SAFETY.CAT.COM

3618 ENGINE

Maintenance Intervals

Excerpted from Operation & Maintenance Manual (SEBU7150-05-01)

CATERPILLAR

i02696000

Maintenance Interval Schedule

SMCS Code: 1000; 4450; 7500

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

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

Use mileage, fuel consumption, service hours, or calendar time, WHICHEVER 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

Daily

Every 250 Service Hours or Monthly

Every 500 Service Hours or 3 Months

Initial 1000 Service Hours or 6 Months

Every 1000 Service Hours or 6 Months

Every 2000 Service Hours or 1 Year

Every 4000 Service Hours or 1 Year

Every 8000 Service Hours or 2 Years

Between 12 605 000 and 14 763 000 L (3 330 000 and 3 900 000 US gal) of Fuel or between 10 000 and 12 000 Service Hours

Between 25 211 000 and 29 526 000 L (6 660 000 and 7 800 000 US gal) of Fuel or Between 20 000 and 24 000 Service Hours

i01916525

Aftercooler Core - Clean/Test

SMCS Code: 1064-070; 1064-081; 1064

Before cleaning the aftercooler core, determine if the aftercooler requires cleaning. Use the 152-2067 Differential Pressure Gauge to measure the differential pressure of the air side of the aftercooler. If the differential pressure of the air side is greater than 10 kPa (40 inches of H_2O), clean the aftercooler core.

Cleaning the Aftercooler

See the Service Manual, “Disassembly and Assembly” module for instructions on removal, disassembly, assembly, and installation.

1. Remove the core.
2. Turn the core upside-down in order to remove debris.

NOTICE
Do not use a high pressure spray for cleaning the fins of the core. A high pressure spray can damage the surface of the fins and reduce the flow of air through the core.

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. Table 21 lists liquid cleaners that are available from your Caterpillar dealer.

   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.

Table 21

Liquid Cleaners(1)		
Part Number	**Description**	**Size**
1U-5490	Hydrosolv 4165	19 L (5 US gallon)
174-6854	Caterpillar Cabinet and Tank Liquid Cleaner	19 L (5 US gallon)
174-6855	Caterpillar Cabinet and Tank Liquid Cleaner	208 L (55 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 to a pressure of 1.5 times the working pressure of the cooling circuit for one hour. Many shops that service radiators are equipped to perform pressure tests. If necessary, repair the core.
8. Install the core.

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

i01762654

Air Starting Motor Lines Screen - Clean

SMCS Code: 1451-070-LI

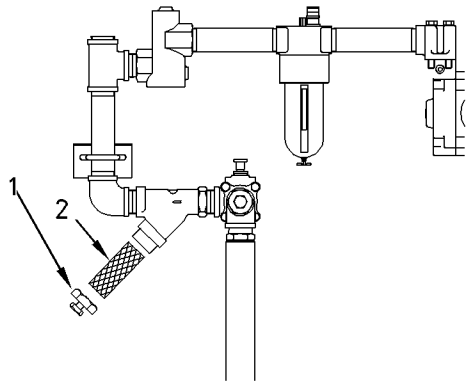

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Illustration 44

(1) Plug
(2) Screen

If the engine is equipped with an air starting motor, use the following procedure:

1. Ensure that the air supply to the air lines is OFF.
2. Remove plug (1).
3. Carefully remove screen (2). Clean the screen with nonflammable solvent. Inspect the screen for damage. If the screen is damaged, replace the damaged screen with a new screen.
4. Install clean, dry screen (2). Clean plug (1). Install the plug.

i02654935

Air Starting Motor Lubricator Bowl - Clean

SMCS Code: 1451-070

If the engine is equipped with an air starting motor, use the following procedure:

⚠ WARNING

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

Failure to relieve pressure can cause personal injury.

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

1. Ensure that the air supply to the lubricator is OFF.

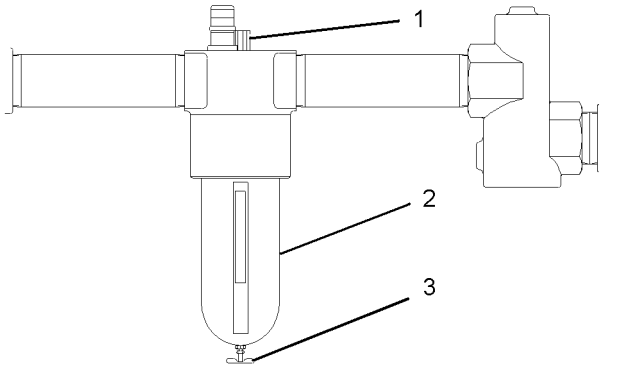

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Illustration 45

(1) Filler plug
(2) Bowl
(3) Drain valve

2. Slowly loosen filler plug (1) in order to release the pressure from the lubricator.

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.

3. Place a suitable container under bowl (2) and open drain valve (3) in order to drain the oil from the bowl.
4. Remove bowl (2). Clean the bowl with warm water.

5. Dry the bowl. Inspect the bowl for cracks. If the bowl is cracked, replace the damaged bowl with a new bowl. Inspect the gasket. If the gasket is damaged, replace the gasket.

6. Install the bowl.

7. Make sure that drain valve (3) is closed.

8. For instructions on filling the lubricator, see this Operation and Maintenance Manual, “Air Starting Motor Lubricator Oil Level - Check” topic.

i02654969

Air Starting Motor Lubricator Oil Level - Check

SMCS Code: 1451-535

NOTICE
Never allow the lubricator bowl to become empty. The air starting motor will be damaged by a lack of lubrication. Ensure that sufficient oil is in the lubricator bowl.

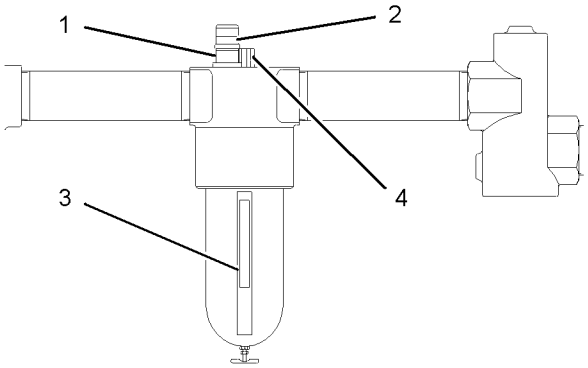

Illustration 46 g01333366

1. Observe the oil level in sight gauge (3). If the oil level is less than 1/2, add oil to the lubricator bowl.

⚠ WARNING

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

Failure to relieve pressure can cause personal injury.

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

2. Ensure that the air supply to the lubricator is OFF. Slowly loosen filler plug (4) in order to release pressure from the lubricator bowl.

3. Remove filler plug (4). Pour oil into the lubricator bowl. Use nondetergent SAE 10W oil for temperatures that are greater than 0 °C (32 °F). Use air tool oil for temperatures that are below 0 °C (32 °F).

4. Install filler plug (4).

Adjust the Lubricator

Note: Adjust the lubricator with a constant rate of air flow. After the adjustment, the lubricator will release oil in proportion to variations of the air flow.

1. Ensure that the fuel supply to the engine is OFF.

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. Operate the air starting motor. Observe the drops of oil that are released in dome (1).

Note: Some lubricators have an adjustment screw rather than a knob.

3. If necessary, adjust the lubricator in order to release from one to three drops of oil per second. To increase the rate, turn knob (2) counterclockwise. To decrease the rate, turn the knob clockwise.

i00351324

Air Tank Moisture and Sediment - Drain

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.

i01903909

Annunciator Panel - Inspect

SMCS Code: 1926

Inspect the annunciator panel for good condition. Perform a lamp test. All of the warning lamps should illuminate. If a warning lamp does not illuminate, replace the bulb immediately. If the alarm does not sound, investigate the problem and correct the problem.

Check the Gauges

Check the condition of all of the gauges. If a gauge is broken, repair the gauge or replace the gauge immediately.

Record the Data and Review the Data

Check the oil pressure and the fuel pressure on an hourly basis during normal operation. Record the data in a log. Compare the new data to the data that was previously recorded. Comparing the new data to the recorded data will establish the normal gauge readings for the engine. A gauge reading that is abnormal may indicate a problem with operation or a problem with the gauge.

Oil Pressure

Normal oil pressure at low idle rpm and at operating temperature is 172 kPa (25 psi). Normal oil pressure at rated rpm and at operating temperature is 448 kPa (65 psi).

Oil Filter Differential Pressure

Replace the oil filter elements when one or more of the following situations occur:

- The engine is operating at rated speed and at operating temperature and the oil filter differential pressure reaches 103 kPa (15 psi).
- The engine oil is changed.

Fuel Pressure

The typical fuel pressure range is from 450 kPa (65 psi) at low idle to 700 kPa (102 psi) at high idle.

Fuel Filter Differential Pressure

Replace the fuel filter elements when either of the following situations occur:

- The engine is operating at rated speed and at operating temperature and the fuel filter differential pressure reaches 69 kPa (10 psi).
- The fuel filter elements have been used for 1000 hours of operation.

Air Restriction

When the air restriction reaches 3.7 kPa (15 inch of H_2O) then replace the soot filter. If the air restriction exceeds this limit, excessive fuel consumption and exhaust temperatures will result.

i01904523

Barring Device - Lubricate

SMCS Code: 1235-086

NOTICE
Do not use an impact wrench to operate the barring device. The use of an impact wrench will cause gear tooth failure.

WARNING

Guards must be in place prior to operating barring device motor.

Remove all hand tools prior to operating barring device motor.

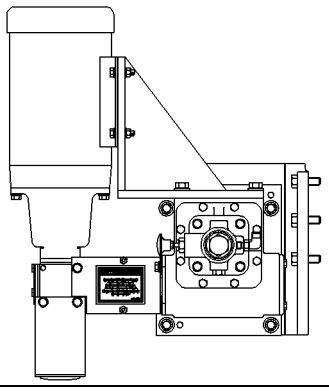

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Illustration 47
Rear view of a barring device with an electric motor

Note: Prelube of the engine is recommended before the crankshaft is rotated for normal maintenance.

The barring device provides a means for slowly turning the flywheel in order to service the engine. The barring device can also be used to prevent rotation of the crankshaft. When the barring device is in the engaged position, the engine starting system is disabled.

When the barring device is not used, the barring device must be fully disengaged from the flywheel and secured in the disengaged position.

NOTICE
Do not operate the engine starting motor until the barring group pinion gear is fully disengaged from the flywheel ring gear. Serious damage to the engine could result.

Lubricating the Pinion

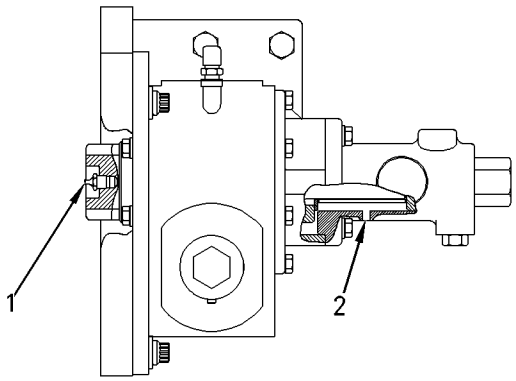


Illustration 48 g00991436

Section view of a barring device without an electric motor

(1) Grease fitting
(2) Vent

1. Ensure that the barring device is locked in the disengaged position.
2. Lubricate grease fitting (1) with MPGM until the grease is visible at vent (2).

