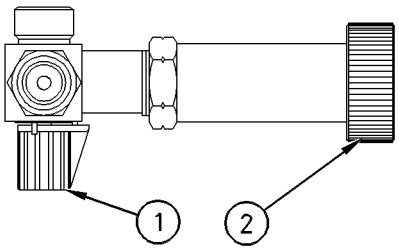


Illustration 36 g00516899

(1) Select knob
(2) Plunger

1. Turn select knob (1) counterclockwise until the indicator is in line with the body of the priming pump.
2. Unlock the plunger and operate the plunger until a resistance is felt. A considerable number of pump strokes may be required.
3. Push in plunger (2) and tighten by hand.
4. Turn select knob (1) clockwise until the indicator is in line with the fuel outlet.

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

5. Promptly start the engine. If the engine runs rough, increase the engine rpm to one half of the rated rpm.

Note: If the engine will not start, further priming may be necessary. If the engine continues to misfire or smoke after starting, further priming may be necessary.

Engines that are Not Equipped with a Fuel Priming Pump

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.

If the engine is not equipped with a fuel priming pump, it may be necessary to fill the fuel filter with clean fuel. The following procedure will only allow filtered fuel to enter the fuel system.

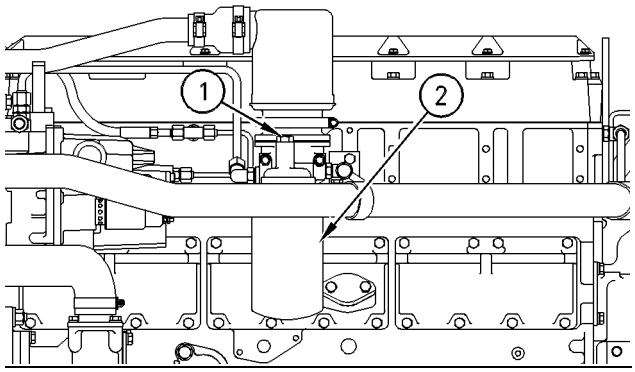


Illustration 37 g00516900

(1) Plug
(2) Fuel filter

1. Remove plug (1) in order to fill fuel filter (2). Ensure that air is able to vent from the fitting of the plug while the fuel filter is being filled. Clean up any spilled fuel immediately. Clean plug (1). Install plug (1).

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.

2. Start the engine and immediately increase the engine rpm to one half of the rated rpm.

3. Maintain the engine rpm until the engine operates smoothly.

4. Reduce the engine rpm to low idle.

i02927282

Fuel System Primary Filter (Water Separator) Element - Replace

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

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

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

Replace the Element

⚠ WARNING

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

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

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

Dispose of all fluids according to local regulations and mandates.

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

1. Close the main fuel supply valve.

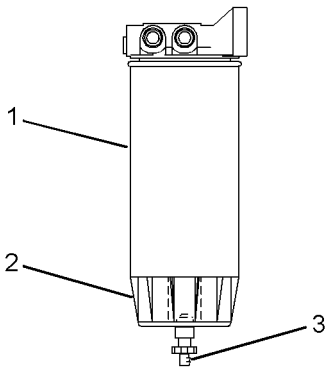


Illustration 38 g01453091

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

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

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

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

   - Bowl
   - O-ring
   - Mounting base

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

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

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

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

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

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

8. Open the main fuel supply valve.

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

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

i01007602

Fuel System Secondary Filter - Replace

SMCS Code: 1261-510-SE

⚠ WARNING

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

1. Stop the engine.

2. Turn off the start switch, or disconnect the battery (starting motor) when maintenance is performed on fuel filters.

3. Shut off the fuel tank supply valve to the engine.

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

4. Unlock the fuel priming pump (if equipped). This relieves any residual pressure in the fuel system.

5. Remove the used fuel filter. Use a cloth, or use a container to catch excess fuel.

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

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

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

8. Install a new fuel filter, and tighten the fuel filter until the gasket contacts the base.

9. Tighten the fuel filter by hand according to the instructions that are shown on the fuel filter.

   Do not overtighten the fuel filter.

10. Lock the fuel priming pump (if equipped). Open the fuel tank supply valve.

11. If the engine stalls, refer to the Operation and Maintenance Manual, “Fuel System - Prime” topic (Maintenance Section) for more information.

i04170131

Fuel System Water Separator - Check/Drain

SMCS Code: 1263-535; 1263-543

⚠ WARNING

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

NOTICE
The water separator is not a filter. It separates water from the fuel.

The engine should never be allowed to run with the water level in the separator more than 1/2 full or engine damage may result.

A water separator is recommended. The water separator should be installed between the fuel tank and the engine fuel inlet. Drain the water and sediment from the water separator on a daily basis.

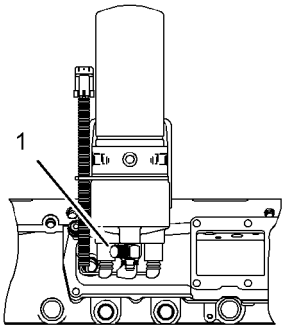


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Illustration 39

(1) Drain

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

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

Dispose of all fluids according to local regulations and mandates.

