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C9

INDUSTRIAL ENGINES

Maintenance Intervals

Excerpted from Operation & Maintenance Manual (SEBU7772-02-01)

i02471504

Maintenance Interval Schedule

SMCS Code: 1000; 7500

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

The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, filters, and the replacement of components due to normal wear and aging. The performance of this product may be diminished if proper maintenance intervals and procedures are not followed. Components may experience accelerated wear if proper maintenance intervals and procedures are not followed.

Use 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.

When Required

Battery - Replace	62
Battery or Battery Cable - Disconnect	64
Engine Air Cleaner Element (Dual Element) - Clean/Replace	75
Engine Storage Procedure - Check	83
Fuel System - Prime	84
Severe Service Application - Check	93

Daily

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Driven Equipment - Check	74
Engine Air Cleaner Service Indicator - Inspect	77
Engine Oil Level - Check	79
Fuel System Primary Filter/Water Separator - Drain	85
Power Take-Off Clutch - Check/Adjust/Lubricate ..	92
Walk-Around Inspection	95

Initial 20 to 40 Service Hours

Belts - Inspect/Adjust	65
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Every Week

Battery Charger - Check	63
Engine Air Precleaner - Check/Clean	78
Jacket Water Heater - Check	89

Every 250 Service Hours

Belts - Inspect/Adjust	65
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Initial 500 Service Hours

Cooling System Coolant Sample (Level 1) - Obtain	71
Engine Valve Lash - Inspect/Adjust	83

Every 500 Service Hours

Cooling System Coolant Sample (Level 1) - Obtain	71
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Every Year

Cooling System Coolant Sample (Level 1) - Obtain	71
Cooling System Coolant Sample (Level 2) - Obtain	71

Every 6000 Service Hours or 6 Years

Cooling System Coolant (ELC) - Change	68
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Every 10 000 Service Hours

Cylinder Head Grounding Stud - Inspect/Clean/ Tighten	74
Fuel System Primary Filter (Water Separator) Element - Replace	85

PM Level 1 - Every 10 400 L (2750 US gal) of Fuel or 250 Service Hours or 6 Months

Air Compressor Filter - Clean/Replace	61
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PM Level 2 - Every 83 250 L (22 000 US gal) of Fuel or 2000 Service Hours or 1 Year

Aftercooler Core - Inspect	60
Alternator - Inspect	62
Engine Crankcase Breather - Clean	78
Engine Valve Lash - Inspect/Adjust	83

PM Level 3 - Every 166 500 L (44 000 US gal) of Fuel or 4000 Service Hours or 2 Years

Aftercooler Core - Clean/Test	60
Air Compressor - Inspect	61

Belt Tensioner - Inspect	64
Cooling System Coolant (DEAC) - Change	66
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Cooling System Water Temperature Regulator - Replace	73
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**Every 208 000 L (55 000 US gal) of Fuel or
5000 Service Hours**

Starting Motor - Inspect	93
Turbocharger - Inspect	94
Water Pump - Inspect	95

**Every 340 000 L (90 000 US gal) of Fuel or
10 000 Service Hours**

Cylinder Head Grounding Stud - Inspect/Clean/ Tighten	74
Overhaul Considerations	89

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

Table 11

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

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

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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Aftercooler Core - Inspect

SMCS Code: 1064-040

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the aftercooler for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the aftercooler, if necessary.

For air-to-air aftercoolers, use the same methods that are used for cleaning radiators.

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.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a "comb".

Note: If parts of the aftercooler system are repaired or replaced, a leak test is highly recommended. The FT1984 Aftercooler Testing Group is used to perform leak tests on the aftercooler. Refer to the Systems Operation/Testing and Adjusting, "Aftercooler - Test" and the Special Instruction, SEHS8622 for the proper testing procedure.

Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, see Special Publication, SEBD0518, "Know Your Cooling System".

i02113479

Air Compressor - Inspect

SMCS Code: 1803-040

! WARNING

Do not disconnect the air line from the air compressor governor without purging the air brake and the auxiliary air systems. Failure to purge the air brake and the auxiliary air systems before removing the air compressor and/or the air lines could cause personal injury.

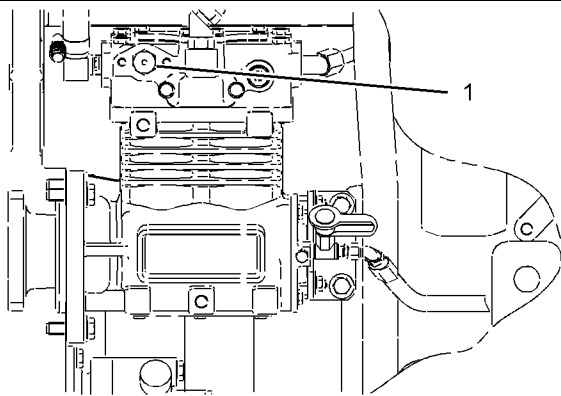


Illustration 36

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(1) Pressure relief valve

! WARNING

If the air compressor pressure relief valve that is mounted in the air compressor cylinder head is bypassing compressed air, there is a malfunction in the air system, possibly ice blockage. Under these conditions, your engine may have insufficient air for normal brake operation.

Do not operate the engine until the reason for the air bypass is identified and corrected. Failure to heed this warning could lead to property damage, personal injury, or death to the operator or bystanders.

The function of the pressure relief valve is to bypass air when there is a malfunction in the air compressor system.

The pressure relief valve releases air at 1723 kPa (250 psi). Do not stand near the pressure relief valve. Compressed air may be released without warning. All personnel should also stay clear of the air compressor when the engine is operating and the air compressor is exposed.

Refer to the Service Manual or refer to the OEM specifications in order to find information concerning the air compressor. Consult your Caterpillar dealer for assistance.

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Air Compressor Filter - Clean/Replace (If Equipped)

SMCS Code: 1803-070-FQ; 1803-510-FQ

One of the single most important aspects of preventive maintenance for the air compressor is the induction of clean air. The type of maintenance that is required for the air compressor and the maintenance interval depends on the type of air induction system that is used. Operating conditions (dust, dirt and debris) may require more frequent service.