Lubricating the Reducer

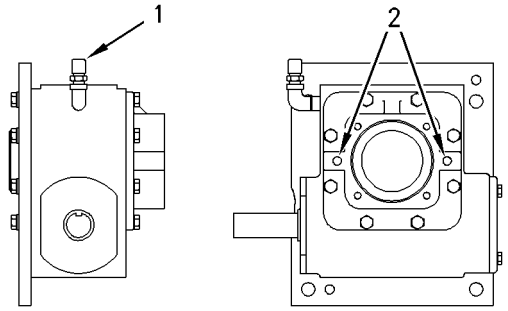


Illustration 49 g00991445

1. Ensure that the barring device is locked in the disengaged position.
2. Remove level plugs (2) and check the lubricant level.
3. If necessary, remove cap (1) and add Caterpillar 4C-6767 Synthetic Oil until the oil is visible at the level plugs.
4. Reinstall the level plugs and reinstall the cap.

i01904185

Camshaft Roller Followers - Inspect

SMCS Code: 1209-040

For instructions on disassembly and assembly of the valve lifter group, see the Service Manual, “Disassembly and Assembly” module.

Inspect the following components for wear at each metal to metal contact point:

- Rollers for the valve lifters
- Camshaft

Inspect each roller for wear, excessive movement, and end play.

If excessive wear or other signs of deterioration are found, replace the damaged components.

i01317136

Centrifugal Oil Filter - Clean

SMCS Code: 1328-070

⚠ WARNING

Hot oil and components can cause personal injury.

Do not allow hot oil or components to contact skin.

Intervals for cleaning the centrifugal oil filters depend on the buildup of sludge in the centrifugal oil filters. After disassembling the centrifugal oil filter, measure the buildup of sludge in the rotor cover.

If the buildup of sludge is more than 12 mm (.47 inch) thick, the centrifugal oil filters must be cleaned more often.

If the buildup of sludge is not more than 12 mm (.47 inch) thick, clean the centrifugal oil filters after every 100 operating hours.

If the buildup of sludge is less than 12 mm (.47 inch) thick, the interval for cleaning the centrifugal oil filters can be increased. Increase the interval in 50 hour increments until a suitable interval is determined.

Note: To prevent oil from spraying, shut down the engine prior to removal of the centrifugal oil filter. The shutoff valve for the centrifugal oil filter must also be in the closed position.

1. Disassemble the centrifugal oil filter according to the instructions in the Service Manual, “Disassembly and Assembly”.
2. Thoroughly clean all of the parts of the filter. Carefully inspect all of the parts.

NOTICE
Ensure that all of the rotor components are thoroughly clean before assembling the rotor. Failure to do so can cause an out of balance condition that can cause rapid wear to the bearings and the spindle.

Note: Install a new paper liner when the filter is assembled.

3. Assemble the filter according to the instructions in the Service Manual, “Disassembly and Assembly”.

i01317156

Centrifugal Oil Filter - Inspect

SMCS Code: 1328-040

⚠ WARNING

Hot oil and components can cause personal injury.

Do not allow hot oil or components to contact skin.

Note: To prevent oil from spraying, the engine should be shut down prior to removal of the centrifugal oil filter. The shutoff valve for the filter must also be in the closed position.

1. Disassemble the centrifugal oil filter according to the instructions in the Service Manual, “Disassembly and Assembly”.
2. Thoroughly clean all of the parts of the filter. Carefully inspect all of the parts.
3. Measure the clearance between the bearing and the base and measure the clearance between the bearing and the spindle. Follow the instructions that are in the Service Manual. Replace any part that does not meet the specifications that are in the Service Manual.

NOTICE
Ensure that all of the rotor components are thoroughly clean before assembling the rotor. Failure to do so can cause an out of balance condition that can cause rapid wear to the bearings and the spindle.

Note: Install a new paper liner when the filter is assembled.

4. Assemble the centrifugal oil filter according to the instructions in the Service Manual, “Disassembly and Assembly”.

i02554244

Cooling System Coolant - Change

SMCS Code: 1350-044

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

- The engine overheats frequently.
- Foaming is observed.

- Oil or 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.

Drain the Cooling System

1. Stop the engine and allow the engine to cool. Ensure that the engine will not start when the cooling system is drained.

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

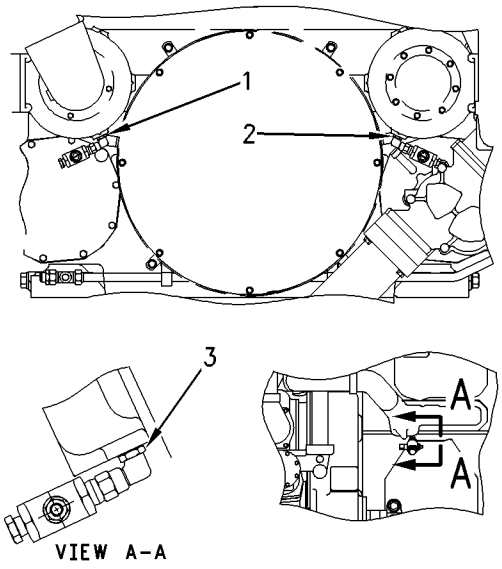


Illustration 50 g00702833

(1) Drain for the jacket water pump
(2) Drain for the water pump of the aftercooler and oil cooler system
(3) Drain for the elbow for the jacket water on the left side of the engine

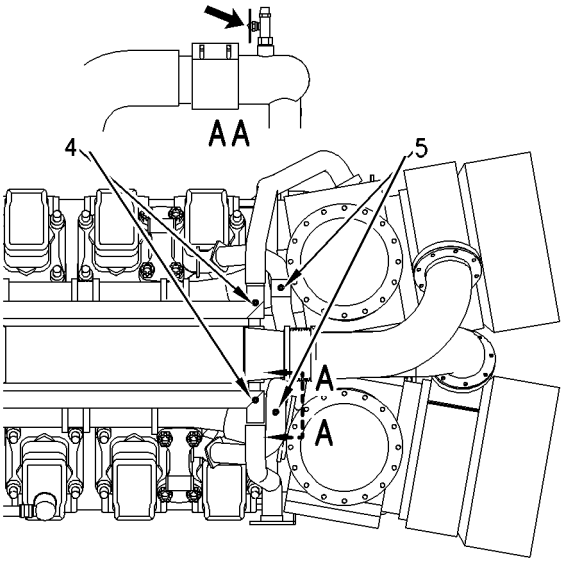


Illustration 51 g00702438

(4) Location of the vent valves for the aftercooler and oil cooler system
(5) Location of the vent valves for the jacket water system
(AA) Vent valve

Note: Vent valves (4) and (5) must be open during engine operation.

3. Ensure that vent valves (4) and (5) are open during this procedure. Open the cooling system drain valves or drain plugs (1), (2), and (3). 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 Tools:

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

Clean the Cooling System

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

2. Close the cooling system drain valves (if equipped). Clean the cooling system drain plugs and install the cooling system drain plugs.

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

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Install the cooling system filler cap.

4. Start the engine. Operate the engine for a minimum of 30 minutes with a coolant temperature of at least 82°C (180°F).

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

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

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the cooling system drain valves (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water until the water that drains is clean. Close the cooling system drain valves (if equipped). Clean the cooling system drain plugs and install the cooling system drain plugs.

Cleaning a Cooling System that has Heavy Deposits or Plugging

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

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

2. Close the cooling system drain valves (if equipped). Clean the cooling system drain plugs and install the cooling system drain plugs.

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

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

4. Start the engine. Operate the engine for a minimum of 90 minutes with a coolant temperature of at least 82°C (180°F).

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

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

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the cooling system drain valves (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water until the water that drains is clean. Close the cooling system drain valves (if equipped). Clean the cooling system drain plugs and install the cooling system drain plugs.

Fill the Cooling System

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

1. Fill the cooling system with water and SCA. For information about the proper mixture to use, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations”. For the capacity of the cooling system, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations”. Do not install the cooling system filler cap.

2. Start the engine. Operate the engine in order to purge the air from the cavities of the engine block. Allow the coolant to warm and allow the coolant level to stabilize. Stop the engine.

3. Check the coolant level. Maintain the coolant to the proper level on the sight gauge (if equipped). If a sight gauge is not equipped, maintain the coolant within 13 mm (.5 inch) below the bottom of the filler pipe.

4. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets of the cooling system filler cap are damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gaskets of the cooling system filler cap are not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure 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.

i02158408

Cooling System Coolant Level - Check

SMCS Code: 1350-535-FLV

⚠ WARNING

Climbing equipment may be required to access this service point. Refer to the Operation and Maintenance Manual, "Mounting and Dismounting" topic for safety information.

Engines That Are Equipped With a Sight Gauge

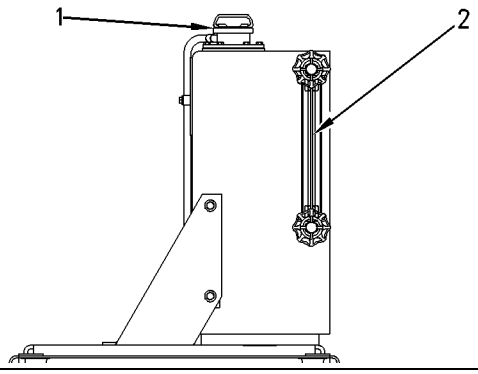


Illustration 52 g00750429

(1) Filler cap
(2) Sight gauge

If the engine is equipped with a sight gauge, observe the position of the coolant in the sight gauge. At normal operating temperature, the proper coolant level is in the upper half of the sight gauge. If the coolant level is low, add the proper coolant mixture.

Engines That Are Not Equipped With a Sight Gauge

⚠ 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.

Check the coolant level when the engine is stopped and cool. Check the coolant level only after the engine has been stopped and the cooling system filler cap is cool enough to touch with your bare hand.

Remove the cooling system filler cap slowly in order to relieve any pressure. Maintain the coolant within 13 mm (0.5 inch) below the bottom of the filler pipe.

Add Coolant

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

1. Stop the engine. Allow the engine to cool.

2. Remove the cooling system filler cap slowly in order to relieve any pressure. Pour the proper coolant mixture into the filler pipe.

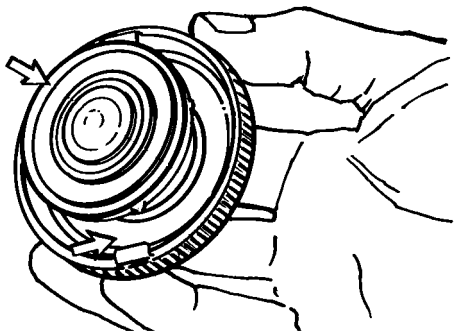


Illustration 53 g00103639

Gaskets

3. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets are damaged, replace the old cooling system filler cap with a new cooling system filler cap. Install the cooling system filler cap.

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

i02693129

Cooling System Coolant Sample (Level 1) - 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.

Check the concentration of supplemental coolant additive (SCA) regularly. The concentration of SCA can be checked by using a 298-5311 Coolant Nitrite Test Kit.