1. Open drain (1). Catch the draining water in a suitable container. Dispose of the water properly.

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.

2. Close drain (1).

i04363480

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

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

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

Dispose of all fluids according to local regulations and mandates.

Fuel Tank

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

Drain the Water and the Sediment

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

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

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

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

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

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

Fuel Storage Tanks

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

- Weekly
- Oil change
- Refill of the tank

This will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank. A four micron(c) absolute filter for the breather vent on the fuel tank is also recommended.

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.

i01057362

Heat Exchanger - Inspect

SMCS Code: 1379-040

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

- Cleanliness of the tubes of the heat exchanger
- 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 similar to the 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.

i04301694

Hoses and Clamps - Inspect/Replace

SMCS Code: 7554-040; 7554-510

Hoses and clamps must be inspected periodically in order to ensure safe operation and continuous operation of the engine. Take proper safety precautions before inspecting or replacing hoses and clamps.

Note: Always use a board or cardboard when the engine components are checked for leaks. Leaking fluid that is under pressure can cause serious injury or possible death. Leaks that are the size of a pin hole are included. Refer to Operation and Maintenance Manual, “General Hazard Information” for more information.

Inspect the Hoses and the Clamps

Inspect all hoses for leaks that are caused by the following conditions. Replace any hose which exhibits any of the following conditions. Failure to replace a hose which exhibits any of the following conditions may result in a hazardous situation.

- Hoses which are cracked
- Hoses which are soft
- 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
- Hoses which exhibit signs of leakage which are not the result of loose couplings or clamps

Inspect all clamps for the following conditions. Replace any clamp which exhibits signs of any of the following conditions.

- Cracking
- Looseness
- Damage

Inspect all couplings for leaks. Replace any coupling which exhibits signs of leaks.

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

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

Replace hoses that are cracked or soft. Replace hoses that show signs of leakage. Replace hoses that show signs of damage. Replace hose clamps that are cracked or damaged. Tighten or replace hose clamps which are loose.

Replace the Hoses and the Clamps

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

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

Dispose of all fluids according to local regulations and mandates.

Cooling System

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.

WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

1. Stop the engine.
2. Allow the engine to cool.
3. Before servicing a coolant hose, slowly loosen the filler cap for the cooling system in order to relieve any pressure.
4. Remove the filler cap for the cooling system.
5. Drain the coolant from the cooling system to a level that is below the hose that is being replaced. Drain the coolant into a suitable clean container. The coolant can be reused.
6. Remove the hose clamps.

7. Disconnect the old hose.

8. Replace the old hose with a new hose.

9. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications”, “Hose Clamps” for information about selecting and installing the proper hose clamps.

10. Refill the cooling system.

11. Clean the filler cap for the cooling system. Inspect the gaskets on the filler cap. Replace the filler cap if the gaskets are damaged. Install the filler cap.

12. Start the engine. Inspect the cooling system for leaks.

Fuel System

⚠ WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

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.

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.

Note: High-pressure fuel lines may be installed between the high-pressure fuel pump and the fuel injectors. High-pressure fuel lines are constantly charged with high pressure. Do not check the high-pressure fuel lines with the engine or the starting motor in operation. Wait for 10 minutes after the engine stops before you perform any service or repair on high-pressure fuel lines. Waiting for 10 minutes will to allow the pressure to be purged.

1. Drain the fuel from the fuel system to a level that is below the hose that is being replaced.

2. Remove the hose clamps.

3. Disconnect the old hose.

4. Replace the old hose with a new hose.

5. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications”, “Hose Clamps” for information about selecting and installing the proper hose clamps.

6. Carefully inspect the engine for any spilled fuel. Make sure that no fuel remains on or close to the engine.

Note: Fuel must be added to the fuel system ahead of the fuel filter.

7. Refill the fuel system. Refer to this Operation and Maintenance Manual, “Fuel System - Prime” for information about priming the engine with fuel.

8. Start the engine. Inspect the fuel system for leaks.

Lubrication System

⚠ WARNING

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

1. Drain the oil from the lubrication system to a level that is below the hose that is being replaced.

2. Remove the hose clamps.

3. Disconnect the old hose.

4. Replace the old hose with a new hose.

5. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications”, “Hose Clamps” for information about selecting and installing the proper hose clamps.

6. Refill the lubrication system. Refer to this Operation and Maintenance Manual, “Engine Oil Level - Check” in order to ensure that the lubrication system is filled with the proper amount of engine oil.

7. Start the engine. Inspect the lubrication system for leaks.

Air System

1. Remove the hose clamps.

2. Disconnect the old hose.

3. Replace the old hose with a new hose.

4. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications”, “Hose Clamps” for information about selecting and installing the proper hose clamps.

Note: The bellows and the V-clamps that are used on the bellows should never be reused.