Refer to the Service Manual for the type of air compressor that is installed on the engine. Follow the maintenance recommendations that are provided by the OEM of the air compressor. Some engines use boost air pressure so the engine air cleaner will require servicing.

i00847451

Air Tank Moisture and Sediment - Drain (If Equipped)

SMCS Code: 1466-543-M&S

Moisture and sediment in the air starting system can cause the following conditions:

- Freezing
- Corrosion of internal parts
- Malfunction of the air starting system

WARNING

When opening the drain valve, wear protective gloves, a protective face shield, protective clothing, and protective shoes. Pressurized air could cause debris to be blown and result in personal injury.

1. Open the drain valve that is on the bottom of the air tank. Allow the moisture and sediment to drain.
2. Close the drain valve.
3. Check the air supply pressure. The air starting motor requires a minimum of 620 kPa (90 psi) of air pressure to operate properly. The maximum air pressure must not exceed 1550 kPa (225 psi). The normal air pressure will be 758 to 965 kPa (110 to 140 psi).

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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.

i02153996

Battery - Replace

SMCS Code: 1401-510

WARNING

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

WARNING

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

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

1. Turn the key start switch to the OFF position. Remove the key and all electrical loads.
2. Turn OFF the battery charger. Disconnect the charger.
3. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the ground plane. Disconnect the cable from the NEGATIVE “-” battery terminal.
4. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.

Note: Always recycle a battery. Never discard a battery. Return used batteries to an appropriate recycling facility.

5. Remove the used battery.

6. Install the new battery.

Note: Before the cables are connected, ensure that the key start switch is OFF.

7. Connect the cable from the starting motor to the POSITIVE "+" battery terminal.

8. Connect the cable from the ground plane to the NEGATIVE "-" battery terminal.

i01039758

Battery Charger - Check

SMCS Code: 1401-535

Checking Before Start-Up

Check the battery charger for proper operation. If the batteries are properly charged, the needle of the ammeter will register near "0" (zero).

The battery charger must not produce excessive current during start-up. Alternatively, the charger must be automatically disconnected for start-up. If the engine has an alternator, the charger must be automatically disconnected during start-up and during engine operation.

Charging the Battery

WARNING

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operated. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Injury to personnel can be the result.

Perform the following procedure to charge the battery:

1. Ensure that the charger is turned OFF.
2. Adjust the voltage of the charger in order to match the voltage of the battery.

3. Connect the POSITIVE "+" lead of the charger to the POSITIVE "+" battery terminal. Connect the NEGATIVE "-" lead of the charger to the NEGATIVE "-" battery terminal.

4. Turn ON the battery charger.

Overcharging of Batteries

Overcharging reduces the service life of batteries. Use a battery charger that will not overcharge the battery. DO NOT charge the battery if the meter of the battery charger is in the RED zone.

Overcharging is indicated by the following symptoms:

- The battery is very warm to the touch.
- A strong odor of acid is present.
- The battery emits smoke or a dense vapor (gas).

Perform one of the following procedures if the battery shows symptoms of overcharging:

- Reduce the rate of charging by a significant amount. Complete the charging at the reduced rate.
- Turn OFF the charger.

Table 12 describes the effects of overcharging on different types of batteries.

Table 12

Effects of Overcharging Batteries	
Type of Battery	Effect
Caterpillar General Service Batteries Caterpillar Premium High Output Batteries	All of the battery cells have a low level of electrolyte.
	When the plates of the battery are inspected through the filler holes, the plates may appear to be warped. This is caused by an excessive temperature.
	The battery may not pass a load test.
Caterpillar Maintenance Free Batteries	The battery may not accept a charging current.
	The battery may not pass a load test.

Checking After Stopping

Ensure that the battery charger is connected properly. Observe the meter of the charger. Record the amperage.

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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.

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Battery or Battery Cable - Disconnect

SMCS Code: 1402-029

WARNING

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

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

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

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Belt Tensioner - Inspect (If Equipped)

SMCS Code: 1358-040

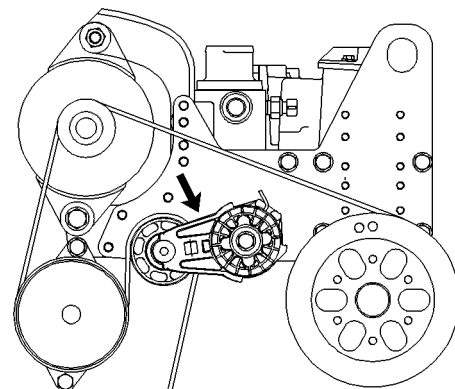


Illustration 37
Belt tensioner

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Inspect the belt tensioner for unusual noise, excessive looseness and/or shaking of the bearings.

If the belt tensioner should require disassembly, refer to the Service Manual for the procedure.

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Belts - Inspect/Adjust

SMCS Code: 1357-025; 1357-040

Inspection

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

After the initial check, the belt tension should be checked at every oil change.

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

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

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

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

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

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

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

Adjustment

Alternator Belt

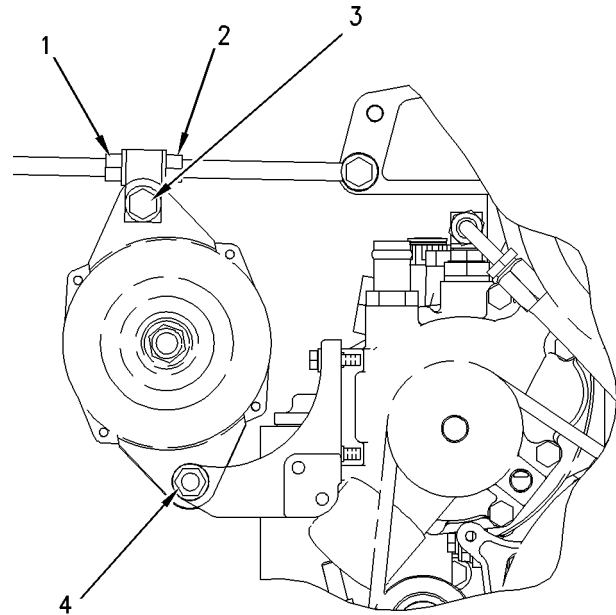


Illustration 38

g00768640

- (1) Nut
- (2) Adjusting Nut
- (3) Bolt
- (4) Nut

1. Slightly loosen mounting bolt (3) and nut (4).
2. Loosen nut (1).
3. Tighten adjusting bolt (2) and mounting bolts (3) and (4). Tighten bolt (1). Refer to the Specifications Manual, SENR3130, "Torque Specifications".