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:

- Never collect samples from expansion bottles.
- Never collect samples from the drain for a system.
- Obtain coolant samples directly from the coolant sample port. You should not obtain the samples from any other location.

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

For additional information about coolant analysis, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations” or consult your Caterpillar dealer.

i02469122

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.

Obtain the sample of the coolant as close as possible to the recommended sampling interval. Supplies for collecting samples can be obtained from your Caterpillar dealer.

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 the Special Publication, SEBU7003, “3600 Series and C280 Series Diesel Engine Fluids Recommendations” or consult your Caterpillar dealer.

i02322137

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: Test the concentration of the SCA or obtain an S·O·S coolant analysis (Level I).

Test the Concentration of the SCA

Water and SCA

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

Test the concentration of the SCA with the 210-2606 Coolant Conditioner Test Kit. Follow the instructions that are in this Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic.

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. See this Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic.

4. Clean the cooling system filler cap. Install the cooling system filler cap.

i02623987

Crankshaft Vibration Damper - Inspect

SMCS Code: 1205-040

The crankshaft vibration damper limits the torsional vibration of the crankshaft. The visconic damper has a weight that is located inside a fluid filled case.

Damage to the crankshaft vibration damper or failure of the 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.

A damper that is hot may be the result of excessive friction. This could be due to misalignment. Use an infrared thermometer to monitor the temperature of the damper during operation. If the temperature reaches 93 °C (200 °F), consult your Caterpillar dealer.

Inspect the damper for evidence of dents, cracks, and leaks of the fluid.

If a fluid leak is found, determine the type of fluid. The fluid in the damper is silicone. Silicone has the following characteristics: transparent, viscous, and smooth.

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

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

- The damper is dented, cracked, or leaking.
- The paint on the damper is discolored from heat.
- The engine has had a failure because of a broken crankshaft.
- The crankshaft bearings are showing excessive wear.
- There is a large amount of gear train wear that is not caused by a lack of oil.

Dampers With Sampling Ports

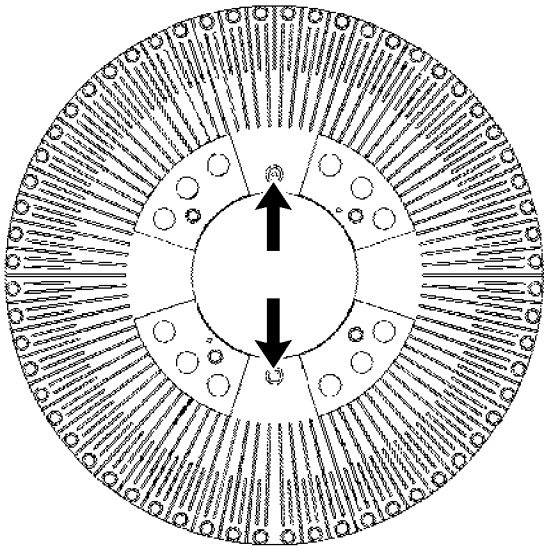


Illustration 54 g00819045

Some dampers have ports for fluid samples. If the damper has no external damage, collect a 2 to 5 mL sample of the damper fluid. The fluid should be analyzed in order to check for a loss of viscosity. Use the results of the analysis to determine if the damper should be rebuilt or replaced. Kits for fluid samples are available from the address that follows. Return the kits to the same address for analysis.

Hasse & Wrede GmbH
Mohriner Allee 30-42
D-12347 Berlin
Germany
Phone: 49 30 / 70 181 195
Fax: 49 30 / 70 09 08-11

Dampers Without Sampling Ports

Some dampers do not have a port for a fluid sample. These dampers must be rebuilt or the dampers must be replaced when one of the following criteria has been met:

- the damper has reached 20,000 hours of operation.
- the engine is undergoing a major overhaul.

Removal and Installation

Refer to the Disassembly and Assembly Manual, “Vibration Damper - Remove and Install” article or consult your Caterpillar dealer for information about damper replacement.

i01904417

Driven Equipment - Check

SMCS Code: 3279-535

To minimize bearing problems and vibration of the engine crankshaft and the driven equipment, the alignment between the engine and driven equipment must be maintained properly.

Check the alignment according to the commissioning data and refer to the instructions that are provided by the following manufacturers:

- Caterpillar
- OEM of the coupling
- OEM of the driven equipment
- OEM of the vessel

Note: Caterpillar recommends the use of laser alignment tools in order to check the alignment of the driven equipment. Refer to the documentation above for specifications and alignment procedures.

i00935098

Driven Equipment - Inspect/Replace/Lubricate

SMCS Code: 3279-040

Observe the driven equipment during operation. Look for the following items:

- Unusual noise and vibration
- Loose connections
- Damaged parts

Perform any maintenance that is recommended by the OEM of the driven equipment. Refer to the literature of the OEM of the driven equipment for the following service instructions.

- Inspection
- Lubricating grease and lubricating oil requirements
- Specifications for adjustment
- Replacement of components
- Requirements for ventilation

i00453473

Engine Air Cleaner Element - Replace

SMCS Code: 1051-510; 1054-510

Replace the Soot Filter

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

Unfiltered air will drastically accelerate internal engine wear. The air silencer is wrapped in a disposable soot filter. The soot filter helps prevent airborne dust and debris from entering the air inlet. As the soot filter becomes dirty, the air restriction increases. Replace the soot filter when the air restriction reaches 3.75 kPa (15 inches of water).

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

1. Remove the used soot filter from the air silencer. Discard the used soot filter.
2. Inspect the air silencer. Clean the air silencer, if necessary.
3. Install a new soot filter.

i01421692

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

Clean the crankcase breather elements and replace the O-ring seals at every oil change. Perform this maintenance when the engine is stopped.

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

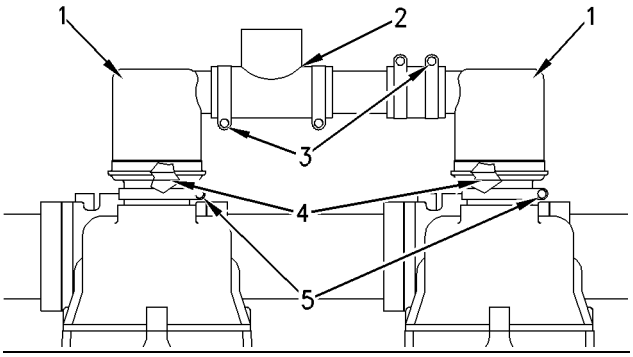


Illustration 55 g00745657

(1) Breather assembly
(2) Tee
(3) Hose clamp
(4) O-ring seal
(5) Retaining clamp

1. Loosen hose clamps (3). Remove tee (2).
2. Loosen retaining clamps (5). Remove breather assemblies (1) and O-ring seals (4).
3. Wash the breather elements in clean nonflammable solvent. Inspect tee (2) for cracks that can be caused by vibration. Replace the old tee with a new tee if cracking is found.
4. Install new O-ring seals (4).
5. Allow the breather elements to dry before installation. Install the breather assemblies in the original position. Coat the rubber parts with clean engine oil or petroleum jelly in order to make installation easier.
6. Install the retaining clamps and the hose clamps. See the Service Manual, “Specifications” module for the proper torque.

i01903735

Engine Mounts - Check

SMCS Code: 1152-535

Check the condition of the isolators. The isolators must be kept clean and dry. Ensure that the isolators are free of oil and contamination.

Resilient Isolators

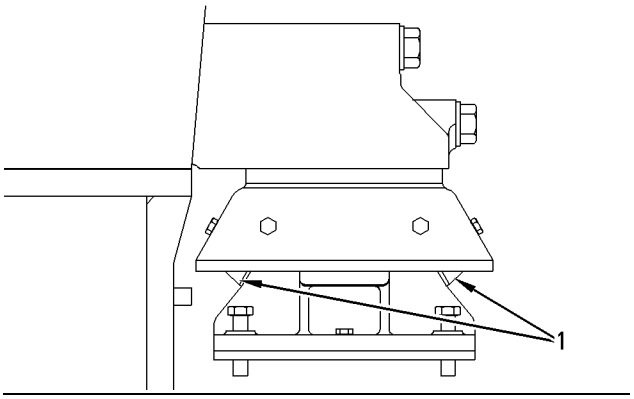


Illustration 56 g00745665

(1) Rubber element

Each isolator has four rubber elements. The most usual cause for failure of the isolator is oil contamination of the rubber elements. Inspect the rubber elements of each isolator for the following conditions.

- Swelling
- Blistering
- Cracking

Perform the following procedures when deterioration of the rubber elements is initially observed:

- Record the observation in a log.
- Check the alignment of the driven equipment.

After deterioration of the rubber elements is initially observed, the rubber elements must be carefully inspected. Any further deterioration of the rubber elements must be recorded. The isolator must be repaired or replaced if rapid deterioration of the rubber elements is observed.

Deterioration of the rubber elements is usually accompanied by settling of the isolator. Settling of the isolator will result in misalignment between the engine and the driven equipment.

Ensure that the covers are in the correct position and that the O-rings are in good condition. This will help prevent water from entering the top of the mount. Water may cause the adjustment screw and/or the locknut to seize.

Measure the Height of the Isolators

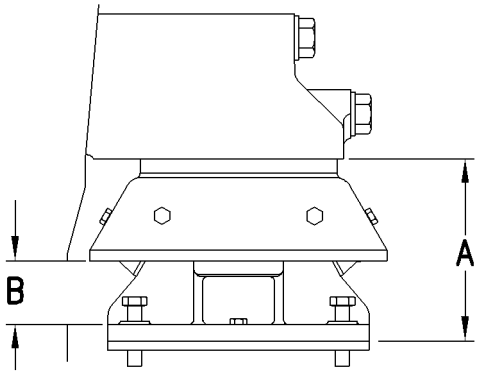


Illustration 57 g00705353

There are two methods of measuring the heights of the isolator:

Acceptable – This method does not take into account deformation of the bed of the engine. Measure the loaded height of each isolator. Use an inside micrometer and measure dimension (A) between the top of the soleplate and the bottom of the engine support assembly. All measurements must be taken at the location that was marked by the manufacturer of the vessel at the time of the engine commissioning.

Preferred – This is the most accurate method. This method will ensure that each of the mounts are carrying the same load. Measure each corner of each isolator (B) and record the average height of the four measurements from each isolator.

Compare the measurement to the height that is stamped on the mounting foot of the engine or compare the measurement to the specifications from the report from the engine commissioning. If the measurement has changed ± 1 mm (± 0.04 inch) from the recorded height, the height of the mounting foot must be adjusted back to the original specifications. See this Operation and Maintenance Manual, “Engine Mounts-Inspect” for information on adjusting the engine mounts.

Note: It is important to keep accurate records of all of the measurements so that trends can be developed for the life of the isolators.

i01905152

Engine Mounts - Inspect

SMCS Code: 1152-040; 1152

Inspect the Center Bolt

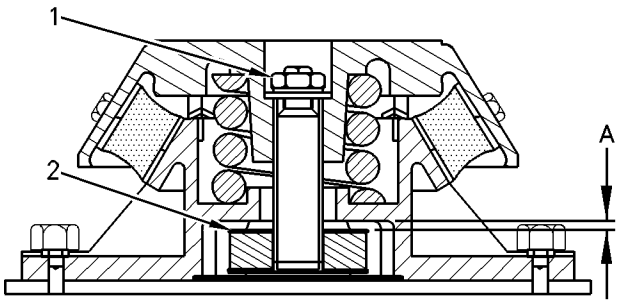


Illustration 58 g00992208

(1) Locknut
(2) Adjustable assembly
(A) Clearance above the adjustable assembly

Inspect the tightness of locknut (1) on the center bolt. Use a minimum torque of 220 N·m (162 lb ft).

