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# **3408C, 3412, 3412C and 3412D HIGH PERFORMANCE MARINE ENGINES**

**Maintenance Intervals**

Excerpted from Operation & Maintenance Manual (SEBU6497-07-01)

i02469150

## Maintenance Interval Schedule

**SMCS Code:** 1000; 7500

**S/N:** 8RG1-Up

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

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

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

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

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

The operating conditions may cause the following maintenance items to be performed at a "When Required" maintenance interval: "Aftercooler Core - Clean/Test", "Heat Exchanger - Inspect", "Seawater Strainer - Clean/Inspect", and "Zinc Rods Inspect/Replace". Refer to these sections in this Operation and Maintenance Manual in order to determine if these maintenance items need to be performed at the service hour interval listed in the Maintenance Interval Schedule or at the "When Required" interval.

### When Required

Aftercooler Core - Clean/Test .....	79
Battery - Recycle .....	80
Battery or Battery Cable - Disconnect .....	81
Fuel System - Prime .....	100
Heat Exchanger - Inspect .....	103
Sea Water Strainer - Clean/Inspect .....	110
Zinc Rods - Inspect/Replace .....	113

### Daily

Cooling System Coolant Level - Check .....	86
Engine Air Cleaner Service Indicator - Inspect .....	94
Engine Oil Level - Check .....	96
Marine Transmission Oil Level - Check .....	107
Walk-Around Inspection .....	111

### Every 250 Service Hours

Cooling System Coolant Sample (Level 1) - Obtain .....	87
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### Initial 500 Hours (for New Systems, Refilled Systems, and Converted Systems)

Cooling System Coolant Sample (Level 2) - Obtain .....	88
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### Every Year

Cooling System Coolant Sample (Level 2) - Obtain .....	88
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### Every 6000 Service Hours or 3 Years

Cooling System Coolant Extender (ELC) - Add ....	86
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### Every 12 000 Service Hours or 6 Years

Cooling System Coolant (ELC) - Change .....	84
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### Every 3800 L (1000 US gal) of Fuel or 50 Service Hours

Sea Water Strainer - Clean/Inspect .....	110
Zinc Rods - Inspect/Replace .....	113

### First 12 750 L (3375 US gal) of Fuel or 250 Service Hours

Engine Valve Lash - Inspect/Adjust .....	98
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### Every 12 750 L (3375 US gal) of Fuel or 250 Service Hours or Yearly

Alternator Belt - Inspect/Adjust/Replace .....	79
Battery Electrolyte Level - Check .....	81
Cooling System Supplemental Coolant Additive (SCA) - Test/Add .....	88
Engine Air Cleaner Element - Clean/Replace .....	90
Engine Crankcase Breather - Clean .....	95
Engine Oil Sample - Obtain .....	96
Engine Oil and Filter - Change .....	97
Fuel System Primary Filter - Clean/Replace .....	101
Fuel System Secondary Filter - Replace .....	102
Fuel Tank Water and Sediment - Drain .....	103
Hoses and Clamps - Inspect/Replace .....	106

### Every 76 000 L (20 000 US gal) of Fuel or 1000 Service Hours

Aftercooler Core - Clean/Test .....	79
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Heat Exchanger - Inspect ..... 103

**Every 76 500 L (20 250 US gal) of Fuel or  
1500 Service Hours**

Engine Speed/Timing Sensors - Check/Clean/  
Calibrate ..... 98  
Engine Valve Lash - Inspect/Adjust ..... 98  
Engine Valve Rotators - Inspect ..... 99

**Every 153 500 L (40 500 US gal) of Fuel or  
3000 Service Hours**

Alternator - Inspect ..... 79  
Auxiliary Water Pump - Inspect ..... 80  
Cooling System Coolant (DEAC) - Change ..... 81  
Cooling System Water Temperature Regulator -  
Replace ..... 90  
Crankshaft Vibration Damper - Inspect ..... 90  
Engine Mounts - Inspect ..... 95  
Fuel Injection Nozzles - Test/Exchange ..... 99  
Starting Motor - Inspect ..... 110  
Turbocharger - Inspect ..... 110  
Water Pump - Inspect ..... 112

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

Overhaul Considerations ..... 107

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## Maintenance Interval Schedule

**SMCS Code:** 1000; 7500

**S/N:** REA1-Up

**S/N:** 3JK1-Up

**S/N:** 7BL1-Up

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

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

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

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

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

The operating conditions may cause the following maintenance items to be performed at a "When Required" maintenance interval: "Aftercooler Core - Clean/Test", "Heat Exchanger - Inspect", "Seawater Strainer - Clean/Inspect", and "Zinc Rods Inspect/Replace". Refer to these sections in this Operation and Maintenance Manual in order to determine if these maintenance items need to be performed at the service hour interval listed in the Maintenance Interval Schedule or at the "When Required" interval.

### When Required

Aftercooler Core - Clean/Test .....	79
Battery - Recycle .....	80
Battery or Battery Cable - Disconnect .....	81
Fuel System - Prime .....	100
Heat Exchanger - Inspect .....	103
Sea Water Strainer - Clean/Inspect .....	110

Zinc Rods - Inspect/Replace .....	113
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### Daily

Cooling System Coolant Level - Check .....	86
Engine Air Cleaner Service Indicator - Inspect .....	94
Engine Oil Level - Check .....	96
Marine Transmission Oil Level - Check .....	107
Walk-Around Inspection .....	111

### Every 250 Service Hours

Cooling System Coolant Sample (Level 1) - Obtain .....	87
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### Initial 500 Hours (for New Systems, Refilled Systems, and Converted Systems)

Cooling System Coolant Sample (Level 2) - Obtain .....	88
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### Every Year

Cooling System Coolant Sample (Level 2) - Obtain .....	88
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### Every 6000 Service Hours or 3 Years

Cooling System Coolant Extender (ELC) - Add ....	86
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### Every 12 000 Service Hours or 6 Years

Cooling System Coolant (ELC) - Change .....	84
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### Every 3800 L (1000 US gal) of Fuel or 50 Service Hours

Sea Water Strainer - Clean/Inspect .....	110
Zinc Rods - Inspect/Replace .....	113

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

Battery Electrolyte Level - Check .....	81
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### First 19 000 L (5000 US gal) of Fuel or 250 Service Hours

Engine Valve Lash - Inspect/Adjust .....	98
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### Every 19 000 L (5000 US gal) of Fuel or 250 Service Hours or Yearly