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

Water Pump Belt

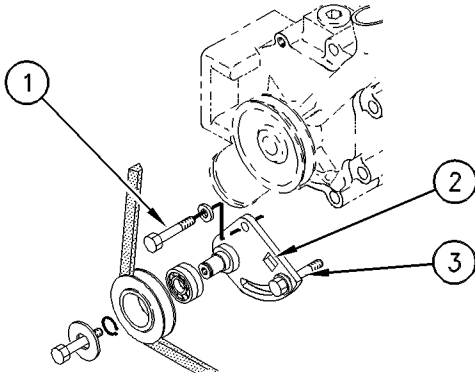


Illustration 39 g00426869

Typical example

Exploded view of the drive assembly for a water pump belt

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

1. Slightly loosen mounting bolt (1) and adjusting bolt (3).
2. Adjust the belt tension with a square drive in square hole (2).
3. Tighten adjusting bolt (3) and mounting bolt (1). Refer to the Specifications Manual, SENR3130, "Torque Specifications".
4. Install the belt guard, if equipped.

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

i02139869

Cooling System Coolant (DEAC) - Change

SMCS Code: 1350-070; 1395-044

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

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

NOTICE

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

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

Drain

WARNING

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

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

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

Allow the coolant to drain.

NOTICE

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

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

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

Flush

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

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

NOTICE

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

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Install the cooling system filler cap.
 4. Start and run the engine at low idle for a minimum of 30 minutes. The coolant temperature should be at least 82 °C (180 °F).
-

NOTICE

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

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

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. If equipped, be sure to flush the heater and any related supply and return lines. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, "Torque Specifications" for more information on the proper torques.

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.

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

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

NOTICE

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

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity. Install the cooling system filler cap.
 4. Start and run the engine at low idle for a minimum of 90 minutes. The coolant temperature should be at least 82 °C (180 °F).
-

NOTICE

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

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

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, "Torque Specifications" for more information on the proper torques.

Fill

NOTICE

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

1. Fill the cooling system with coolant/antifreeze. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.

2. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).
4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

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Cooling System Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

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

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

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

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

Drain

WARNING

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

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

Allow the coolant to drain.

NOTICE

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

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Caterpillar Dealer Service Tool 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.

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

2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. For the proper torque, refer to the Specifications Manual, SENR3130, "Torque Specifications".

NOTICE

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

3. Fill the cooling system with clean water. Install the cooling system filler cap.

i02482066

4. Start and run the engine at low idle until the temperature reaches 49 to 66 °C (120 to 150 °F).
5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. For the proper torque, refer to the Specifications Manual, SENR3130, "Torque Specifications".

Fill

NOTICE

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

1. Fill the cooling system with Extended Life Coolant (ELC). See Special Publication, SEBU6385, "Caterpillar On-highway Diesel Truck Engine Fluids Recommendations" for more information on cooling system specifications. Do not install the cooling system filler cap.
2. Start and run the engine at low idle. Increase the engine rpm to high idle. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).
4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

Cooling System Coolant Extender (ELC) - Add

SMCS Code: 1352-045; 1395-081

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

NOTICE

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

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

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

WARNING

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

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

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

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

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

NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

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

i01197583

Cooling System Coolant Level - Check

SMCS Code: 1395-082

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

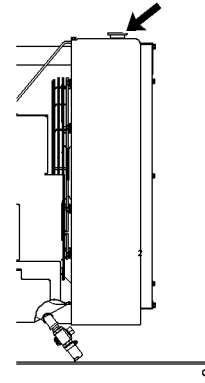


Illustration 40

g00285520

Cooling system filler cap

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.

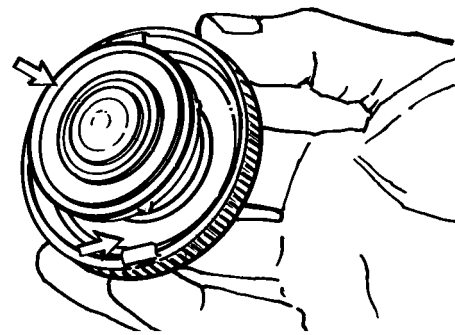


Illustration 41

g00103639

Typical filler cap gaskets

3. Clean the cooling system filler cap and check 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 13

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

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

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

- 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.

i02017557

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 eyes. Do not drink cooling system coolant additive.

Note: Caterpillar recommends an S·O·S coolant analysis (Level 1).

Test the Concentration of the SCA

Coolant/Antifreeze and SCA

NOTICE

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

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Follow the instructions that are provided in the kit.

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. Use the instructions that follow:

1. Fill the syringe to the "1.0 ml" mark with the coolant.
2. Dispense the 1.0 mL coolant sample from the syringe into the empty mixing bottle.
3. Add tap water to the mixing bottle in order to bring the level up to the "10 ml" mark. Place the cap on the bottle and shake the bottle.

4. Add 2 to 3 drops of the "NITRITE INDICATOR SOLUTION B" to the mixing bottle. Move the bottle in a circular motion in order to mix the solution.
5. Add 1 drop of "NITRITE TEST SOLUTION A" to the mixing bottle. Move the bottle in a circular motion in order to mix the solution.
6. Repeat 5 until the solution changes color from red to light gray, green, or blue. Record the number of drops of "NITRITE TEST SOLUTION A" that were required to cause the color change.
7. Use Table 14 to interpret the results.

Table 14

Number of Drops	Concentration of SCA	Maintenance Required
Less than 25	Less than the recommended concentration of SCA	Add SCA. Retest the coolant.
25 to 30	The recommended concentration of SCA	None
More than 30	More than the recommended concentration of SCA	Remove the coolant. Replace with water only. Retest the coolant.

Add the SCA, If Necessary

WARNING

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

1. Remove the cooling system filler cap slowly.

Note: Always dispose of fluids according to local regulations.

2. If necessary, drain some coolant in order to allow space for the addition of the SCA.

NOTICE

Excessive supplemental coolant additive concentration can form deposits on the higher temperature surfaces of the cooling system, reducing the engine's heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components.

Excessive supplemental coolant additive concentration could also result in blockage of the heat exchanger, overheating, and/or accelerated wear of the water pump seal.