If the locknut is loose, perform the following Steps:

1. Tighten the locknut to 220 N·m (162 lb ft).
2. Measure clearance (A) above adjustable assembly (2).
3. Compare the clearance to the specification from the engine commissioning. The clearance and the specification from the engine commissioning must be equal.

Any difference in the clearance indicates that the height of the isolator has changed. A change in the height of the isolator will result in misalignment between the engine and the driven equipment.

Adjusting the Height Of the Engine Support Assembly

Note: When shims are used in order to maintain the height of the engine support assembly, the alignment of the engine and the driven equipment must be verified.

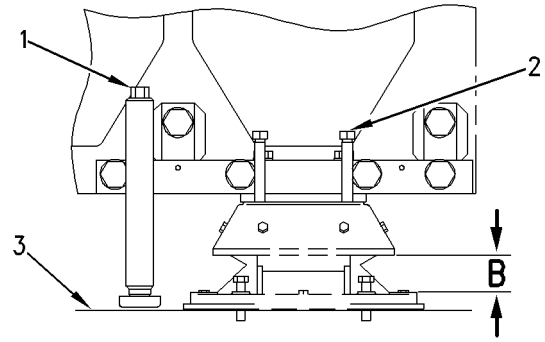


Illustration 59 g00992217

(1) Jacking screw
(2) Setscrew
(3) Shim

1. Loosen setscrews (2).
2. Raise the engine with jacking screw (1).
3. Add or remove shims (3), if necessary. Tighten set screws (2).

Maintain a record of all of the shims that are added and/or removed from each isolator. When any of the following conditions occur the isolators must be rebuilt or replaced:

- There is more than 5 mm (0.2 inch) of difference between dimension (B) and the dimension that is stamped on the mounting foot of the engine.
- Clearance (A) from illustration 58 can not be adjusted to the required height.

For a standard rotation engine, the specification for clearance (A) for the left side isolators is 9.5 mm (0.4 inch). The specification for clearance (A) for the right side isolators is 4.5 mm (0.2 inch).

For a reverse rotation engine, the specification for clearance (A) for the left side isolators is 4.5 mm (0.2 inch). The specification for clearance (A) for the right side isolators is 9.5 mm (0.4 inch).

Note: If the isolators are repaired or replaced the engine must be realigned with the driven equipment. The new heights of the engine mounts must be stamped on the mounting feet. A copy of the new specifications must be added to the report from the engine commissioning and/or ship's documents.

For the proper adjustment, refer to the shipyard's installation manual.

i02310009

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

The most accurate check of the oil level is performed when the engine is running at low idle and the lube oil is warm. Perform this maintenance when the vessel is as stationary as possible.

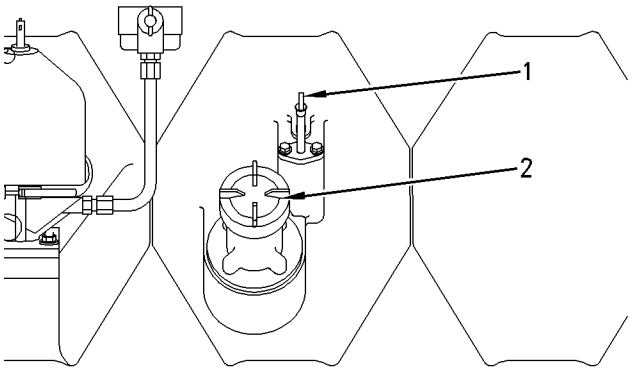


Illustration 60 g00745692

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

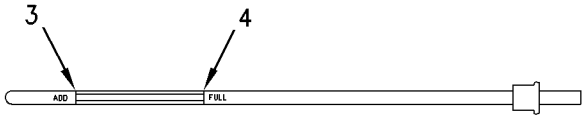


Illustration 61 g00992262

(3) “ADD” mark
(4) “FULL” mark

1. If the engine is not running, start the prelube pump. If the engine is running, reduce the engine speed to low idle.

2. Remove the oil level gauge. Observe the oil level on the oil level gauge. Maintain the oil level between the “ADD” mark (3) and the “FULL” mark (4).

NOTICE

Operating the engine with the oil level above the “FULL” mark could cause the crankshaft to dip into the oil.

The air bubbles that are created by the crankshaft dipping into the oil reduces the lubricating characteristics of the oil. This could result in the loss of power and cause damage to the engine.

Do not overfill the engine with oil.

3. If necessary, remove oil filler cap (2) and add oil. For the correct oil to use, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic (Maintenance Section). Do not fill the crankcase above “FULL” mark (4). Clean the oil filler cap. Install the oil filler cap.

i01935337

Engine Oil Sample - Obtain

SMCS Code: 1348-554-SM

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

Obtain the Sample and the Analysis

⚠ WARNING

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

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

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

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

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

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

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

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

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

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

i00839584

Engine Oil Temperature Regulator - Replace

SMCS Code: 1330-510

The oil temperature regulators divert the engine oil to the oil cooler in order to maintain engine oil temperature.

For instructions on replacing the oil temperature regulators, see the Service Manual, “Disassembly and Assembly” module.

i02554249

Engine Oil and Filter - Change

SMCS Code: 1318-510

Oil Change Interval

The oil change interval is primarily determined by the results of oil analysis. Other considerations include the type of fuel, the lubrication oil, and the engine application. When you establish an S·O·S oil analysis program, you will be able to evaluate the used oil. The evaluation can be used to determine if this oil change interval is suitable for your specific engine.

Replace the lubrication oil when oil analysis determines that the oil has reached the condemning limit.

In the absence of oil analysis, change the oil after every 500 hours of operation.

Drain the Engine Oil

⚠ WARNING

Hot oil and components can cause personal injury.

Do not allow hot oil or components to contact skin.

NOTICE
Ensure that the engine is stopped before performing this procedure. Attach a DO NOT OPERATE tag to the starting controls.

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

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

1. After the engine has been operated at normal operating temperature, STOP the engine.

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.

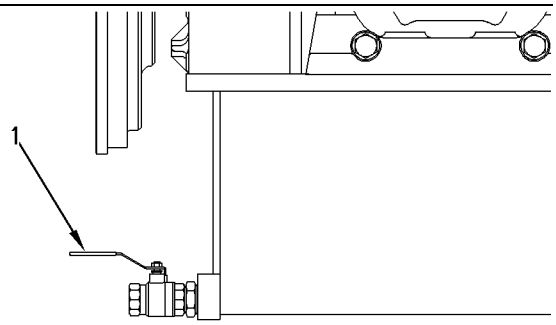


Illustration 62 g00745694

2. Open drain valve (1) in order to drain used oil. After the oil has drained, close drain valve (1).

   If a suction device is used to drain the oil, ensure that the suction device is clean in order to prevent dirt from entering the oil pan. Be careful not to strike the engine oil suction tubes or the piston cooling jets.

Note: After the used oil has been drained and before the new oil is added, clean the oil suction screen. Replace the engine oil filter elements.

Clean the Oil Suction Screen

⚠ WARNING

Hot oil and components can cause personal injury.

Do not allow hot oil or components to contact skin.

Clean the oil suction screen at every oil change. Clean the oil suction screen after the oil sump has been drained.

Note: Approximately 1 L (1 qt) of oil will remain in the housing after the sump has been completely drained. This oil will pour out of the housing when cover (1) is removed. Catch the oil with a pan. Clean up any spilled oil with absorbent pillows or towels. DO NOT use absorbent particles to clean up the oil.

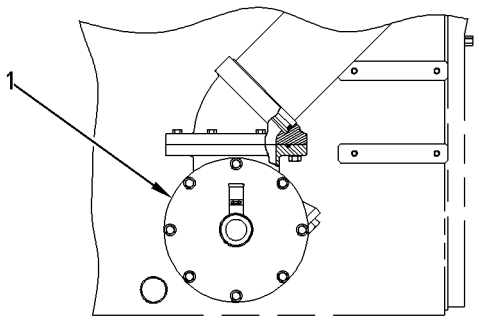


Illustration 63 g00701472

1. Remove the bolts and washers from cover (1). Remove cover (1) and the O-ring seal. Inspect the seal for good condition. If the seal is cut, scratched, or cracked, obtain a new seal for assembly.

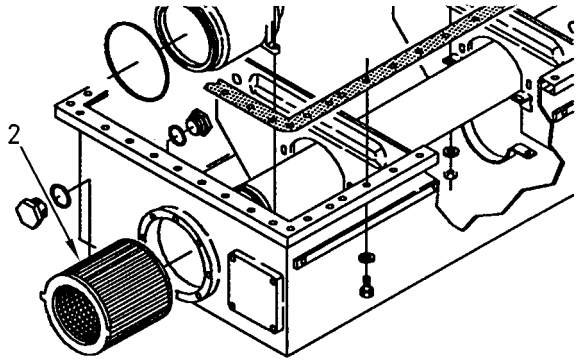


Illustration 64 g00745695

2. Slide screen assembly (2) from the tube.

3. Wash screen assembly (2) in clean nonflammable solvent. Allow the screen assembly to dry before installation.

4. Install screen assembly (2). Install cover (1) and the O-ring seal. Secure the cover with the bolts and washers.

Replace the Engine Oil filters

Replace the engine oil filters for any of the following occurrences:

- Every oil change
- The engine oil filter differential pressure reaches 100 kPa (15 psi).

Service tools are available to aid in the service of oil filters and fuel filters. Consult your Caterpillar dealer for the part names and the part numbers. Follow the instructions that are supplied with the service tools. If the service tools are not used, perform the following procedure.

⚠ WARNING

Hot oil and components can cause personal injury.

Do not allow hot oil or components to contact skin.

Perform the following procedure after the oil sump has been drained.

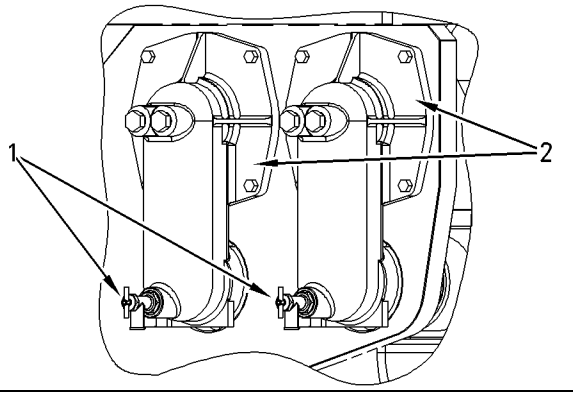


Illustration 65 g00745696

1. Connect a hose from each drain valve (1) to a suitable container in order to catch the oil.

2. Open both drain valves (1). Allow the oil to drain.

Note: Some oil will remain in the housing after the oil has been drained. This oil will pour out of the housing when cover (2) is removed. Catch the oil with a pan. Clean up any spilled oil with absorbent pillows or towels. DO NOT use absorbent particles to clean up the oil.

⚠ WARNING

Personal injury can result from parts and/or covers under spring pressure.