Alternator Belt - Inspect/Adjust/Replace .....	79
Battery Electrolyte Level - Check .....	81
Cooling System Supplemental Coolant Additive (SCA) - Test/Add .....	88
Engine Air Cleaner Element - Clean/Replace .....	90
Engine Crankcase Breather - Clean .....	95
Engine Oil Sample - Obtain .....	96
Engine Oil and Filter - Change .....	97
Fuel System Primary Filter - Clean/Replace .....	101
Fuel System Secondary Filter - Replace .....	102

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Fuel Tank Water and Sediment - Drain .....	103
Hoses and Clamps - Inspect/Replace .....	106

**Every 76 000 L (20 000 US gal) of Fuel or  
1000 Service Hours**

Aftercooler Core - Clean/Test .....	79
Heat Exchanger - Inspect .....	103

**Every 114 000 L (30 000 US gal) of Fuel or  
1500 Service Hours**

Engine Speed/Timing Sensors - Check/Clean/ Calibrate .....	98
Engine Valve Lash - Inspect/Adjust .....	98
Engine Valve Rotators - Inspect .....	99

**Every 228 000 L (60 000 US gal) of Fuel or  
3000 Service Hours**

Alternator - Inspect .....	79
Auxiliary Water Pump - Inspect .....	80
Cooling System Coolant (DEAC) - Change .....	81
Cooling System Water Temperature Regulator - Replace .....	90
Crankshaft Vibration Damper - Inspect .....	90
Engine Mounts - Inspect .....	95
Fuel Injection Nozzles - Test/Exchange .....	99
Starting Motor - Inspect .....	110
Turbocharger - Inspect .....	110
Water Pump - Inspect .....	112

**Every 760 000 L (200 000 US gal) of Fuel or  
10 000 Service Hours**

Overhaul Considerations .....	107
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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 Hydrosolv liquid cleaner. Table 32 lists Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 32

Hydrosolv Liquid Cleaners <sup>(1)</sup>	
Description	Container
1U-5490 Hydrosolv 4165	19 L (5 US gal)
174-6854 Hydrosolv 100	19 L (5 US gal)

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

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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# Alternator - Inspect

**SMCS Code:** 1405-040

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

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

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# Alternator Belt - Inspect/Adjust/Replace

**SMCS Code:** 1357-036; 1357-510

## Inspection

To maximize the engine performance, inspect the belt for wear and for cracking. Check the belt tension. Adjust the belt tension in order to minimize belt slippage. Belt slippage will decrease the life of the belt.

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

## Adjustment

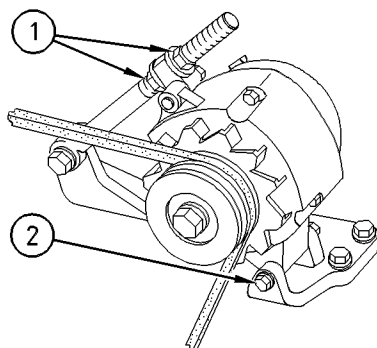


Illustration 28

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(1) Typical Adjusting Nuts. (2) Mounting Bolt.

1. Remove the belt guard.
2. Loosen mounting bolt (2) and adjusting nuts (1).
3. Turn adjusting nuts (1) in order to increase or decrease the belt tension.
4. Tighten adjusting nuts (1). Tighten mounting bolt (2). Refer to the Operation and Maintenance Manual for the proper torques.
5. Reinstall the belt guard.

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

## Replacement

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

Refer to the Service Manual for more information on the procedures for the following topics:

- Removal of an alternator belt
- Installation of an alternator belt

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## Auxiliary Water Pump - Inspect

**SMCS Code:** 1371-040

Impellers require periodic inspection 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 of the pump 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 and check the following components for damage:

- Cam
- Impeller
- Seals
- Wear plate

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

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## Battery - Recycle

**SMCS Code:** 1401-561

Always recycle a battery. Never discard a battery.

Always return used batteries to one of the following locations:

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

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## Battery Electrolyte Level - Check

**SMCS Code:** 1401-535

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing. If batteries are properly charged, ammeter reading should be very near zero, when the engine is in operation.

### 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.

## Battery or Battery Cable - Disconnect

**SMCS Code:** 1402-029

### WARNING

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

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

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

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## Cooling System Coolant (DEAC) - Change

**SMCS Code:** 1350-070; 1395-044

Flush the cooling system and clean the cooling system before the recommended maintenance interval if the following conditions exist:

- Coolant is dirty.
- Coolant is heavily contaminated by oil.
- Coolant is heavily contaminated by fuel.
- The engine overheats frequently.
- Foaming is observed.

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#### NOTICE

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

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**Note:** Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace any of the following items, if a replacement is needed: the water pump, the water temperature regulator, and the hoses.

## Drain

1. Stop the engine and allow the engine to cool.
  2. Take extreme care to loosen the cooling system filler cap slowly so you can relieve any pressure. Carefully 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 the following cooling system drain plugs:
    - Drain plug for water temperature regulator
    - Drain plug for oil cooler
  4. Allow the coolant to drain.
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#### 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.

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

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

## Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). If the cooling system is not equipped with a drain valve, clean the drain plugs and the drain plug fittings.

Reinstall these drain plugs:

- drain plug for water temperature regulator
- drain plug for oil cooler

**Note:** Refer to the Operation and Maintenance Manual, "Torque Specifications" for more information on the proper torques.

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#### NOTICE

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

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3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Reinstall cooling system filler cap (3).
4. Now, run the engine at low idle for a minimum of 30 minutes. Make sure that the coolant temperature remains at a minimum temperature of 82°C (180°F).
5. Stop the engine and allow the engine to cool.
6. **Loosen the cooling system filler cap slowly.** This relieves the pressure from the system. Remove cooling system filler cap.
7. Open the drain valve (if equipped), or remove the following cooling system drain plugs:
  - Drain plug for water temperature regulator
  - Drain plug for oil cooler
8. Allow the mixture of both the water and the cleaner to drain.
9. Flush the cooling system with clean water until the draining water is clean.
10. Close the drain valve (if equipped). If the cooling system is not equipped with a drain valve, clean the drain plugs and the drain plug fittings.

Reinstall these drain plugs:

- Drain plug for water temperature regulator
- Drain plug for oil cooler

**Note:** Refer to the Operation and Maintenance Manual, "Torque Specifications" for more information on the proper torques.