Do not exceed the recommended amount of supplemental coolant additive concentration.

3. Add the proper amount of SCA. The concentration of the SCA depends on the type of coolant that is used. To determine the proper amount, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic.
4. Clean the 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.

i01473487

Cylinder Head Grounding Stud - Inspect/Clean/Tighten

SMCS Code: 7423-040; 7423-070; 7423-079

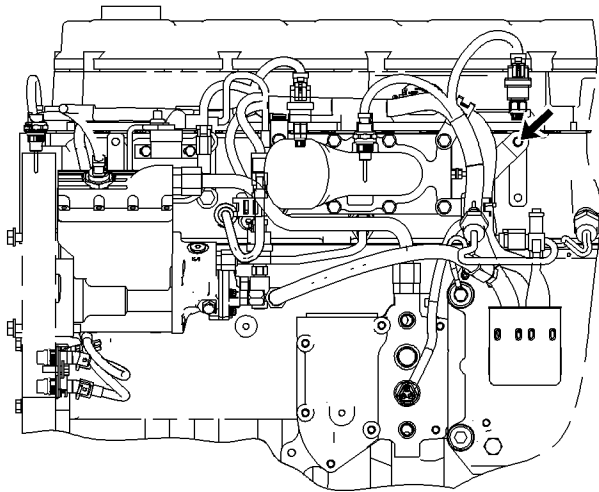


Illustration 42
Typical example

g00768411

Inspect the OEM harness for good connections and condition.

The electrical grounding stud must have a wire ground to the battery. Tighten the electrical grounding stud at every oil change. Ground wires and straps should be combined at engine grounds. All grounds should be tight and free of corrosion.

- If the connections are corroded, clean the connections with a solution of baking soda and water.
- Keep the electrical grounding stud and the strap clean and coated with MPGM grease or petroleum jelly.

i00174798

Driven Equipment - Check

SMCS Code: 3279-535

Refer to the OEM specifications for more information on the following maintenance recommendations for the driven equipment:

- Inspection
- Adjustment
- Lubrication
- Other maintenance recommendations

Perform any maintenance for the driven equipment which is recommended by the OEM.

i01646701

Engine - Clean

SMCS Code: 1000-070

WARNING

Personal injury or death can result from high voltage.

Moisture can create paths of electrical conductivity.

Make sure that the electrical system is OFF. Lock out the starting controls and tag the controls "DO NOT OPERATE".

NOTICE

Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

Periodic cleaning of the engine is recommended. Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

Note: Caution must be used in order to prevent electrical components from being damaged by excessive water when you clean the engine. Avoid electrical components such as the alternator, the starter, and the ECM.

i01553486

Engine Air Cleaner Element (Dual Element) - Clean/Replace

SMCS Code: 1054-037; 1054-510

NOTICE

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

Servicing the Air Cleaner Elements

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

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

Replace the dirty paper air cleaner elements with clean air cleaner elements. Before installation, the air cleaner elements should be thoroughly checked for tears and/or holes in the filter material. Inspect the gasket or the seal of the air cleaner element for damage. Maintain a supply of suitable air cleaner elements for replacement purposes.

Dual Element Air Cleaners

The dual element air cleaner contains a primary air cleaner element and a secondary air cleaner element. The primary air cleaner element can be used up to six times if the element is properly cleaned and inspected. The primary air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

The secondary air cleaner element is not serviceable or washable. The secondary air cleaner element should be removed and discarded for every three cleanings of the primary air cleaner element. When the engine is operating in environments that are dusty or dirty, air cleaner elements may require more frequent replacement.

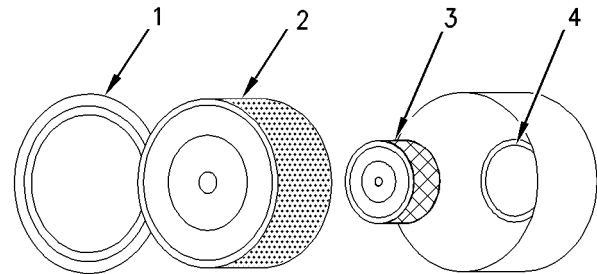


Illustration 43

g00736431

- (1) Cover
- (2) Primary air cleaner element
- (3) Secondary air cleaner element
- (4) Turbocharger air inlet

1. Remove the cover. Remove the primary air cleaner element.
2. The secondary air cleaner element should be removed and discarded for every three cleanings of the primary air cleaner element.

Note: Refer to "Cleaning the Primary Air Cleaner Elements".

3. Cover the turbocharger air inlet with tape in order to keep dirt out.
4. Clean the inside of the air cleaner cover and body with a clean, dry cloth.
5. Remove the tape for the turbocharger air inlet. Install the secondary air cleaner element. Install a primary air cleaner element that is new or cleaned.
6. Install the air cleaner cover.
7. Reset the air cleaner service indicator.

Cleaning the Primary Air Cleaner Elements

NOTICE

Caterpillar recommends certified air filter cleaning services that are available at Caterpillar dealers. The Caterpillar cleaning process uses proven procedures to assure consistent quality and sufficient filter life.

Observe the following guidelines if you attempt to clean the filter element:

Do not tap or strike the filter element in order to remove dust.

Do not wash the filter element.

Use low pressure compressed air in order to remove the dust from the filter element. Air pressure must not exceed 207 kPa (30 psi). Direct the air flow up the pleats and down the pleats from the inside of the filter element. Take extreme care in order to avoid damage to the pleats.

Do not use air filters with damaged pleats, gaskets, or seals. Dirt entering the engine will cause damage to engine components.

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

Use clean primary air cleaner elements while dirty elements are being cleaned.

NOTICE

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

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

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

- Pressurized air
- Vacuum cleaning

Pressurized Air

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

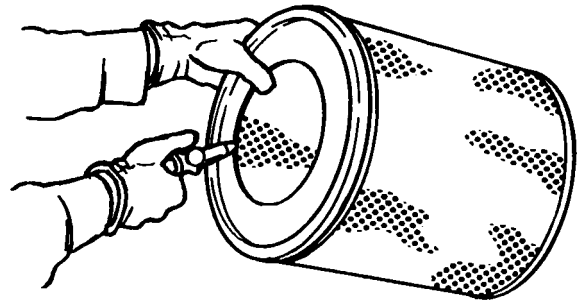


Illustration 44

g00281692

Note: When the primary 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 primary air cleaner element. Dirt could be forced further into the pleats.