Spring force will be released when covers are removed.

Be prepared to hold spring loaded covers as the bolts are loosened.

3. Be alert to the spring force. Cover (2) has a spring force up to 240 N (54 lb). Gradually loosen but do not remove the last two bolts or nuts that are located at opposite corners of the cover. Before removing the last two bolts or nuts, pry the cover loose in order to relieve any spring pressure.

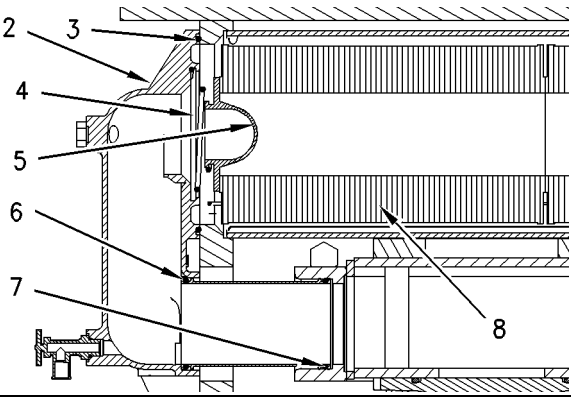


Illustration 66 g00745697

(2) Cover
(3) O-ring seal
(4) Spring
(5) Retainer
(6) O-ring seal
(7) O-ring seal
(8) Filter

4. Remove cover (2). Inspect O-ring seals (3), (6), and (7) for good condition. If a seal is cut, scratched, or cracked, obtain a new seal for assembly.

5. Remove spring (4) and retainer (5).

6. Use a pan to catch the oil that drips when the filters are removed. Remove the four used filters. Clean up any oil that is spilled.

7. Clean cover (2), spring (4), and retainer (5).

8. Inspect four new filters for each housing for good condition. Coat the sealing surfaces of the new filters with clean engine oil. Install the filters into the housing.

9. Install new O-ring seal (3) in the cover. Install new O-ring seals (6) and/or (7) in the lower tube. Install the lower tube into the cover. Cover the bores and cover the seals with clean engine oil. Check the location of O-ring seal (7) during installation of the cover.

Note: The use of 2 guide pins will make installation of the cover easier.

10. Install retainer (5), spring (4), and cover (2). Ensure that the retainer and the spring are seated properly against the filter and the cover. Secure the cover with the bolts.

11. Make sure that the drain valves on the covers are closed.

Fill the Engine with Oil

1. Remove the oil filler cap. Fill the crankcase through the oil filler tube only. Clean the oil filler cap. Install the oil filler cap.

   For the correct oil to use, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic (Maintenance Section).

   For the amount of oil to use, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic (Maintenance Section).

2. Operate the prelube pump in order to fill both of the oil filter housings with oil. Check the oil level while the prelube pump is still running. Maintain the oil level between the “ADD” and “FULL” marks on the oil level gauge.

3. Shut off the prelube pump. Start the engine. Operate the engine at low idle rpm. Check the oil level. Check for oil leaks.

Inspect the Used Oil Filters

Cut the used oil filter open with a utility knife. Remove the metal wrap. Cut the filter element free from the end caps. Spread apart the pleats and inspect the element for metal debris. An excessive amount of debris in the element 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 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 components: 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 element. If an excessive amount of debris is found in the oil filter element, consult your Caterpillar dealer in order to arrange for further oil analysis.

i01317223

Engine Protective Devices - Check

SMCS Code: 7400-535

Calibration Check

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

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

NOTICE
During testing, abnormal operating conditions must be simulated.

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

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

- For the calibration of temperature contactors, see Special Instruction, SEHS9827, “Calibration of Temperature Contactors”.

- For the calibration of pressure contactors, see Special Instruction, SEHS9828, “Calibration of Pressure Contactors”.

Consult your Caterpillar dealer or refer to the Service Manual for more information.

Check the Magnetic Pickups

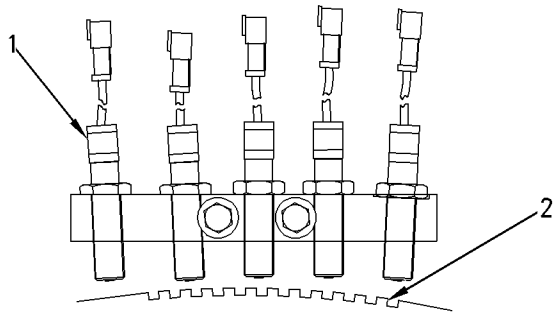


Illustration 67 g00705318

(1) Magnetic pickup
(2) Flywheel ring gear

1. Clean the face of the magnet. Check the condition of the magnetic pickup.
2. Measure the resistance of the magnetic pickup. Resistance should be about 150 ohms.
3. If necessary, remove the magnetic pickup from the flywheel housing.

Note: Some sensors have flat bottoms but other sensors may have small tips. Ensure that the tip of the sensor contacts the center point (highest point) of the gear tooth.

4. Install the magnetic pickup in the flywheel housing. Turn the magnetic pickup clockwise until the magnet contacts a tooth of the flywheel ring gear.
5. Turn the magnetic pickup counterclockwise for 1 1/4 turns (450 degrees). Maintain a clearance of 1.41 to 1.76 mm (.0555 to .0693 inch) between the magnetic pickup and the tooth of the flywheel ring gear. Tighten the locknut to 45 ± 7 N·m (33 ± 5 lb ft).

i01906035

Engine Timing, Synchronization, and Valve Lash - Inspect/Adjust

SMCS Code: 1102-040; 1105-535; 1290-040

For instructions on the following procedures, see the Service Manual, “Systems Operation/Testing and Adjusting”. Consult your Caterpillar dealer for assistance.

Check the Timing of the Crankshaft and Camshaft

The timing of the crankshaft and camshaft must be checked, and the valve bridge must be adjusted before the valve lash is adjusted. The camshafts must be correctly timed with the crankshaft before the fuel timing is adjusted.

NOTICE
If the camshaft is rotated with the timing pin installed, the timing pin will break. This can result in further damage. Make sure to remove the timing pin before the camshaft is rotated.

NOTICE
DO NOT use the starting motor to rotate the crankshaft. The lubrication oil can drain out from between the crankshaft and the engine bearings if the engine has not been operated for a period of time. Damage can result if the crankshaft is rotated on dry bearing surfaces.

To prevent damage to the crankshaft bearings, DO NOT crank the engine before prelube, especially after this maintenance procedure.

NOTICE
The prelube pump should not be operated continuously for extended periods of time. If, during repairs, the prelube pump has run continuously for a period of three hours or more, it will be necessary to remove any oil that may have collected in the cylinders and/or above the valves.

Prelube of the engine is required before the crankshaft is rotated for normal maintenance. Activate the prelube pump for rotating the engine crankshaft.

NOTICE
Do not use an impact wrench to operate the barring device. The use of an impact wrench will cause gear tooth failure.

The barring device provides a means for slowly turning the flywheel in order to service the engine. The barring device can also be used to prevent rotation of the crankshaft.

Fuel Injector Timing (Fuel Timing)

The camshafts must be correctly timed with the crankshaft before the fuel timing is adjusted. The fuel timing dimension is stamped on the engine Information Plate.

Fuel Injector Clamp

The top surface of the clamp for the fuel injector must be parallel to the top surface of the cylinder head.

Fuel Injector Synchronization

Synchronize the fuel injectors. When this maintenance procedure is complete, ensure that the barring device is disengaged from the flywheel and ensure that the handle of the barring device is secured in the disengaged position.

Valve Bridge

NOTICE
Do NOT attempt to adjust the valves if the crankshaft and camshaft are not synchronized. Disregard for this can result in engine damage such as bent valves.

Check the valve bridge and adjust the valve bridge, if necessary. Perform the procedure for both valve bridges for each cylinder.

After the valve bridge is satisfactory, check the valve lash.

Engine Valve Lash

If the valve lash is within the tolerance, an adjustment of the valve lash is NOT necessary.

The crankshaft and camshaft timing must be checked, and valve bridge adjustment must be performed before making a valve lash adjustment.

Perform the valve lash setting when the engine is cold. After the engine has been shut down and the valve covers are removed, the engine is considered cold.

Before performing maintenance, prevent the entry of foreign matter into the top of the cylinder head and the valve mechanism. Thoroughly clean the area around the valve mechanism covers.

i01765711

Engine Valve Rotators - Inspect

SMCS Code: 1109-040

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

Note: Use of a platform may be necessary to reach the engine valve rotators.

Perform this procedure after the valve lash has been set.

1. Mark the tops of the valve rotators with a permanent marker. Note the position of the marks.
2. Install the valve covers. See the Service Manual for the procedure.
3. Start the engine. Operate the engine for 5 minutes. Stop the engine.
4. Remove the valve covers. Observe the position of the marks that are on the valve rotators.

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

i00746289

Exhaust Shields - Inspect

SMCS Code: 1067-040

WARNING

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

NOTICE
The insulation for the exhaust system can be damaged if work is performed on the insulation or around the insulation.

Do not tear the surface of the insulation. A torn surface will allow the insulation to absorb flammable liquids and a fire can result from engine heat.

Remove the insulation or protect the insulation before performing work on the insulation or around the insulation. Handle the insulation carefully.

Ensure that the exhaust manifold is cool. Inspect the insulation for the exhaust system. Replace any insulation that is damaged. Consult your Caterpillar dealer for assistance.

i02355562

Fuel Analysis - Obtain

SMCS Code: 1280-554

To ensure optimum performance of the engine, obtain a complete fuel analysis when fuel is delivered. Obtain the analysis before using the fuel.

1. Ask the supplier of the fuel for the fuel specifications.
2. Obtain samples of the fuel.

Note: If a fuel supply is delivered to the site by trucks, obtain samples from approximately five percent of the supply tanks.

   a. Submit a sample of the fuel immediately to an independent laboratory for analysis.

      The fuel analysis must include all of the properties that are listed in Special Publication, SEBU7003, “3600 Series and C280 Series Diesel Engine Fluids Recommendations”.

   b. Retain samples of the fuel in case future analysis is needed.

      Label the samples accurately for future identification. The samples may be needed for future analysis if questions about quality, stability, or compatibility arise.

3. Compare the supplier’s report to the report from the analysis.

   The reports may indicate variations within the fuel. If the reports are inconsistent, obtain another analysis of the fuel. This will eliminate the possibility of testing error.

4. Compare the reports to Special Publication, SEBU7003, “3600 Series and C280 Series Diesel Engine Fluids Recommendations”.

   If the fuel does not meet the minimum requirements, deposits and/or corrosion could cause excessive wear on the fuel system and/or failure of the fuel system.

Clean fuel that meets the fuel recommendations will help ensure rated engine performance and maximum engine service life.

i01317685

Fuel System - Prime

SMCS Code: 1250-548; 1258-548

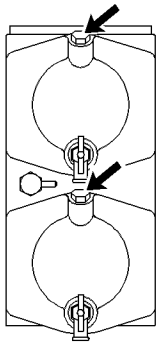
WARNING

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

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

Prime the fuel system in order to fill dry fuel filters and purge air from the fuel system. Prime the fuel system after the following occurrences:

- The fuel filter elements are replaced.
- The engine is run dry.
- The fuel lines have been disconnected.
- The engine has been overhauled.
- The engine is removed from storage.



g00366372

Illustration 68

Vent plugs for the fuel filters

1. Open the vent plugs for the fuel filters.
2. Operate the fuel priming pump of the vessel until fuel appears at the openings of the vent plugs. Operate the priming pump until the fuel flows free of air bubbles. Clean up any spilled fuel immediately.
3. Tighten the vent plugs.