## Cooling Systems with Heavy Deposits or Plugging

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

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). If the cooling system is not equipped with a drain valve, clean the drain plugs and the drain plug fittings.

Reinstall these drain plugs:

- Drain plug for water temperature regulator
- Drain plug for oil cooler

**Note:** Refer to the Operation and Maintenance Manual, "Torque Specifications" for more information on the proper torques.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity.

Reinstall cooling system filler cap.

4. Now, run the engine at low idle for a minimum of 90 minutes. Make sure that the coolant temperature remains at a temperature of at least 82°C (180°F).
5. Stop the engine and allow the engine to cool.
6. Loosen cooling system filler cap slowly in order to relieve any pressure. Remove cooling system filler cap .
7. Open the drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove the following cooling system drain plugs:
  - Drain plug for water temperature regulator
  - Drain plug for oil cooler
8. Allow the mixture of both the water and the cleaner to drain. Flush the cooling system with clean water until the draining water is transparent.
9. Close the drain valve (if equipped). If the cooling system is not equipped with a drain valve, clean the cooling system drain plugs and the drain plug fittings.

Reinstall these drain plugs:

- Drain plug for water temperature regulator

- Drain plug for oil cooler

**Note:** Refer to the Operation and Maintenance Manual, "Torque Specifications" for more information on the proper torques.

## Engines That Are Equipped with a Coolant Recovery Tank

**Note:** Refer to the Operation and Maintenance Manual (Maintenance Section) for more information on cooling system specifications.

1. Fill the system with the mixture of coolant/antifreeze that is recommended.
2. Reinstall recovery tank's filler cap.
3. Place the marine transmission into the NEUTRAL position.
4. Now, run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at this rate for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
5. Remove recovery tank's filler cap.
6. Pour coolant/antifreeze into the tank until the coolant reaches the "COLD FULL" mark. Do not fill the tank above the "COLD FULL" mark.
7. Clean the recovery tank's filler cap, and then reinstall this filler cap.
8. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

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

1. Fill the system with coolant/antifreeze. Do not install the cooling system filler cap.
2. Place the marine transmission into the NEUTRAL position.
3. Run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at this rate for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
4. Check the coolant level. Maintain the coolant level within 13 mm (.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (.5 inch) to the proper level on the sight glass (if equipped).

5. Clean cooling system's filler cap . Also clean the receptacle for this filler cap, and inspect the filler cap gasket.
  - If the filler cap gasket is damaged, discard the old cooling system filler cap and install a new cooling system filler cap.
  - If the filler cap gasket is not damaged, use a 9S-8140 Pressurized Pump Group to pressure test the cooling system filler cap.
  - If the cooling system filler cap does not maintain the correct pressure, install a new cooling system filler cap.

**Note:** The correct pressure for the cooling system filler cap is stamped on the filler cap's face .

6. Reinstall filler cap.
7. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

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## Cooling System Coolant (ELC) - Change

**SMCS Code:** 1350-070; 1395-044

Flush the cooling system and clean the cooling system before the recommended maintenance interval under the following conditions:

- The coolant is dirty.
- The coolant is heavily contaminated by oil.
- The coolant is heavily contaminated by fuel.
- The engine overheats frequently.
- Foaming is observed.

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

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### NOTICE

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

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**Note:** Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace any of the following items, if a replacement is needed: the water pump, the water temperature regulator, and the hoses.

## Drain

1. Stop the engine and allow the engine to cool.
2. **Take extreme care to slowly loosen the coolant system's filler cap.** This relieves the pressure from the cooling system. Remove this filler cap.
3. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove the cooling system drain plugs:
  - Drain plug from the bottom of the water cooled exhaust manifold
  - Drain plug for the water temperature regulator
  - Drain plug for the aftercooler
  - Drain plug for the oil cooler
4. Allow the coolant to drain.

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### 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.

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

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

## Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). If the cooling system is not equipped with a drain valve, clean the drain plugs:
  - drain plug for oil cooler
  - drain plug for water temperature regulator

**Note:** Refer to the Operation and Maintenance Manual (Maintenance Section), "Torque Specifications" for more information on the proper torques.

Reinstall both drain plugs.

3. Fill the cooling system with clean water, and reinstall the coolant filler cap.
4. Operate the engine until the temperature reaches 49 to 66°C (120 to 150°F).
5. Stop the engine and allow the engine to cool. Open the drain valve (if equipped), or remove the cooling system drain plugs:
  - Drain plug on the bottom of the water cooled exhaust manifold
  - Drain plug for the water temperature regulator
  - Drain plug for the aftercooler
  - Drain plug for the oil cooler
6. Allow the water to drain.
7. **Take extra care to loosen the coolant filler cap slowly.** This helps to relieve the cooling system's pressure. Remove the coolant filler cap.
8. Flush the cooling system with clean water.
9. Repeat step 2 through step 5.

## Fill

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

1. Fill the expansion tank with ELC. Fill the expansion tank to the top. Refer to the Operation and Maintenance Manual (Maintenance Section), "Cooling System Specifications" for more information on cooling system specifications.
2. Reinstall the filler cap for the recovery tank.
3. Place the marine transmission into the NEUTRAL position. Run the engine at low idle.
4. Increase the engine rpm to 1500 rpm. Run the engine at 1500 rpm for one minute in order to purge the air from the cavities of the engine block. Then, stop the engine.
5. Slowly loosen the filler cap for the recovery tank in order to relieve any pressure. Remove the filler cap for the recovery tank.

6. Pour ELC into the tank until the coolant reaches the "COLD FULL" mark. DO NOT fill the tank above the "COLD FULL" mark.
7. Clean the filler cap for the recovery tank. Then, reinstall this filler cap.
8. Start the engine. Inspect the coolant recovery tank for both coolant leaks and proper operating temperature.

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

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

i00670616

## Cooling System Coolant Extender (ELC) - Add

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

Caterpillar Extended Life Coolant (ELC) does not require frequent additions of Supplemental Coolant Additive (SCA). Only add any SCA after an addition is determined from the results with an SCA test kit.

Check the cooling system after the engine is stopped and after the engine is cool.

1. Loosen the cooling system filler cap slowly in order to relieve pressure. Remove the cooling system filler cap.
2. Drain enough coolant from the cooling system in order to allow enough room for the addition of this Extender.
3. Add Extender according to the requirements for your engine's cooling system capacity.