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

Vacuum Cleaning

Vacuum cleaning is a good method for cleaning primary 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 Primary Air Cleaner Elements".

Inspecting the Primary Air Cleaner Elements

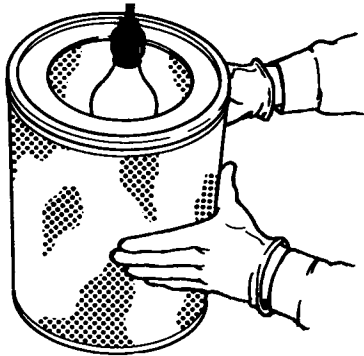


Illustration 45

g00281693

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

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

Storing Primary Air Cleaner Elements

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

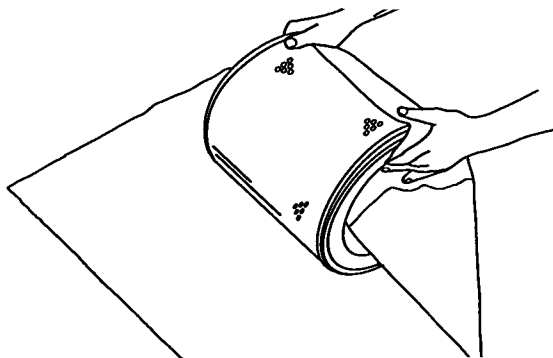


Illustration 46

g00281694

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

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

- Date of cleaning
- Number of cleanings

Store the box in a dry location.

i01900118

Engine Air Cleaner Service Indicator - Inspect (If Equipped)

SMCS Code: 7452-040

Some engines may be equipped with a different service indicator.

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

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

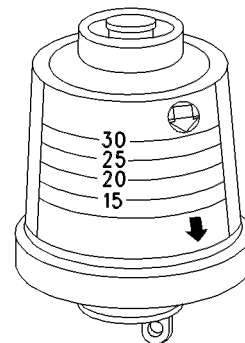


Illustration 47

Typical service indicator

g00103777

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

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

Test the Service Indicator

Service indicators are important instruments.

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

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

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

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

i02498263

Engine Air Precleaner - Check/Clean

SMCS Code: 1055-070; 1055-535

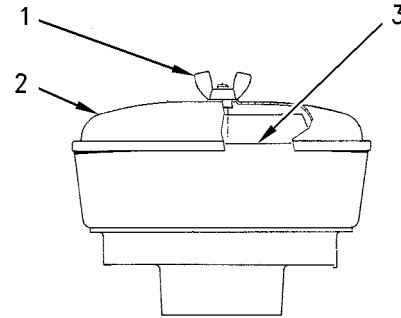


Illustration 48

g00736588

Typical precleaner

- (1) Wing nut
- (2) Cover
- (3) Body

Check the engine air precleaner weekly for debris and dirt. Clean the precleaner when any material which would impair the performance of the engine is found. Check and clean the precleaner by performing the following steps:

1. Remove wing nut (1) and cover (2).
2. Check for an accumulation of dirt and debris in body (3).
3. Clean the body, if necessary.
4. After cleaning the precleaner, install cover (2) and wing nut (1).

Your precleaner may vary from the precleaner which is pictured above. For further information about maintaining your precleaner, see your Caterpillar dealer.

Note: When the engine is operated in dusty applications, more frequent cleaning is required..

i01724662

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

NOTICE

Perform this maintenance with the engine stopped.

i02139969

NOTICE

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

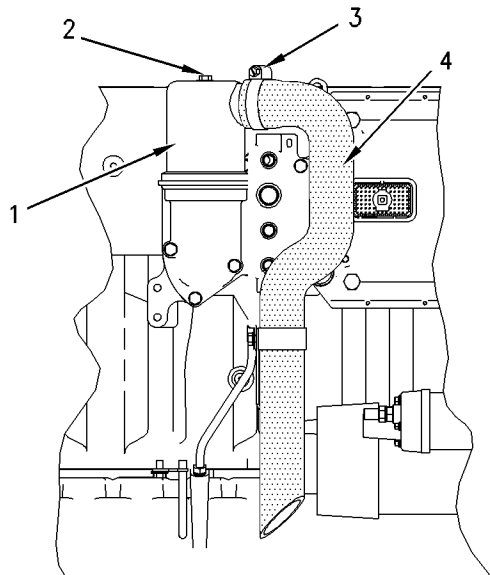


Illustration 49

g00768439

- (1) Breather assembly
- (2) Bolt
- (3) Hose clamp
- (4) Hose

1. Loosen hose clamp (3) and remove hose (4) from breather assembly (1).
2. Remove bolt (2) and the washer. Remove the breather assembly (1) and the seal.
3. Wash the breather element in solvent that is clean and nonflammable. Allow the breather element to dry before installation.
4. Install a breather element that is clean and dry. Install breather assembly (1) and the seal.
5. Install bolt (2) and the washer. Refer to Specifications, SENR3130, "Torque Specifications" for the correct torque.
6. Install hose (4) on breather assembly (1). Tighten hose clamp (3). Refer to Specifications, SENR3130, "Torque Specifications" for the correct torques.

Engine Mounts - Inspect**SMCS Code:** 1152-040

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

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

Any engine mount that shows deterioration should be replaced. Refer to the Specifications Manual, SENR3130, "Torque Specifications". Refer to your Caterpillar dealer for more information.

i00623423

Engine Oil Level - Check**SMCS Code:** 1348-535-FLV**WARNING**

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

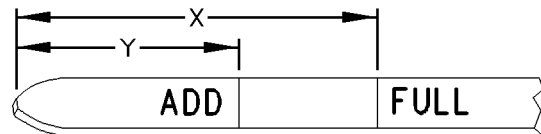


Illustration 50

g00110310

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

NOTICE

Perform this maintenance with the engine stopped.

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

NOTICE

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 the oil filler cap and add oil, if necessary. Clean the oil filler cap. Install 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 contamination 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.

i02488152

Engine Oil and Filter - Change

SMCS Code: 1318-510; 1348-044

Selection of Oil Change Interval

WARNING

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

Caterpillar oil filters are recommended for oil changes. Recommended multigrade oil types are listed in Table 15. Do not use single grade oils.