Priming the Fuel System After Disconnecting Fuel Lines or After an Overhaul

1. Loosen the connector that is above the fuel pressure regulator valve. Use a cloth to catch any fuel and clean up any fuel that overflows.
2. Operate the fuel priming pump of the vessel until fuel appears at the opening of the connector. Operate the priming pump until the fuel flows free of air bubbles. Clean up any spilled fuel immediately.
3. Tighten the connector that is above the fuel pressure regulator valve.

i02310947

Fuel System Primary Filter (Water Separator) Element - Replace

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

⚠ 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 disconnected fuel system component.

Replace the element of the primary filter/water separator according to the instructions that are provided by the OEM of the primary filter/water separator.

Note: It may be necessary to prime the fuel system before the engine will start. See this Operation and Maintenance Manual, “Fuel System - Prime” topic (Maintenance Section).

i00744357

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.

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

Drain the primary filter/water separator on a daily basis before starting the engine.

For specific instructions for draining the primary filter/water separator, see the service information that is provided by the OEM of the primary filter/water separator.

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.

i02553920

Fuel System Secondary Filter - Replace

SMCS Code: 1261-510-SE

Replace the secondary fuel filter elements when either of the following conditions occur:

- The engine is operating at rated speed and at operating temperature and the fuel filter differential pressure reaches 69 kPa (10 psi).
- The fuel filter elements have been used for 1000 hours of operation.

Service tools are available to aid in the service of oil filters and fuel filters. Consult your Caterpillar dealer for the part names and the part numbers. Follow the instructions that are supplied with the service tools. If the service tools are not used, perform the following appropriate procedure.

Replacing the Secondary Filters With the Engine Stopped

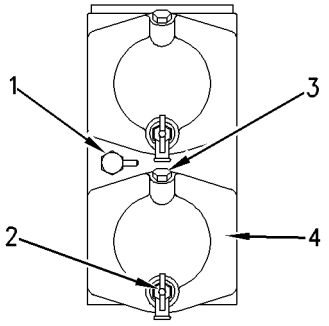
⚠ WARNING

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

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

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

Dispose of all fluids according to local regulations and mandates.



g00745778

Illustration 69

(1) Control valve
(2) Drain valve
(3) Vent plug
(4) Cover

1. Stop the engine. Connect one end of a hose to each drain valve (2). Insert the other end of the hoses into a suitable container in order to catch the fuel.

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

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

2. Remove both vent plugs (3). Open both drain valves (2) in order to drain the secondary fuel filters.

Note: If the fuel filter is installed vertically, then the drain valves are in the bottom.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

Personal injury can result from parts and/or covers under spring pressure.

Spring force will be released when covers are removed.

Be prepared to hold spring loaded covers as the bolts are loosened.

Note: Some fuel will remain in the housing after the fuel has been drained. This fuel will pour out of the housing when cover (4) is removed. Catch the fuel with a pan. Clean up any spilled fuel with absorbent pillows or towels. DO NOT use absorbent particles to clean up the fuel.

3. Be alert to the spring force. Gradually loosen but do not remove the last two bolts or nuts that are located at opposite corners of cover (4). Before removing the last two bolts or nuts, pry the cover loose in order to relieve any spring pressure.

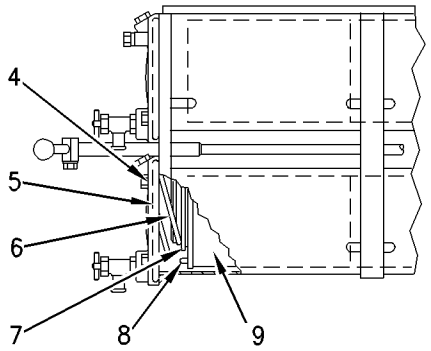


Illustration 70 g00745776

(4) Cover
(5) O-ring seal
(6) Spring
(7) Retainer
(8) Rack
(9) Filter

4. Remove cover (4) and O-ring seal (5). Inspect the seal for good condition. If a seal is cut, scratched, or cracked, obtain a new seal for assembly.

5. Remove spring (6) and retainer (7).

6. Filters (9) are loaded on wire rack (8) that is inside of the housing. Remove wire racks (6). Use a pan to catch the fuel that drips when the rack and filters are removed. Remove the used filters. Clean up any fuel that is spilled.

7. Clean cover (4), spring (6), and retainer (7). Clean rack (8) and clean the inside of the housing.

8. Inspect 4 new filters for each housing for good condition. Coat the sealing surfaces of the new filters with clean diesel fuel. Place the filters onto rack (8). Install the filters and the rack into the housing.

9. Install retainer (7), spring (6), cover (4) and O-ring seal (5). Ensure that the retainer and the spring are seated properly against the filter and the cover. Secure the cover with the bolts.

10. Make sure that the drain valves on the covers are closed. Clean vent plugs (3). Install the vent plugs loosely. Prime the fuel system. See this Operation and Maintenance Manual, “Fuel System - Prime” topic (Maintenance Section).

11. Start the engine and check for fuel leaks.

Replacing the Secondary Filters During Engine Operation

⚠ WARNING

Filter contains hot pressurized fluid when engine is running.

Follow instructions on control valve to avoid personal injury.

If rapid air movement exists to blow fluid, Stop the engine to avoid fire.

⚠ WARNING

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

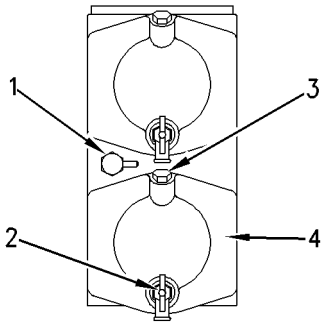


Illustration 71 g00745778

(1) Control valve
(2) Drain valve
(3) Vent plug
(4) Cover

1. To service the lower secondary fuel filter, turn control valve (1) to the “UPPER RUN” position.

2. Connect one end of a hose to drain valve (2). Insert the other end of the hose into a suitable container in order to catch the fuel.

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

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

3. Remove vent plug (3). Open drain valve (2) in order to drain the secondary fuel filter.

4. Perform Steps 3 through 9 from “Replacing the Secondary Filters With the Engine Stopped”.

5. Close drain valve (2). Clean vent plug (3). Install the vent plug loosely. Slowly turn control valve (1) to the “LOWER FILL” position. After five minutes, turn control valve (1) to the “BOTH RUN” position. Tighten vent plug (3).

6. To service the upper secondary fuel filter, turn control valve (1) to the “LOWER RUN” position. Perform Steps 1 through 5 for the upper secondary fuel filter.

7. After both of the secondary fuel filters have been serviced, turn control valve (1) to the “BOTH RUN” position.

i00746380

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

Day 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 day tank. This causes water to accumulate in the day tank. Draining the day tank regularly and obtaining fuel from reliable sources can help to eliminate water from the fuel.

Day tanks should have a provision for draining water and sediment.

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

Drain the water and sediment from the day tank daily. The quality of the fuel or the operating conditions may require the water and sediment to be drained more often.

Fill the day 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 day tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe. Some day 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 daily. Ensure that the water and sediment is drained from the fuel storage tank when the tank is refilled. This will help prevent water and/or sediment from being pumped from the fuel storage tank into the engine fuel tank.

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

i01917123

Governor Actuator Linkage - Check

SMCS Code: 1265-535

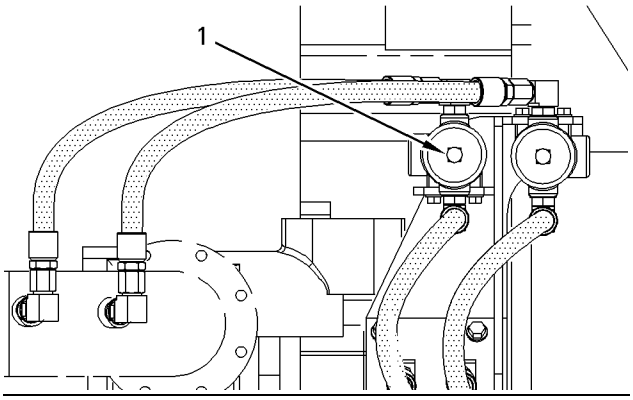
Check the governor actuator linkage for proper operation. For the procedure to adjust the actuator linkage, see the Service Manual, “Systems Operation/Testing and Adjusting”.

i01906057

Metal Particle Detector - Inspect

SMCS Code: 7400-040

If the metal particle detector causes a shutdown, inspect the detector.



g00745503

Illustration 72

Metal particle detector

(1) Cover

1. Use a 1/2 inch ratchet to remove cover (1) and the O-ring seal from the detector.

2. Remove the grid and the O-ring seal for the grid from the inside of the detector.

3. If metal particles are found, determine the source of the particles. Make repairs, as needed.

NOTICE

Metal particles in the lube oil may indicate a serious condition that requires immediate attention.

If metal particles are found in the grid of the detector, do not start the engine until the source of the particles is found and the condition is corrected. Failure to do so could cause severe damage to the engine.

4. Clean the inside of the detector and clean the grid with nonflammable solvent.

Note: To replace the O-ring seals and the grid, use the 165-5690 Particle Detector Kit.

5. Inspect the grid and the O-ring seals for good condition. Obtain new parts, if necessary.

6. Install the clean, dry grid and the O-ring seal for the grid.

7. Install the cover and the O-ring seal for the cover. Torque the cover to 54 N·m (40 lb ft).

i01421138

Oil Mist Detector - Maintain

SMCS Code: 1336-042

NOTICE

The engine can be severely damaged by excessive oil mist.

To help ensure proper operation of the oil mist detector, perform the recommended maintenance on the detector.

Failure to perform the recommended maintenance for the oil mist detector can allow these possible effects on the operation of the detector:

- Inability to activate an alarm for excessive oil mist
- Activation of faults in the detector
- Activation of false alarms for excessive oil mist

Perform the maintenance procedures for the oil mist detector according to the instructions in Service Manual, RENR2225, “Oil Mist Detectors”.

The regular maintenance that is required for the oil mist detector is listed in Table 22.

Note: The intervals for performing the maintenance are provided as guidelines. Particular installations may require more frequent maintenance intervals.

Table 22

Maintenance Schedule for the Oil Mist Detector	
Interval	**Maintenance Procedure**
When Required	Perform all of the following maintenance after the vessel has been in storage:
Daily	Maintain the system for the compressed air.
Every Month	Check the pressure of the vacuum in the measuring head. Adjust the pressure, if necessary. (1)
	Clean the box for the oil drain (if equipped).
Every 3 Months	Perform the following maintenance on these items in the measuring head: Clean the bores for the filtered air. Replace the sintered bronze filters. Clean the glass of the infrared filters.
Every Year	Replace the sintered bronze filter for the pressure regulator.
	Clean the suction lines for sampling the atmosphere from the crankcase.
	Clean the oil drain line.