**Note:** Refer to the Operation and Maintenance Manual, "Refill Capacities" in the Maintenance Section for the capacity of the cooling system for your engine. Refer to the Operation and Maintenance Manual, "Cooling System Specifications" information for the Caterpillar ELC Extender additions.

4. Clean the cooling system filler cap, and inspect the cooling system filler cap's gaskets. Replace the cooling system filler cap if these gaskets are damaged.
5. Reinstall the cooling system filler cap.

## Replace the SCA Element (If Equipped)

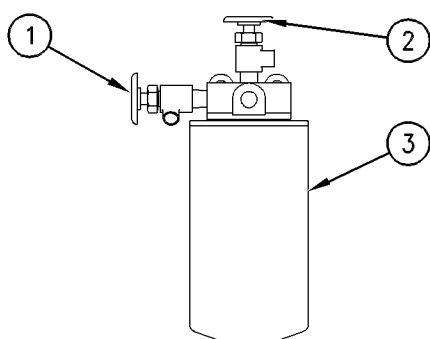


Illustration 29

g00292998

(1) Inlet valve. (2) Outlet valve. (3) SCA element.

1. Close inlet valve (1) for the SCA maintenance element, and close the outlet valve (2) as well.
2. Remove the SCA element (3). Remember to properly discard the SCA element.
3. Clean the SCA element's mounting base, and make sure that the old gasket is removed.
4. Coat the gasket for the new SCA element (3) with coolant.

**Note:** Refer to Operation and Maintenance, "Cooling System Specifications" for the proper SCA element for your system.

5. Place the element into position. Tighten the SCA element until the seal contacts the base. Tighten the SCA element (3) by another three quarters of a turn by hand. Do not overtighten the SCA element.
6. Open inlet valve (1) and open outlet valve (2).
7. Remove the cooling system filler cap, and start the engine in order to check for leaks. Allow the coolant level to stabilize.
8. Add the necessary amount of coolant/water mixture in order to increase the coolant level to the proper level. The proper level for the coolant/water mixture is an amount that is at 13 mm (0.5 inch) below the bottom of the pipe. If equipped, use a sight glass to make sure that an appropriate amount of coolant/water mixture is added.
9. Clean the cooling system filler cap, and inspect the filler cap's gaskets. Replace any damaged gasket. Also, clean the receptacle for the cooling system filler cap. Finally, install the cooling system filler cap.

i02456586

## Cooling System Coolant Level - Check

**SMCS Code:** 1395-082

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

## Engines That Are Equipped with a Coolant Recovery Tank

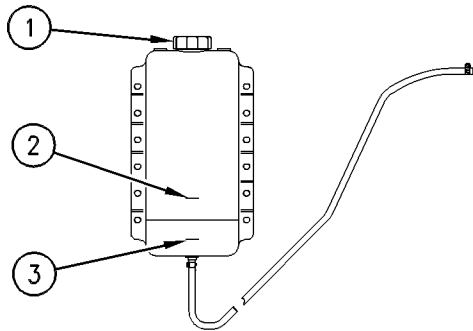


Illustration 30

g00103638

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

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

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

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

### **WARNING**

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

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

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

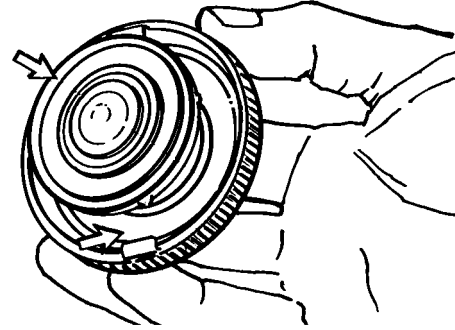


Illustration 31

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.

i02326688

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

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

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

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

Table 33

Recommended Interval		
Type of Coolant	Level 1	Level 2
Cat DEAC	Every 250 Hours <sup>(1)</sup>	Yearly <sup>(1)(2)</sup>
Cat ELC	Optional <sup>(2)</sup>	Yearly <sup>(2)</sup>

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

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

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

#### NOTICE

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

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

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

Use the following guidelines for proper sampling of the coolant:

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

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

Submit the sample for Level 1 analysis.

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

i01987714

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

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

#### NOTICE

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

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

Submit the sample for Level 2 analysis.

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

i02456600

## 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.

i00912898

## Cooling System Water Temperature Regulator - Replace

**SMCS Code:** 1355-510

Replace the water temperature regulator before the water temperature regulator fails. This is a recommended preventive maintenance practice. Replacing the water temperature regulator reduces the chances for unscheduled downtime.

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

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

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

---

### NOTICE

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

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

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

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

---

Refer to the Service Manual for the replacement procedure of the water temperature regulator, or consult your Caterpillar dealer.

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

i00072369

## Crankshaft Vibration Damper - Inspect

**SMCS Code:** 1205-040

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

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

## Removal and Installation

Refer to the Service Manual for the damper removal procedure and for the damper installation procedure.

## Visconic Damper

The visconic damper has a weight that is located inside a fluid filled case. The weight moves in the case in order to limit torsional vibration. Inspect the damper for evidence of dents, cracks or leaks of the fluid.

Replace the damper if the damper is dented, cracked or leaking. Refer to the Service Manual or consult your Caterpillar dealer for damper replacement.

i01083053

## Engine Air Cleaner Element - Clean/Replace

**SMCS Code:** 1054-070; 1054-510

## AIRSEP®

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### 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.

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### NOTICE

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

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

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

---

#### NOTICE

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

4. Spray the element with the cleaning solution. Allow the element to stand for 20 minutes.
5. Rinse the element with low water pressure. The maximum water pressure for this procedure is 275 kPa (40 psi). Tap water is acceptable. Start to rinse the element from the clean side (inside). Next, clean the dirty side (outside) in order to flush out dirt. Inspect the element for tears and/or holes after the element is cleaned. Do not reuse damaged elements.

---

#### NOTICE

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

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

---

#### NOTICE

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

7. The dry element should be oiled before installation. Apply small amounts of oil across the top of each pleat. Allow the oil to soak into the element for 20 minutes. Oil any remaining "white" spots.
8. Inspect the housing and the clamp for the element. Replace the housing and the clamp, if necessary.

9. Remove the seal from the air inlet opening. Install the clean, oiled element. Refer to the Specifications Manual for your particular engine for more specific information on the proper torques. Refer to the Specifications, SENR3130, "Torque Specifications" for more general information on the proper torques.