Cat DEO Multigrade Oils exceed industry standard ECF-1. Any oil that is used in a Caterpillar engine must meet the ECF-1 standard. Abnormally harsh operating cycles or harsh environments can shorten the service life of the engine oil. Arctic temperatures, corrosive environments, or extremely dusty conditions may require a reduction in engine oil change intervals from the recommendations in Table 15. Poor maintenance of air filters or of fuel filters requires reduced oil change intervals. See your Caterpillar dealer for more information if this product will experience abnormally harsh operating cycles or harsh environments.

Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" for further information about oils that may be used in Caterpillar engines.

Table 15

Oil Change Interval for C-9 Industrial Engine ⁽¹⁾				
Multigrade Oil Type	Operating Conditions			
	Normal ⁽²⁾	High Load Factor above 43 L (11 US gal per hour of fuel) ⁽³⁾	Severe	
			Fuel Sulfur from 0.3% to 0.5% ⁽⁴⁾	Altitude above 1830 m (6000 ft)
Cat DEO Preferred	250 hr	250 hr	250 hr	250 hr ⁽⁶⁾
API CH-4 11.0 minimum TBN ⁽⁴⁾ Preferred	250 hr	250 hr	250 hr	250 hr ⁽⁶⁾
API CH-4 TBN ⁽⁴⁾ below 11.0	250 hr	250 hr	250 hr ⁽⁵⁾	250 hr ⁽⁶⁾
API CG-4	250 hr	250 hr ⁽⁵⁾	250 hr ⁽⁵⁾	250 hr ⁽⁶⁾

⁽¹⁾ The standard oil change interval in this engine is 250 hours, if the operating conditions and recommended oil types that are listed in this table are met. If the type of oil, the quality of the oil and the operating conditions meet certain standards, the oil change intervals may be increased to 500 hours. Refer to Special Publication, PEDP7035, "Optimizing Oil Change Intervals" in order to determine whether the oil change interval can be extended beyond 250 hours.

⁽²⁾ Normal conditions include these factors: Fuel sulfur below 0.3%, altitude below 1830 m (6000 ft), and good air filter and fuel filter maintenance. Normal conditions do not include high load factor, harsh operating cycles, or harsh environments.

⁽³⁾ High load factors can shorten the service life of your engine oil. Continuous heavy load cycles and very little idle time result in increased fuel consumption and oil contamination. These factors deplete the oil additives more rapidly. If the average fuel consumption of your engine exceed 43 L (11 US gal) per hour, follow the "High Load Factor" recommendations in Table 15. To determine average fuel consumption for your engine, measure average fuel consumption for a period of 50 to 100 hours. If the application of the engine is changed, the average fuel consumption may change.

⁽⁴⁾ For sulfur content above 0.5%, refer to, "Total Base Number (TBN) and Fuel Sulfur Levels for Direct Injection (DI) Diesel Engines" in Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations".

⁽⁵⁾ In order to verify an oil change interval of 500 hours, refer to "Program A" below.

⁽⁶⁾ Use "Program B" below to determine an appropriate interval.

Adjustment of the Oil Change Interval

Note: Your Caterpillar dealer has additional information on these programs.

Program A

- Proceed to Program B.

- Change to a preferred oil type in Table 15.

Program B

Optimizing Oil Change Intervals

Begin with a 250 hour oil change interval. The oil change intervals are adjusted by increments. Each interval is adjusted an additional 50 hours. Periodic oil sampling and analysis is done during each interval. The analysis includes oil viscosity and infrared (IR) analysis of the oil. Repeat Program B if you change the application of the engine.

If an oil sample does not pass the analysis, shorten the oil change interval, or change to a preferred multigrade oil type in the listing above.

References

Reference: Form, PEDP7035, "Optimizing Oil Change Intervals"

Reference: Form, PEDP7036, "S·O·S Fluid Analysis"

Reference: Form, PEDP7076, "Understanding the S·O·S Oil Analysis Tests"

Drain the Engine Oil

After the engine has been run at the normal operating temperature, stop the engine. Attach a "DO NOT OPERATE" or a similar warning tag to the ignition keyswitch before the engine is serviced. Catch the oil in a suitable container. Recycle the used oil, or dispose of the used oil properly.

1. Remove the oil drain plug in order to allow the oil to drain.
2. After the oil has drained, the oil drain plug 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 185-3630 Strap Wrench.

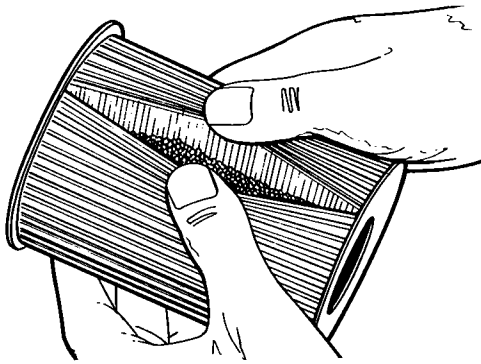


Illustration 51
Element with debris

g00588944

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

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

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

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

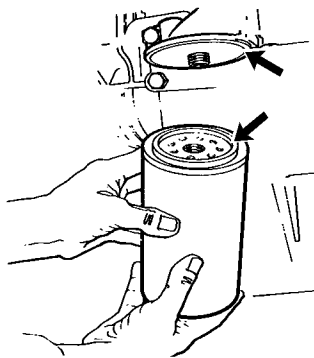


Illustration 52
Typical filter mounting base and filter gasket

g00103713

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. Fill the crankcase with the proper amount of oil. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section) for more information.

NOTICE

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

NOTICE

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

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

i01430860

Engine Storage Procedure - Check

SMCS Code: 1000-535

Caterpillar requires all engines that are stored for more than 3 months to follow storage procedures and start-up procedures. These procedures provide maximum protection to internal engine components. Refer to Special Instruction, SEHS9031, "Storage Procedure For Caterpillar Products" for information on these procedures.

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

- Operating hours
- Fuel consumption

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.

i02239650

Fan Drive Bearing - Lubricate

SMCS Code: 1359-086-BD

Some of the fan drives have grease fittings and some of the fan drives do not have grease fittings. If there is no grease fitting, periodic lubrication is not required. The fan drive requires grease only if the fan drive is equipped with a zerk.