5. Start the engine. Inspect the air lines for leaks.

i01081132

Overhaul Considerations

SMCS Code: 7595-043

The following items can increase the engine service life before an overhaul is required:

- Use only lubricants that are recommended by Caterpillar.
- Follow the recommended guidelines for maintenance.
- Use an S·O·S Oil Analysis to determine the maximum interval for changing the oil filter and the oil.
- Follow the rating definitions that are recommended for the engine.

Repair of Piston, Ring, And Bore As An Indicator

Investigate the piston, the ring, and the bore or repair the piston, the ring, and the bore if one of the following conditions occurs:

- Oil consumption is in excess of 1 quart of oil per 60 gallons of fuel that is consumed. The oil consumption must not be caused by leakage.
- Crankcase blowby is in excess of 2 cubic feet per hour per horsepower. Measure the crankcase blowby with an 8T-2700 Blowby Indicator .
- Fuel consumption has increased.
- Loss of power has occurred.

The cylinder head must be removed in order to repair the piston, the ring, and the bore. After removing the cylinder head, inspect the valves and the valve seats. Repair the valve and the valve seats, if necessary. Determine if any other components of the engine should be inspected.

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 - Clean/Test” 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 1). 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 2).

S·O·S Coolant Analysis (Level 2)

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

- Complete S·O·S Coolant Analysis (Level 1)
- Visual inspection of properties
- Identification of metal corrosion
- Identification of contaminants
- Identification of built up impurities (corrosion and scale)

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

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

i00905687

Sea Water Strainer - Clean/Inspect

SMCS Code: 1371-040; 1371-070

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

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

1. Remove the sea water strainer and clean the screen. Remove any dirt and debris.

2. Install the sea water strainer. Fill the sea water strainer and the suction line for the auxiliary water pump with water.

i04237689

Transmission Oil Level - Check

SMCS Code: 3030-535-FLV

Check the marine transmission oil level according to the instructions that are provided by the OEM of the transmission or the OEM of the vessel.

For the lubrication requirements of the transmission, refer to the recommendations on the nameplate or the service information for the transmission.

Marine Transmission Operation, Maintenance, Warranty, and Parts Support

For information on maintenance and operation of the marine transmission, consult your Cat dealer and/or the OEM dealer of the transmission.

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

i01057899

Turbocharger - Inspect

SMCS Code: 1052-040

Periodic cleaning is recommended for the turbocharger compressor (inlet side). The following items collect in the turbocharger compressor housing since the fumes from the crankcase travel through the inlet air: oil, by-products from oil, and by-products from combustion. The buildup reduces boost and air flow. The buildup also contributes to loss of engine power, increased black smoke, and overall loss of engine efficiency.

Cleaning and Inspecting

1. Remove the air inlet piping from the turbocharger and remove the compressor housing from the turbocharger.

2. Clean the turbocharger compressor housing with Hydrosolv Liquid Cleaners and a hard bristle brush.

3. Clean the turbocharger compressor wheel and clean the backplate assembly with 4C-4079 Brake and Electric Cleaner.

i00893389

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.

i03543200

Water Pump - Inspect

SMCS Code: 1361-040

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

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

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

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

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

i01007424

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 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 15 shows the locations of the zinc rods and the quantities of the zinc rod:

Table 15

Locations of the Zinc Rods	
Location	**Quantity**
Heat Exchanger	3
Transmission Oil Cooler(1)	2
Exhaust Elbow(2)	1
Aftercooler(3)	5

(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.
(3) 3126 Engine Only

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.

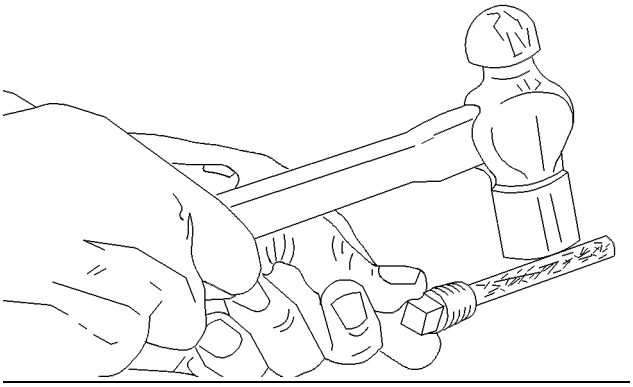

Illustration 40 g00481100

   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.

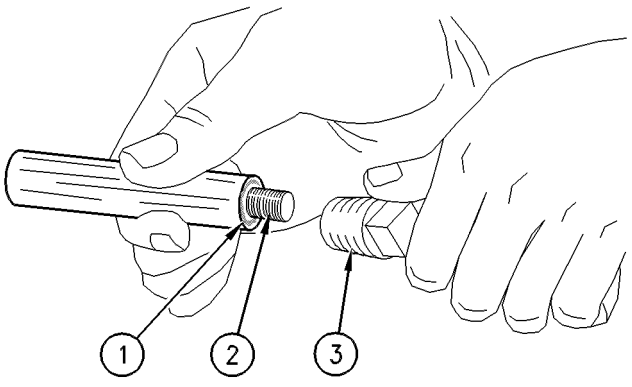

Illustration 41 g00480345

(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).