## Paper Air Cleaner Element

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#### NOTICE

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

---

#### NOTICE

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

1. Remove the cover. Remove the element.
2. Cover the air inlet opening with a clean cloth, or seal with tape in order to prevent dirt from entering the engine.
3. Clean the inside of the air cleaner cover and body with a clean, dry cloth.
4. Clean the element and inspect the element. Replace the element, if necessary. Refer to "Cleaning Paper Air Cleaner Elements".
5. Remove the seal from the air inlet opening. Install an element that is new or cleaned.

## Cleaning Paper Air Cleaner Elements

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

Use clean elements while dirty elements are being cleaned.

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#### 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.

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

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

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

### Pressurized Water

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

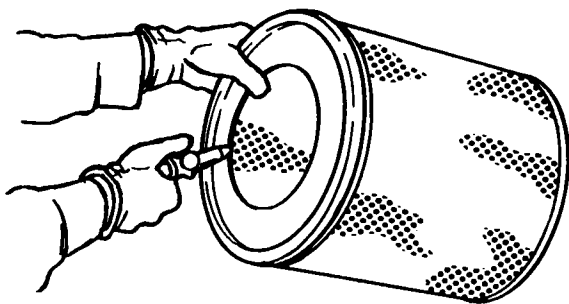
**Note:** When the element is cleaned, always begin with the clean side (inside) in order to force dirt particles toward the dirty side (outside).

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

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

### Pressurized Air

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



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

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

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

### Vacuum Cleaning

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

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

### Washing the Paper Air Cleaner Elements with Nonsudsing Detergent

#### WARNING

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

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

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

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

2. Fill the wash tank with the cleaning agent and warm water to a maximum temperature of 60 °C (140 °F). Follow the manufacturers recommendations for the cleaning agent. Allow the element to soak for six hours.

3. Drain the wash tank. Do not use the cleaning agent more than one time. Remove the element from the wash tank. Rinse the element by performing the method for cleaning with pressurized water.

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

### Drying the Paper Air Cleaner Elements

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

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

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

### Inspecting the Paper Air Cleaner Elements

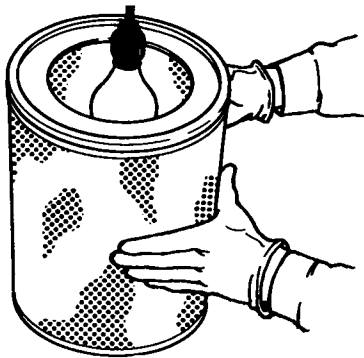


Illustration 33

g00281693

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

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

### Storing Paper Air Cleaner Elements

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

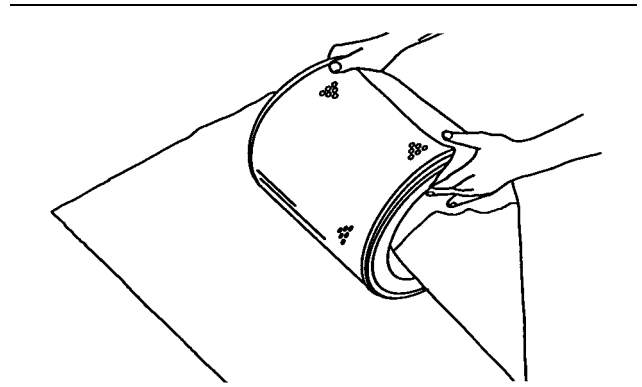


Illustration 34

g00281694

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

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

- Date of the cleaning
- Number of cleanings

Store the box in a dry location.

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

i00641711

## Engine Air Cleaner Service Indicator - Inspect

**SMCS Code:** 7452-040

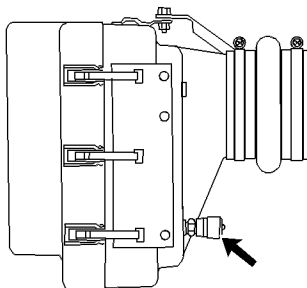


Illustration 35

g00291942

Typical air cleaner service indicator that is mounted on the air cleaner housing

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

Some vessels are equipped with a low air pressure indicator that monitors the inlet air pressure. This indicator measures air pressure before the air is drawn through the air cleaner element. Then, the indicator monitors the pressure level after the air has passed through the air cleaner element. As the air cleaner element becomes dirty, this air cleaner pressure differential rises.

Some vessels may be equipped with a different air cleaner indicator.

If your vessel is equipped with a different type of air cleaner indicator, follow the recommendations for the vessel. You can also follow the recommendations in the air cleaner OEM in order to service the air cleaner element.

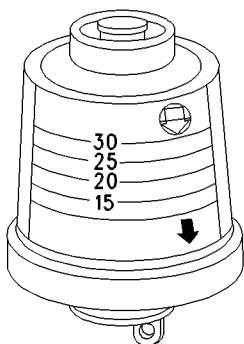


Illustration 36

g00103777

Typical Air Cleaner Service Indicator

Observe the air cleaner service indicator. You should clean the air cleaner element, or you should replace the air cleaner element under two conditions:

- The yellow diaphragm enters the red zone.
- The service indicator displays the red color at any time.
- The red piston locks in the visible position.

## Test the Air Cleaner Service Indicator

Air cleaner service indicators are important, inexpensive instruments. Two methods can be used to test the service indicator.

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

The air cleaner service indicator should be replaced under certain conditions and at certain times:

- The service indicator does not reset easily.
- The yellow core does not latch at the greatest vacuum.
- The engine is used for a year.
- The engine is overhauled.
- Major engine components are replaced.

**Note:** Replace the air cleaner service indicator often whenever you operate in a severely dusty environment.

If the new service indicator will not reset, the hole for the service indicator may be plugged.

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

## Service the Air Cleaner Service Indicator

### NOTICE

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

### NOTICE

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

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

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

Refer to the Operation and Maintenance Manual (Maintenance Section) for more information on servicing the air cleaner element.

i02263740

## Engine Crankcase Breather - Clean

**SMCS Code:** 1317-070

### NOTICE

Perform this maintenance with the engine stopped.

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

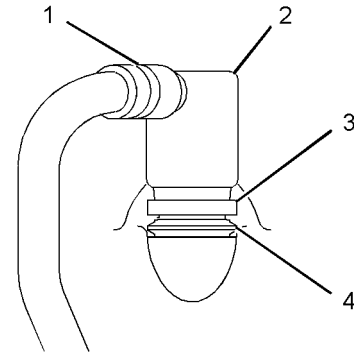


Illustration 37

g01136454

Typical example

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

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

i02456872

## Engine Mounts - Inspect

**SMCS Code:** 1152-040

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

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

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

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.