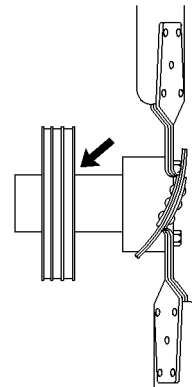


Illustration 53

g00746166

Typical location of the grease fitting (if equipped) that is for the fan drive bearing

The pulley is shown with the belt guards that have been removed.

Lubricate the grease fitting that is on the fan drive bearing with Bearing Lubricant or the equivalent.

Inspect the fan drive pulley assembly for wear or for damage. If the shaft is loose, an inspection of the internal components should be performed. Refer to the Service Manual for additional information.

i02113137

Fuel System - Prime

SMCS Code: 1258-548

WARNING

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

NOTICE

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

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

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

Engines that are Equipped with a Fuel Priming Pump

NOTICE

Do not loosen the fuel lines at the fuel manifold. The fittings may be damaged and/or a loss of priming pressure may occur when the fuel lines are loosened.

1. Open the fuel priming pump and operate the fuel priming pump until a strong pressure is felt. This procedure will require considerable strokes. Lock the fuel priming pump.

NOTICE

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

2. Promptly start the engine. If the engine runs rough, continue to operate the engine at low idle. Do not raise the engine rpm above an idle, until the engine operates smoothly.
3. If the engine does not start, open the fuel priming pump and repeat Steps 1 and 2 in order to start the engine.

Engines that are Not Equipped with a Fuel Priming Pump

If the engine is not equipped with a fuel priming pump, you can use the following procedures to prime the fuel system. These procedures will allow only filtered fuel to enter the fuel system.

Fuel Filter Bases that are Equipped with a Plug

NOTICE

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

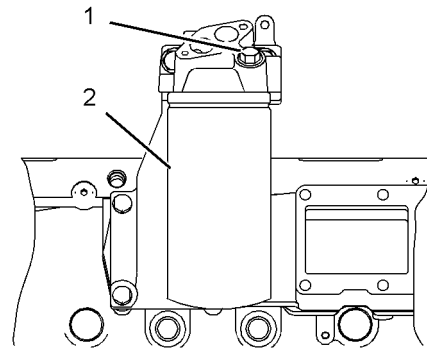


Illustration 54

g01076450

- (1) Plug
- (2) Fuel filter

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

NOTICE

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

2. Start the engine and operate the engine at low idle. Do not raise the engine speed above an idle, until the engine operates smoothly.

Fuel Filter Bases that are Not Equipped with a Plug

NOTICE

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

i02415789

1. Operate the starting motor. This will fill the fuel filter and the fuel lines with fuel.
2. Once the engine starts, operate the engine at low idle. Do not raise the engine speed above an idle, until the engine operates smoothly.

i00259781

Fuel System Primary Filter/Water Separator - Drain

SMCS Code: 1260-543; 1263-543

WARNING

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

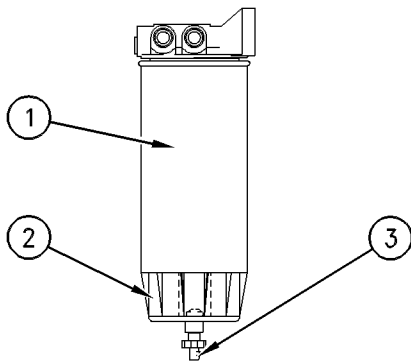


Illustration 55

g00104007

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

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

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

NOTICE

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

Fuel System Primary Filter (Water Separator) Element - Replace

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

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

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

Replace the Element

WARNING

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

Note: A 10 to 15 micron absolute high efficiency fuel filter is required for Caterpillar Electronic Unit Injectors. Caterpillar High Efficiency Fuel Filters meet these requirements. Consult your Caterpillar dealer for the proper part number.

1. Close the main fuel supply valve.

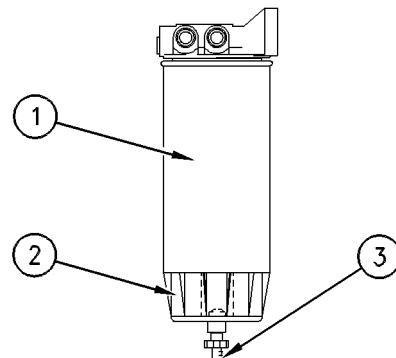


Illustration 56

g00104012

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

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

NOTICE

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

NOTICE

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

3. Dispose of the fuel in the fuel filter element. Remove bowl (2) from element (1). The bowl is reusable. Do not discard the bowl. Dispose of the used element.
4. Remove the O-ring from the gland of the bowl. Clean the following components:
 - Bowl
 - O-ring
 - Mounting base

Inspect the O-ring for damage and for deterioration. Replace the O-ring, if necessary.
5. Lubricate the O-ring with clean diesel fuel.
6. Install bowl (2) on a new element. Tighten the bowl by hand. Do not use tools in order to tighten the bowl.

NOTICE

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

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

NOTICE

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

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

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

i01503750

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.

NOTICE

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

NOTICE

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

1. Stop the engine. Turn the ignition switch to the OFF position or disconnect the battery. Refer to the Operation and Maintenance Manual, "Battery or Battery Cable - Disconnect" topic (Maintenance Section) for more information. Shut off the fuel supply valve (if equipped).
2. Remove the used fuel filter and discard the used fuel filter.
3. Clean the gasket sealing surface of the fuel filter base. Ensure that all of the old gasket is removed.
4. Apply clean diesel fuel to the new fuel filter gasket.

NOTICE

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

NOTICE

In order to maximize fuel system life and prevent premature wear out from abrasive particles in the fuel, a two micron absolute high efficiency fuel filter is required for all Caterpillar Hydraulic Electronic Unit Injectors. Caterpillar High Efficiency Fuel Filters meet these requirements. Consult your Caterpillar dealer for the proper part numbers.

5. Install the new fuel filter. Spin the fuel filter onto the fuel filter base until the gasket contacts the base. Use the rotation index marks on the filters as a guide for proper tightening. Tighten the filter for an additional one turn (360 degrees) by hand. Do not overtighten the filter.
 6. Open the fuel supply valve. Prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" topic (Maintenance Section) for more information. Start the engine and inspect the fuel system for leaks.
-

NOTICE

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

Note: There should be enough residual fuel in the cylinder head in order to start the engine. If the engine stops after starting, do not crank the engine for more than 30 seconds. Then allow the starting motor to cool for two minutes. Repeat this procedure until the engine starts and the engine operates.