(1) When this procedure is performed after Every Three Months, perform this procedure last.

i02539152

Overhaul (Major)

SMCS Code: 7595-020-MJ

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

- An increase of oil consumption
- An increase of crankcase blowby
- A decrease and variation of cylinder compression

Other factors must also be considered for determining a major overhaul:

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

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

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

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

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

A major overhaul includes all of the work that is done for top end overhauls. A major overhaul includes additional parts and labor. Additional parts and labor are required in order to completely rebuild the engine.

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

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

The following definitions explain the terminology for the services that are performed during an overhaul:

Inspect – Inspect the components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”. The guidelines were developed in order to help Caterpillar dealers and customers to avoid unnecessary expenditures. New parts are not required if the existing parts can still be used, reconditioned, or repaired. If the components are not in the reusability guidelines, refer to the Service Manual, “Specifications” module.

Rebuild – The component is reconditioned in order to comply with reusability guidelines.

Replace – The service life of the part is exhausted. The part may fail before the next maintenance interval. The part must be replaced with a part that meets functional specifications. The replacement part may be a new part, a CAT remanufactured part, a rebuilt part, or a used part. Some worn components may be exchanged with your Caterpillar dealer for a credit on replacement parts. Consult your Caterpillar dealer about repair options for your engine.

If you elect to perform an overhaul without the services of a Caterpillar dealer, be aware of the recommendations in Table 23.

Table 23

Recommendations for the Major Overhaul	
Service	**Component**
Rebuild	Centrifugal oil filters
	Cylinder heads
	Starting motor
	Vibration damper

(continued)

(Table 23, contd)

Recommendations for the Major Overhaul	
Service	**Component**
Replace	Accessory group bearings
	Camshaft bearings (1)
	Connecting rod bearings (2)
	Cylinder head valves and valve guides
	Cylinder head valve spring guides
	Exhaust manifold bellows
	Exhaust shields
	Front gear train bearings (3)
	Fuel injectors
	Main bearings (2)
	Oil pump bearings
	Oil temperature regulators
	Turbocharger bearings and bushings
	Water pump bearings
	Water temperature regulators
Inspect	Aftercooler cores
	Alarm and shutoff controls
	Camshafts (1) (4)
	Crankshaft (2) (4)
	Cylinder block
	Cylinder liners
	Cylinder sleeves
	Exhaust manifolds
	Front gear group (3)
	Oil cooler
	Oil pump bushings
	Oil suction screen
	Pistons and piston rings
	Priority valve
	Rear gear group (3)
	Rear gear train bearings (3)
	Rocker arm bearings
	Thermocouples
	Thrust bearings
	Valve mechanism group

(continued)

(Table 23, contd)

Recommendations for the Major Overhaul	
Service	**Component**
Replace the gaskets and seals of these components.	Air inlet lines
	Camshaft front covers
	Camshaft drive gear covers
	Central structure covers
	Crankcase side covers
	Crankshaft (5)
	Crankshaft vibration damper
	Cylinder heads
	Exhaust manifold
	Front housing group
	Fuel lines
	Fuel transfer pump
	Gear inspection group
	Oil cooler
	Oil lines
	Oil temperature regulators
	O-ring seals and plugs
	Power take-off covers
	Priority valve group
	Rear gear train
	Rear housing group
	Rear structure covers
	Turbocharger
	Valve covers
	Water lines
	Water pumps
	Water temperature regulators

(1) Inspect the camshaft for damage to the journals and the lobes. Inspect the camshaft bearings and the camshaft followers for signs of wear and/or scuffing.

(2) Inspect the crankshaft for these conditions: deflection, damage to the journals, and bearing material that has seized to the journals. Inspect the profile and the taper of the crankshaft journals. Compare the crankshaft journals to the wear patterns in the connecting rod bearings and the main bearings.

(3) Inspect the gears and the bushings of the gear trains for worn gear teeth, unusual fit, and unusual wear.

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

(5) Inspect the area around the front seal and the rear seal of the crankshaft. It is not necessary to replace a crankshaft seal if the seal is not leaking.

i02723990

Overhaul (Top End)

SMCS Code: 7595-020-TE

The overhaul interval that is listed in this Operation and Maintenance Manual, “Maintenance Interval Schedule” is expressed in fuel consumption and service hours. The more accurate figure to use is fuel consumption. Fuel consumption corresponds more accurately to the engine load.

Table 24 lists an average range of fuel consumption for a reasonable load factor before a top end overhaul. Use the range of fuel consumption only as a guideline.

Table 24

Approximate Fuel Consumption Before A Top End Overhaul	
Engine Model	**Fuel Consumption** (1)
3618	12 605 000 to 14 763 000 L 3 330 333 to 3 900 000 US gal

(1) The fuel consumption is based on fuel with a low heat value of 42 780 kJ/kg and density of 838.9 g/L.

A top end overhaul involves the removal, the inspection, and the rework of the cylinder head components. Some additional components are replaced and serviced.

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

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

The following definitions explain the terminology for the services that are performed during an overhaul:

Inspect – Inspect the components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”. The guidelines were developed in order to help Caterpillar dealers and customers to avoid unnecessary expenditures. New parts are not required if the existing parts can still be used, reconditioned, or repaired. If the components are not in the reusability guidelines, refer to the Service Manual, “Specifications” module.

Rebuild – The component is reconditioned in order to comply with reusability guidelines.

Replace – The service life of the part is exhausted. The part may fail before the next maintenance interval. The part must be replaced with a part that meets functional specifications. The replacement part may be a new part, a CAT remanufactured part, a rebuilt part, or a used part. Some worn components may be exchanged with your Caterpillar dealer for a credit on replacement parts. Consult your Caterpillar dealer about repair options for your engine.

If you elect to perform an overhaul without the services of a Caterpillar dealer, be aware of the recommendations in Table 25.

Table 25

Recommendations for the Top End Overhaul	
Service	**Component**
Inspect Replace	Cylinder sleeves
	Exhaust shields
	Starting motor
	Turbocharger bearings, bushings, and seals
Clean Inspect	Oil cooler core
	Oil suction screen
Rebuild Cylinder heads	Exhaust valves (1)
	Exhaust valve seat inserts
	Inlet valves (1)
	Inlet valve seat inserts
	Inner valve springs
	Outer valve springs
	Valve spring guides
	Valve spring locks
	Valve rotators
Replace	Cylinder head gaskets
	Exhaust manifold gaskets
	Fuel injectors
	Fuel transfer pump seals
	Oil pump bearings and seals
	Oil temperature regulators and seals
	O-ring seals and plugs
	Seals for the inlet air lines
	Water pump bearings and seals
	Water temperature regulators and seals

(continued)

(Table 25, contd)

Recommendations for the Top End Overhaul	
Service	**Component**
Replace the gaskets and seals.	Exhaust Bypass Valve

(1) The angles of the valves and the seats are different. If the valves and the seats are not replaced, lap the valves and the seats. The valve and the outer diameter of the seat must have 360 degrees of contact. If the valves and the seats require grinding, see the Service Manual, “Specifications” for the angles.

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Overhaul Considerations

SMCS Code: 7595-043

Overhaul Information

An overhaul is replacing the major worn components of the engine. An overhaul interval is a maintenance interval that is planned. The engine is rebuilt with certain rebuilt parts or new parts that replace the worn parts.

An overhaul also includes the following maintenance:

- Inspection of all the parts that are visible during the disassembly
- Replacement of the seals and gaskets that are removed
- Cleaning of the internal passages of the engine and the engine block

Most owners will save money by overhauling the engine at the intervals that are recommended in this Operation and Maintenance Manual. Consider the graph in Illustration 73.

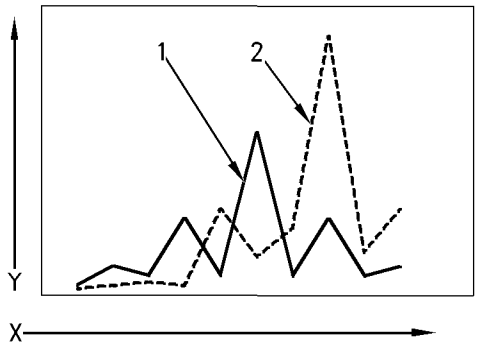

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Illustration 73

(Y) Cost
(X) Time
(1) Cost of maintenance and repair that is planned
(2) Cost of maintenance and repair that is not planned

In Illustration 73, line (1) represents the maintenance and repair costs for an owner that followed the recommendations for inspection, maintenance, and repair. The peaks represent overhauls.

Line (2) represents the maintenance and repair costs for an owner that chose to operate beyond the recommended intervals. The initial cost of the “repair-after-failure” philosophy is lower. Also, the first overhaul was delayed. However, the peaks are significantly higher than the peaks for the customer that used the “repair-before-failure” philosophy .

The higher peaks result from two key factors:

- Delaying an overhaul until a breakdown increases the chance of a catastrophic failure. This type of failure requires more parts, labor, and cleanup.
- Excessive wear means that fewer components will be reusable. More labor may be required for salvage or repair of the components.

When all of the costs are considered, “repair-before-failure” is the least expensive alternative for most components and engines.

It is not practical to wait until the engine exhibits symptoms of excessive wear or failure. It is not less costly to wait. 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 guidelines for reusable parts.
- The service life of the engine can be extended without the risk of a major catastrophe due to engine failure.
- Achieve the best cost/value relationship per hour of extended service life.

Overhaul Intervals

Some factors that are important for determining the overhaul intervals include the following considerations:

- Performance of preventive maintenance
- Use of recommended lubricants
- Use of recommended coolants
- Use of recommended fuels
- Proper installation
- Operating conditions
- Operation within acceptable limits
- Engine load
- Engine speed

Generally, engines that are operated at a reduced load and/or speed achieve more service life before an overhaul. However, this is for engines that are properly operated and maintained.

Other factors must also be considered for determining a major overhaul:

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

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

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

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

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

Using Fuel Consumption For Calculating the Overhaul Intervals

The total fuel consumption is the most important factor for estimating the overhaul interval. Fuel consumption compensates for the application and for the engine load.

If the total fuel consumption has not been recorded, use the equation in Table 26 in order to estimate the hours until the overhaul. The equation may also be used to estimate overhaul intervals for new engines.

Table 26

Equation For Calculating Overhaul Intervals
H = F/R
“H” is the number of estimated hours until the overhaul interval.
“F” is the estimated total amount of fuel consumption of the engine.
“R” is the rate of fuel consumption in liters per hour or gallons per hour.

Use the actual records of fuel consumption, when possible. If the actual records are not available, use the following procedure in order to estimate the fuel consumption.

1. Estimate the average percent of the load for the operation of the engine.

2. Refer to the engine’s Caterpillar, “Engine Specifications” (“spec” sheet). This will determine the fuel consumption for the percent of the load that was estimated in Step 1. Use this figure for the equation in Table 26.

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 Inspection

Refer to the Service Manual for the disassembly and assembly procedures that are necessary in order to perform the required maintenance on the items that are listed. Consult your Caterpillar dealer for assistance.

To determine the reusability publications that are needed to inspect the engine, refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”.

The Guidelines For Reusable Parts and Salvage Operations is part of an established Caterpillar parts reusability program. These guidelines were developed in order to assist Caterpillar dealers and customers reduce costs by avoiding unnecessary expenditures for new parts. If the engine parts comply with the established inspection specifications, the parts can be reused.