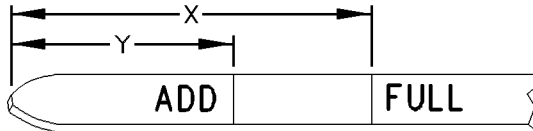


Illustration 38

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.

i01935337

## Engine Oil Sample - Obtain

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

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

## Obtain the Sample and the Analysis

### WARNING

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

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

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

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

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

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

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

### NOTICE

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

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

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

i02107152

## Engine Oil and Filter - Change

SMCS Code: 1318-510; 1348-044

### WARNING

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

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

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

### Drain the Engine Oil

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

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

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

### Replace the Oil Filter

#### NOTICE

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

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

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

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

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

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

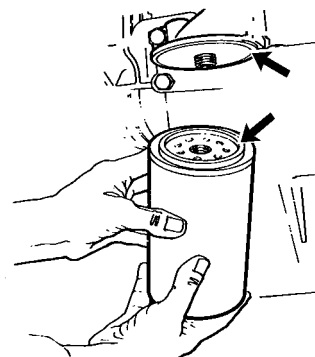


Illustration 39

g00103713

Typical filter mounting base and filter gasket

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

#### NOTICE

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

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

## Fill the Engine Crankcase

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

### NOTICE

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

### NOTICE

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

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

i00645402

## Engine Speed/Timing Sensors - Check/Clean/Calibrate

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

**S/N:** REA1-Up

**S/N:** 8RG1-Up

**S/N:** 3JK1-Up

The 4P-7610 Magnetic Pickup Group is mounted in the flywheel housing. This magnetic pickup functions as a top camshaft engine speed/timing sensor. A second magnetic pickup functions as a backup. The primary engine speed/timing sensor is below the secondary engine speed/timing sensor.

## Inspection

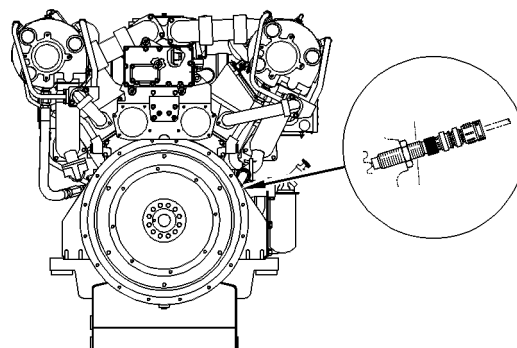


Illustration 40

g00288391

Magnetic pickups are mounted in the flywheel housing.

1. Remove the backup magnetic pickup from the flywheel housing.
2. Inspect the condition of the end of the magnetic pickup. Look for signs of wear. Also, look for any contaminants.
3. Inspect the engine speed sensor connector for damage and for corrosion. Inspect the wire for any damage and for any abrasions.

## Clean

1. Clean any metal shavings from the face of the magnet. Also, clean any other debris from the face of the magnet.
2. Reinstall the magnetic pickup, and adjust the pickup. See the Service Manual, "Magnetic Pickup" for further information.

i00869628

## Engine Valve Lash - Inspect/Adjust

**SMCS Code:** 1102-025

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

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

**NOTICE**

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

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

**⚠ WARNING**

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

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

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

Refer to the Service Manual for more information.

i01597115

**Engine Valve Rotators - Inspect**

**SMCS Code:** 1109-040

**⚠ WARNING**

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

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

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

1. Start the engine according to Operation and Maintenance Manual, "Engine Starting" (Operation Section) for the procedure.
2. Operate the engine at low idle.

3. Observe the top surface of each valve rotator. The valve rotators should turn slightly when the valves close.

**NOTICE**

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

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

i00626014

**Fuel Injection Nozzles - Test/Exchange**

**SMCS Code:** 1254-013; 1254-081

**⚠ WARNING**

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

**NOTICE**

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

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

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

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

---

#### NOTICE

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

---

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

- Abnormal engine operation
- Smoke emission
- Engine knock

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

1. Start the engine.
2. Loosen each fuel line nut one at a time at the fuel injection pump. A cloth or similar material must be used in order to prevent fuel from spraying on the hot exhaust components. Tighten each nut before loosening the next nut.
3. A defective fuel injection nozzle may be identified when a fuel line nut is loosened and the following conditions are present:
  - The exhaust smoke is partially eliminated or the exhaust smoke is completely eliminated.
  - Engine performance is not affected.

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

## Removal and Installation of the Fuel Injection Nozzles

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

## Fuel System - Prime

SMCS Code: 1258-548

### WARNING

**Personal injury or death can result from a fire.**

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

**Clean up all leaked or spilled fuel. Do not smoke while working on the fuel system.**

**Turn the disconnect switch OFF or disconnect the battery when changing fuel filters.**

---

Prime the fuel system in order to fill dry fuel filters. You must also prime the fuel system after any one of the following conditions exist:

- The fuel system has run dry.
- The engine has been in prolonged storage.
- The fuel filter has been cleaned.
- The fuel filter has been replaced.

**Note:** If the engine does not have a fuel priming pump, refer to Step 4.

1. Unlock the priming pump, and operate the priming pump until a resistance is felt. This procedure will probably require a considerable amount of priming.
2. Push in the plunger, and hand tighten the plunger.

---

#### NOTICE

Do not crank the engine for more than 30 seconds. Allow the starter to cool for two minutes before cranking again. Turbocharger damage can result if the engine rpm is not kept low until the oil gauge display verifies that the oil pressure is sufficient.

---

3. Crank the engine.

If the engine starts and the engine runs rough, run the engine at low idle. Continue running the engine until the engine runs smoothly.

---

**NOTICE**

During periodic service, DO NOT remove the fuel filter plug that is in the fuel filter base in order to purge air from the fuel system. The periodic removal of the fuel filter plug will result in increased wear on the threads in the fuel filter base. This wear leads to fuel leakage.

---

4. Open the vent valve (if equipped) on the fuel injection pump's housing.
5. Operate the priming pump until the flow of fuel from the vent valve is continuous and the flow of fuel is free of air bubbles.  
  
If the engine does not have a fuel priming pump, crank the engine. Crank the engine until the fuel flows freely and until the fuel is free of air bubbles.
6. Close the vent valve. Then, push in the plunger. Hand tighten the plunger.
7. Crank the engine. If the engine starts and if the engine runs rough, run the engine at low idle. Continue running the engine until the engine runs smoothly.