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.

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.

i02486400

Jacket Water Heater - Check

SMCS Code: 1383-535

Jacket water heaters help to improve startability in ambient temperatures that are below 21 °C (70 °F). All installations that require automatic starting should have jacket water heaters.

Check the operation of the jacket water heater. For an ambient temperature of 0 °C (32 °F), the heater should maintain the jacket water coolant temperature at approximately 32 °C (90 °F).

i02436705

Overhaul Considerations

SMCS Code: 7595-043

Reduced hours of operation at full load will result in a lower average power demand and reduced fuel consumption. 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, increased oil consumption, excessive engine blowby, and reduced power. Arctic temperatures, extremely high temperatures, corrosive environments, or extremely dusty conditions contribute to premature wear and the need for an overhaul.

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, 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

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

During an overhaul, Caterpillar Inc. recommends the removal of the oil cooler core. Clean the oil cooler core. Then, pressure test the oil cooler core.

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.

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

Note: Caterpillar Inc. recommends the use of Hydrosolv Liquid Cleaners. Table 16 lists the Hydrosolv Liquid Cleaners that are available from your Caterpillar dealer.

Table 16

HydrosolvLiquid Cleaners		
Part Number	Description	Size
1U-8812	Hydrosolv4165	4 L (1 US gallon)
1U-5490		19 L (5 US gallon)
8T-7570		208 L (55 US gallon)
1U-8804	Hydrosolv100	4 L (1 US gallon)
1U-5492		19 L (5 US gallon)
8T-5571		208 L (55 US gallon)

4. Use steam to clean the oil cooler core. This removes any remaining residue from the cleaner. Flush the fins of the oil cooler core. Remove any other trapped debris.
5. Wash the oil cooler core with hot, soapy water. Rinse the oil cooler 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 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 should be pressure tested. Repair the oil cooler core, if necessary. Install the oil cooler 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 2) provides a report of the results of both the analysis and the maintenance recommendations.

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

i01506009

Power Take-Off Clutch - Check/Adjust/Lubricate

SMCS Code: 3055-036; 3055-086

NOTICE

New power take-offs should have the clutch adjustment checked before being placed into service. The clutch adjustment should be checked again after the first ten hours of operation. New clutch plates have a "wear in" period, and the clutch may require several adjustments until the new plates are "worn in".

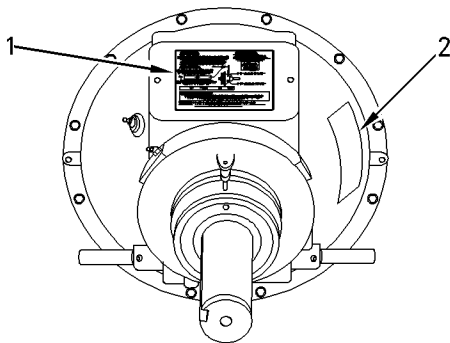


Illustration 57

g00781502

- (1) Instruction plate
(2) Serial number plate

Check the clutch adjustment regularly after "wear in". Heavy-duty applications which have engagements that are frequent and relatively long periods of clutch slippage require more frequent adjustment than light-duty applications. The operating torque should be measured in order to determine if a clutch adjustment is required.

Refer to the OEM information and instruction plate (1) for instructions on lubrication, adjustment, and other recommendations for service. Perform the maintenance that is specified on the instruction plate.

WARNING

Do not operate the engine with the Instruction Plate cover removed from the clutch. Personal injury may result.

If the clutch is damaged to the point of burst failure, expelled pieces can cause personal injury to anyone in the immediate area. Proper safeguards must be followed to help prevent accidents.

i01604510

Radiator - Clean

SMCS Code: 1353-070

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the radiator for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the radiator, if necessary.

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.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a “comb”. Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, refer to Special Publication, SEBD0518, “Know Your Cooling System”.

i00151038

Severe Service Application - Check

SMCS Code: 1000-535

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

- Performance (power range, speed range, and fuel consumption)
- Fuel quality
- Altitude range
- Maintenance intervals
- Oil selection and maintenance
- Coolant selection and maintenance
- Environmental qualities
- Installation

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

Severe service operation can accelerate component wear. Engines that operate under severe conditions may need more frequent maintenance intervals in order to ensure maximum reliability and retention of full service life.

Due to individual applications, it is not possible to identify all of the factors which can contribute to severe service operation. Consult your Caterpillar dealer for the unique maintenance that is necessary for the engine.

The operating environment, improper operating procedures and improper maintenance procedures can be factors which contribute to severe service conditions.

Environmental Factors

Ambient temperatures – The engine may be exposed to extended operation in extremely cold environments or hot environments. Valve components can be damaged by carbon buildup if the engine is frequently started and stopped in very cold temperatures. Extremely hot inlet air reduces engine performance.

Air Quality – The engine may be exposed to extended operation in an environment that is dirty or dusty, unless the equipment is cleaned regularly. Mud, dirt and dust can encase components. Maintenance can be very difficult. The buildup can contain corrosive chemicals.

Buildup – Compounds, elements, corrosive chemicals and salt can damage some components.

Altitude – Problems can arise when the engine is operated at altitudes that are higher than the intended settings for that application. Necessary adjustments should be made.

Improper Operating Procedures

- Extended operation at low idle
- Frequent hot shutdowns
- Operating at excessive loads
- Operating at excessive speeds
- Operating outside the intended application

Improper Maintenance Procedures

- Extending the maintenance intervals
- Failure to use recommended fuel, lubricants and coolant/antifreeze

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.

i01185304

Walk-Around Inspection

SMCS Code: 1000-040

Inspect the Engine for Leaks and for Loose Connections

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

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

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

NOTICE

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

NOTICE

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

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

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

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

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the valve cover.

- Inspect the fuel system for leaks. Look for loose fuel line clamps or for loose fuel line tie-wraps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps. Ensure that hoses and tubes are not contacting other hoses, tubes, wiring harnesses, etc.
- 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 that are cracked. Replace any gauge that 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.