The use of out-of-spec parts could result in unscheduled downtime and/or costly repairs. The use of out-of-spec parts can also contribute to increased fuel consumption and reduction of engine efficiency. New parts are not necessary if the old parts can be reused, repaired, or salvaged. Otherwise, the old parts can be replaced or exchanged.

Your Caterpillar dealer can provide the parts that are needed to rebuild the engine at the least possible cost.

Overhaul Programs

An economical way to obtain most of the parts that are needed for overhauls is to use Caterpillar remanufactured parts. Caterpillar remanufactured parts are available at a fraction of the cost of new parts. These parts have been rebuilt by Caterpillar and certified for use. The following components are examples of the remanufactured parts:

- Cylinder heads
- Oil Pumps

- Turbochargers
- Water pumps

Consult your Caterpillar dealer for details and for a list of the remanufactured parts that are available.

Your Caterpillar dealer may be offering a variety of overhaul options.

A Flat Rate Overhaul guarantees the maximum price that you will pay for an overhaul. Flat rate prices on preventive maintenance programs or major repair options are available from many servicing dealers for all Caterpillar Engines. Consult your Caterpillar dealer in order to schedule a before failure overhaul.

Overhaul Recommendation

Caterpillar recommends a scheduled overhaul in order to minimize downtime. A scheduled overhaul will provide the lowest cost and the greatest value. Schedule an overhaul with your Caterpillar dealer.

Overhaul programs vary between dealers. To obtain specific information about the types of overhaul programs and services, consult your Caterpillar dealer.

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Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

More frequent inspection and replacement of the starting motor may be required for the following conditions:

- Operation in harsh environments
- Applications that require frequent stops and starts, such as the operation of a fast ferry

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

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

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

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

Remove the air starting motors for inspection. Overhaul the air starting motors. Refer to the Service Manual or consult your Caterpillar dealer for instructions on removing and on overhauling the air starting motors.

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Trend Data - Record

SMCS Code: 1000-043

Records of engine performance are an important element of a maintenance program. The data on engine performance can help to predict problems with operation. Also, the data can provide information that is useful for achieving optimum operation.

Traditionally, data on engine performance might be recorded regularly. However, the data might not be reviewed until the occurrence of a problem. This method of monitoring engine operation has several disadvantages:

- The engine may not be providing optimum performance. This may not be noticed because the engine does not exhibit excessive changes in performance.
- Because a problem occurs, the engine may be in an alarm condition that requires a quick response.
- Repairs may cause more downtime.
- The cost of downtime is compounded by the cost of parts and labor for repairs.

The absence of an alarm condition does NOT guarantee normal operation. Not all parameters have alarms and/or shutdowns. Setpoints for alarms are outside of the normal ranges in order to avoid occasional nuisance warnings. An alarm indicates a serious condition that requires immediate attention. Service or repair is a reaction to an alarm condition.

A different approach is necessary in order to schedule service before an alarm condition occurs. **Monitor the trends of the engine's performance.** The following benefits can be realized:

- Reduction of engine performance will be noticed sooner.
- Problems can be predicted. This enables prevention of the problems. Service can be planned before an alarm condition occurs.
- Planning for downtime will also reduce downtime.
- The cost of parts and labor for service that is planned will be less than the cost of repairs that are not anticipated.

Monitoring the Trends of Engine Performance

For marine applications, the power demand can be difficult to determine. Consider the following factors for determining the power demand:

- For propulsion with a water jet or a fixed propeller, the theoretical power is approximately proportional to the cubed engine speed.
- Power demand at a given engine speed is dependent on several factors: loading of the vessel, weather, design of the hull, and other conditions.

To maintain a program for monitoring that is successful, several factors are important:

- Record the data regularly when the engine is operating at similar loads and speeds.
- Obtain accurate data.
- At regular intervals, review the data in a graphic format.
- Perform corrections before damage and/or downtime occurs.

Accurate data is provided by accurate instruments and proper use of the instruments. The gauges and the sensing devices must be in good condition. This is especially true for thermocouples. Establish a program for calibrating the instruments periodically. Avoid using infrared thermometers for obtaining data. Be sure to read the gauges properly. Accurate recording of the data is also important.

Use the following Steps to establish a program.

1. Establish a baseline for the engine parameters. The baseline is necessary in order to know the normal gauge readings. The new data will be compared to the baseline.
   - Use the data from the engine commissioning. The data is recorded for various loads. The data is recorded before any wear or deterioration takes place.
   - If there is no data from the engine commissioning, use data from the engine test cell. Understand that the data will not be specific to the site.
   - If data is not available from the engine commissioning or the engine test cell, calculate an average of the existing data.
   - Establish a new baseline after an overhaul.
2. Frequently record the new data during engine operation. For an example of a log to use, see this Operation and Maintenance Manual, “Hourly Performance Log” (Reference Information Section).

   Be aware that the readings of some parameters depend on the engine load. Record the data when the engine is operating at a high load. This increases the accuracy of the data. Also, any reduction in performance will be revealed sooner. A load of 75 to 100 percent is recommended.
   - For operations with a consistent load cycle, record the data at the same time for each day.
   - If the load can be controlled, set the load to the same amount for each reading.

   Some parameters that are NOT affected by the load ARE affected by the engine rpm. Obtain the readings for these parameters when the engine is operating at the same rpm.

   Some parameters are not affected by either the load or the rpm. See Table 27.

Table 27

Parameters of Engine Operation
Parameters That Depend On the Load
Aftercooler and oil cooler water temperature (outlet)
Cylinder pressure
Crankcase pressure
Exhaust manifold pressure
Exhaust manifold temperature
Exhaust port temperature
Inlet air restriction
Inlet air temperature
Inlet manifold air pressure (boost pressure) (1)
Inlet manifold air temperature (1)
Outlet temperature of the jacket water
Parameters That Depend On the RPM
Fuel filter differential pressure
Fuel pressure
Jacket water pressure
Lube oil pressure
Oil filter differential pressure
Parameters That Are Independent of the Load and RPM
Aftercooler and oil cooler water temperature (inlet)
Inlet temperature of the jacket water
Lube oil temperature

(1) This includes the air before the aftercooling and after the aftercooling.

Note: A gauge reading that is abnormal may indicate a problem with operation or a problem with the gauge.

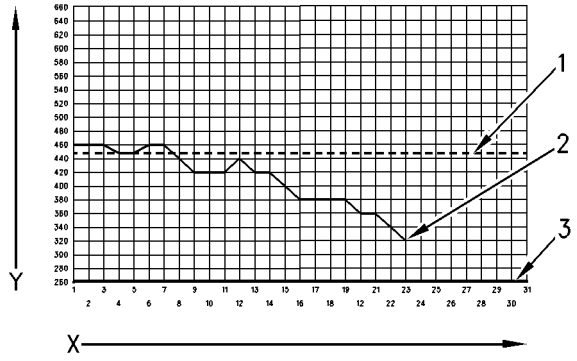

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Illustration 74

Example of a graph of engine oil pressure

(Y) Pressure in kPa
(X) Calendar days
(1) Baseline
(2) Operating pressure
(3) Setpoint (alarm)

3. Average the data for each day. Use a computer or graph paper in order to produce a graph of the data. Compare the new data to the baseline. This will help to reveal the trends of the engine performance.

Illustration 74 shows that the engine oil pressure was near baseline (1). Later, the operating pressure was approaching setpoint (3). The trend of operating pressure (2) indicated that the condition required investigation before activation of the alarm.

4. Compare the new data to the data from previous months. This comparison will be useful for scheduling reconditioning for the engine.

Monitoring the Trends of Oil Consumption

The consumption of lube oil depends on the following factors:

- Engine load
- Hours of operation
- Type of oil

Monitor the engine's oil consumption by calculating the Specific Oil Consumption on a daily basis. Be aware that the following conditions can produce misleading data on oil consumption:

- Improper operation of the lube oil centrifuge
- Inaccurate measurement of additions of oil
- Leaking of lube oil

- Overfilling of the oil sump

To measure additions of oil accurately, use a meter to monitor additions of oil at the engine. Also, check the total oil consumption against the delivery of oil.

Calculating Specific Oil Consumption

Use the equation that is in Table 28 in order to calculate the Specific Oil Consumption.

Table 28

Equation For Calculating the Specific Oil Consumption
$\frac{O \times D}{bkW\text{-}hr} = BSOC$
O is the liters of oil that have been consumed.
D is the density of the oil. The density is expressed in grams per liter.
bkW-hr is the kilowatt hours that have been produced during consumption of the oil.
BSOC is the brake specific oil consumption. This is expressed in grams per kilowatt hour.

To calculate the BSOC, the bkW-hr must be known. Table 29 is an example for calculating the bkW-hr. The data in the example assumes the following conditions:

- A meter was used to measure the fuel consumption of 1000 liters.
- The density of the fuel sample is 980 grams per liter.
- One kilowatt hour per 200 grams of fuel is the average estimate. This is based on Brake Specific Fuel Consumption (BSFC) for various engine loads and for various operating conditions.

Table 29

Example for the Calculation of Kilowatt Hours
$\frac{1000L}{1} \times \frac{980g}{L} \times \frac{bkW\text{-}hr}{200g} = 9{,}800\ bkW$

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Turbocharger - Inspect

SMCS Code: 1052-040

Periodic inspection and cleaning is recommended for the turbocharger compressor housing (inlet side).

Fouling of the compressor 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 could allow parts from the compressor wheel to enter an engine cylinder. This 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 clearances that are precise. The turbocharger cartridge must be balanced due to high rpm. Severe service applications can accelerate the wear of the components. Severe service applications may require more frequent inspections of the turbocharger.

Removal and Installation

For options regarding the removal and installation of the turbocharger, refer to Service Manual, RENR1335, “3618 Engine” or consult your Caterpillar dealer. For repair instructions, refer to Operation and Maintenance Manual, SEBU7642, “TPL 65 Turbocharger” or consult your Caterpillar dealer.

Cleaning and Inspecting

1. Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil.

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

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. Inspect the bore of the turbine housing for corrosion.

5. Clean the turbocharger housing with standard shop solvents and a soft bristle brush.

6. Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

i00528664

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, thoroughly inspect the engine compartment before starting the engine. Look for items such as leaks, loose bolts, loose connections and trash buildup. Make repairs, as needed.

- The guards must be in the proper place. Repair damaged guards or replace missing guards.

- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

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

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

- Ensure that cooling lines are properly clamped and 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 when the engine cools and the parts contract.

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

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

- Inspect the fuel system for leaks. Look for loose fuel line clamps.

- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.

- 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.

- Check the condition of the gauges. Replace any gauge that is damaged. Replace any gauge that can not be calibrated.

- Inspect the exhaust system for leaks. Inspect the gaskets and the exhaust bellows joint. If a leak is found, make repairs.

i02624237

Water Pump - Inspect

SMCS Code: 1361-040

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

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

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

i01906792

Water Temperature Regulator - Replace

SMCS Code: 1355-510

Replace the temperature regulators before the temperature regulators fail. This is a recommended preventive maintenance practice. Replacing the temperature regulators reduces the chances for unscheduled downtime.

NOTICE
Failure to replace the temperature regulators on a regularly scheduled basis could cause severe engine damage.

Never operate the engine without the temperature regulators installed.

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

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

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

A 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.

For the procedure to replace the temperature regulators, see the service information that is provided by the OEM of the temperature regulators.