**Note:** If the engine will not start, more priming is necessary. If the engine continues to run rough, more priming is necessary as well.

---

**NOTICE**

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

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

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

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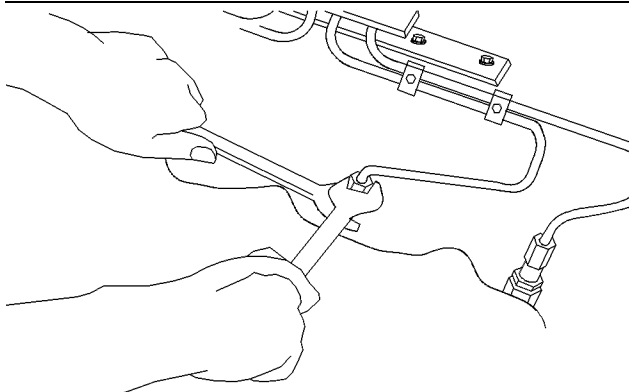


Illustration 41

g00290109

8. Loosen the fuel line nuts at the valve cover base. Loosen these line nuts one at a time.
9. Operate the priming pump until the flow of fuel from the fuel line is continuous and the flow of fuel is free of air bubbles.
10. Push in the plunger, and hand tighten the plunger. If the engine does not have a fuel priming pump, crank the engine.
11. Tighten each fuel line nut before you loosen the next fuel line nut. Tighten the fuel line nuts to a torque of  $40 \pm 7$  N·m ( $30 \pm 5$  lb ft).

Continue this procedure until all of the fuel lines have been cleared of any air. Before you start the engine, make sure that the fuel line nuts are properly tightened. Also make sure that the priming is locked.

i00951418

## Fuel System Primary Filter - Clean/Replace

**SMCS Code:** 1260-070; 1260-510

### **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 the start switch to the "OFF" position. Disconnect the battery.
  3. Shut off the fuel tank supply valve to the engine.
  4. If the primary fuel filter is equipped with a drain valve, open the drain valve in order to drain any fuel from the filter case. Close the drain valve.
- 

**NOTICE**

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

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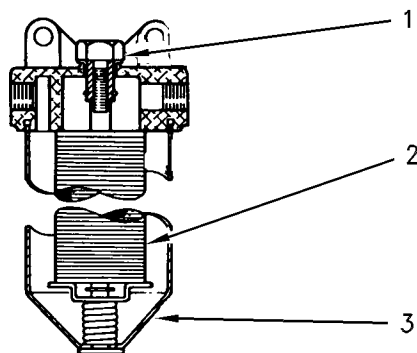


Illustration 42

g00485293

- (1) Bolt  
(2) Element  
(3) Case

5. Loosen the bolt (1) that is on the filter housing. Remove the filter case (3).
6. Remove the element (2) and wash the element in clean, nonflammable solvent.

#### NOTICE

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

7. Install the element (2) and the filter case (3). Tighten the bolt (1) to a torque of  $24 \pm 4$  N·m ( $18 \pm 3$  lb ft).

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.

i02436696

## Fuel Tank Water and Sediment - Drain

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

### NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

## Fuel Tank

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

## Drain the Water and the Sediment

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

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

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 2 micron filter for the breather vent on the fuel tank is also recommended. Refer to Special Publication, SENR9620, "Improving Fuel System Durability".

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

i02259870

## Heat Exchanger - Inspect

**SMCS Code:** 1379-040

### WARNING

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

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

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

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

---

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

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**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 Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

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## Shell and Tube Heat Exchanger

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

- Cleanliness of the tubes for the heat exchanger
- Effectiveness of the heat exchanger system

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

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.

## Cleaning the Shell and Tube Heat Exchanger

Refer to the Disassembly and Assembly Manual for the engine.

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

**NOTICE**

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

---

4. Back flush the core with cleaner.

Caterpillar recommends the use of Hydrosolv liquid cleaner. Table 34 lists Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 34

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

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

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

### **WARNING**

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

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

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

---

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

8. Inspect the core in order to ensure cleanliness. Pressure test the core. Many shops that service radiators are equipped to perform pressure tests. If necessary, repair the core.

9. Install the heat exchanger. Refer to the Service Manual for the procedure.

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

## Plate Type Heat Exchanger

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

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

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

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

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

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

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

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

## Cleaning the Plate Type Heat Exchanger

Refer to the Disassembly and Assembly Manual for the engine. The heat exchanger must be disassembled in order to be cleaned. The Disassembly and Assembly Manual will contain instructions for cleaning the heat exchanger prior to reassembly. The following general guidelines are for cleaning a plate type heat exchanger. Refer to Table 35 for types of cleaners.

---

### NOTICE

Do not use hydrochloric acid to clean stainless steel plates.

Do not use hydrofluoric acid to clean titanium plates.

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

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

Do not use esters such as Ethylacetate and Butylacetate.

Do not use Halogenated hydrocarbons such as Chloroethene and Carbon Tetrachloride

Do not use Aromatics such as Benzene and Toluene.

---

Table 35

Problem	Source	Cleaners <sup>(1)</sup>
Scaling	Calcium carbonate Calcium sulphate Silicates	Nitric acid Sulfamic acid Citric acid Phosphoric acid Complexing agents Sodium polyphosphates
Sediment <sup>(2)</sup>	Corrosion products Metal oxides Silt Diatom organisms	
Gross fouling	Seaweed Chips of wood and fibers Mussels Barnacles	
Biological growth	Bacteria Nematodes Protozoa	
Residue	Oily films Asphalt Fats	Paraffinic or Naphtha based solvent such as Kerosene. <sup>(3)(4)</sup>

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

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

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

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

1. Drain the heat exchanger.
2. Disassemble the heat exchanger and remove the plates. Keep the plates in order.
3. Clean the plates with a cleaning solution and a soft brush. Pressurized water may also be used. Do not use steel wool or a wire brush, which may scratch the plate. Any iron scratches on the plates can lead to corrosion of the plates. Rinse the plates with water.
4. Assemble the heat exchanger.

i02121526

## Hoses and Clamps - Inspect/Replace

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

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

- Cracking

- Softness
- Loose clamps

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

### NOTICE

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

Check for the following conditions:

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

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

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

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

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

## Replace the Hoses and the Clamps

### WARNING

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

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

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

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

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

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

i01089872

## Marine Transmission Oil Level - Check

**SMCS Code:** 3081-535

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 "Owner's Manual" for the transmission.

## Marine Transmission Operation, Maintenance, Warranty, and Parts Support

For information on maintenance and operation of the marine transmission, consult your Caterpillar 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.

i02378613

## Overhaul Considerations

**SMCS Code:** 7595-043

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

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

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

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

## Oil Consumption as an Overhaul Indicator

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

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

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

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

## Overhaul Options

### Before Failure Overhaul

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

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

### After Failure Overhaul

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

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

This lower cost can be attributed to three aspects:

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

## 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

### Cylinder Head Assembly, Cylinder Packs, Oil Pump, and Fuel Transfer Pump

These components should be inspected 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.

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 dealt with in one of the following manners:

- Salvaging
- Repairing
- Replacing

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.

## Inspection and/or Replacement

### Crankshaft Bearings, Valve Rotators, and Crankshaft Seals

The following components may not last until the second overhaul.

- Thrust bearings
- Main bearings
- Rod bearings
- Valve rotators
- Crankshaft seals

Caterpillar Inc. recommends the installation of new parts at each overhaul period.

Inspect these parts while the engine is disassembled for an overhaul.

Inspect the crankshaft for any of the following conditions:

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

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

- Rod bearing
- Main bearings

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

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

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

Inspect the following components for signs of wear or for signs of scuffing:

- Camshaft bearings
- Camshaft followers

Caterpillar Inc. recommends replacing the crankshaft vibration damper.

### Oil Cooler Core and Aftercooler Core

During an overhaul, Caterpillar Inc. recommends the removal of both the oil cooler core and the aftercooler core. Clean the oil cooler core and the aftercooler core. Then, pressure test both of these cores.

### NOTICE

Do not use caustic cleaners to clean the core.

Caustic cleaners can attack the internal metals of the core and cause leakage.

**Note:** Use this cleaning procedure to clean the oil cooler core and the aftercooler core.

1. Remove the oil cooler core and the aftercooler core.
2. Remove any debris from the oil cooler core and the aftercooler core. To remove debris from the oil cooler core, turn the oil cooler core onto one end. To remove debris from the aftercooler core, turn the aftercooler core upside-down.
3. Flush the oil cooler core and the aftercooler core internally with cleaner in order to loosen foreign substances. This will also help to remove oil from the oil cooler core and the aftercooler core.

**Note:** Caterpillar Inc. recommends the use of Hydrosolv Liquid Cleaners. Table 36 lists the Hydrosolv Liquid Cleaners that are available from your Caterpillar dealer.

Table 36

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

<sup>(1)</sup> Use a two to five percent concentration of the cleaner at temperatures up to 93°C (200°F).

4. Use steam to clean the oil cooler core and the aftercooler core. This removes any remaining residue from the cleaner. Flush the fins of the oil cooler core and the aftercooler core. Remove any other trapped debris.
5. Wash the oil cooler core and the aftercooler core with hot, soapy water. Rinse the oil cooler core and the aftercooler 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 oil cooler core and the aftercooler core with compressed air. Direct the air in the reverse direction of the normal flow.
7. Inspect the components in order to ensure cleanliness. The oil cooler core and the aftercooler core should be pressure tested. Repair the oil cooler core and the aftercooler core, if necessary. Install the oil cooler core and the aftercooler core.

For more information about cleaning the cores, consult your Caterpillar dealer.

## 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 II) provides a report of the results of both the analysis and the maintenance recommendations.

For more information about coolant analysis, see 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.

i00651416

## Starting Motor - Inspect

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

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

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

i01539769

## Turbocharger - Inspect

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

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

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

#### NOTICE

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

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

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

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

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

## Removal and Installation

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

## Cleaning and Inspecting

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

2. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger must be reconditioned.

3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the wheel, there is a possibility of a failed turbocharger oil seal.

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

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

i00073831

## 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.

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#### 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.

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#### 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.

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- Ensure that cooling lines are properly clamped and 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.
- Inspect the ECM to the cylinder head ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges which are cracked or can not be calibrated.

i01057943

## Water Pump - Inspect

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

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

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

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

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

i01421084

## Zinc Rods - Inspect/Replace

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

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

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

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

### Inspect the Zinc Rods

The zinc rods are red for easy identification. Table 37 shows the locations of the zinc rods and the quantities of the zinc rod:

Table 37

Locations of the Zinc Rods	
Location	Quantity
Inlet Adapter of the Heat Exchanger	1
Outlet Elbow of the Heat Exchanger	1
Outlet Elbow of the Auxiliary Water Pump	1

1. Remove the zinc rod.

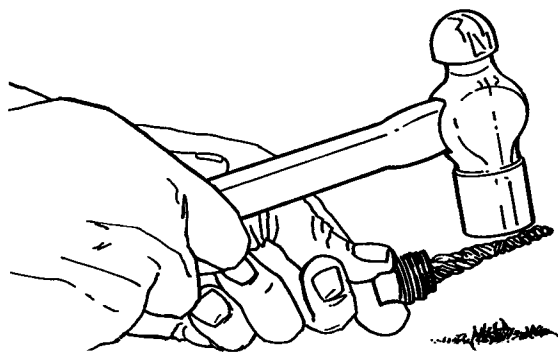


Illustration 43

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

## Replace the Zinc Rods

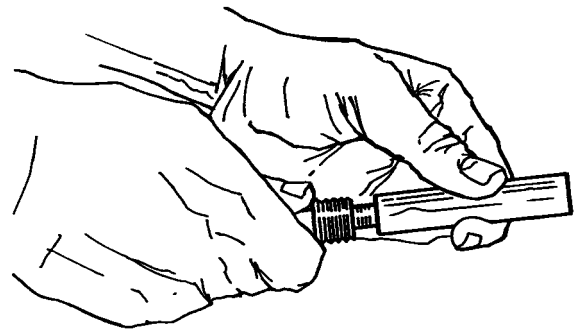


Illustration 44

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1. Unscrew the old zinc rod or drill the old zinc rod from the plug. Clean the plug.
2. Apply 9S-3263 Compound to the shoulder of a new zinc rod. Apply the compound only to the shoulder of the zinc rod. Install the zinc rod into the plug.
3. Coat the external threads of the plug with 5P-3413 Pipe Sealant. Install the zinc rod. Refer to Operation and Maintenance Manual for more information on torque specifications.