

**SAFETY.CAT.COM™**

# **MAINTENANCE INTERVALS**

Operation and Maintenance  
Manual Excerpt



# Operation and Maintenance Manual

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## **G3500B Engines**

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GET1-Up (Engine)  
BGW1-Up (Engine)  
CEY1-Up (Engine)  
7EZ1-Up (Engine)

i01920691

# Maintenance Interval Schedule

**SMCS Code:** 1000; 4450; 7500

**Before performing any operation or maintenance procedures, ensure that the safety information, warnings, and instructions are read and understood.**

Before each consecutive interval is performed, all of the maintenance requirements from the previous interval must be performed. Failure to adhere to proper maintenance intervals may result in the degradation of the engine's performance and/or the accelerated wear of the engine's components.

**Note:** For information on generator maintenance, see the Operation and Maintenance Manual for the generator.

## When Required

|  |    |
|--|----|
| Cooling System Coolant Sample (Level 2) - Obtain ..... | 57 |
| Electrohydraulic System Oil Filter - Change .....      | 63 |
| Engine Air Cleaner Element - Replace .....             | 63 |
| Engine Oil Filter - Change .....                       | 69 |
| Fumes Disposal Filter Element - Replace .....          | 76 |
| Overhaul Considerations .....                          | 92 |
| Throttle Control Valve - Check .....                   | 94 |

## Daily

|   |    |
|---|----|
| Air Starting Motor Lubricator Oil Level - Check ....        | 51 |
| Air Tank Moisture and Sediment - Drain .....                | 51 |
| Control Panel - Inspect .....                               | 53 |
| Cooling System Coolant Level - Check .....                  | 56 |
| Driven Equipment - Inspect/Replace/Lubricate ...            | 61 |
| Electrohydraulic System - Inspect .....                     | 61 |
| Engine Air Cleaner Service Indicator - Inspect ....         | 66 |
| Engine Oil Level - Check .....                              | 71 |
| Fuel System Fuel Filter Differential Pressure - Check ..... | 76 |
| Fumes Disposal Filter Differential Pressure - Check .....   | 76 |
| Walk-Around Inspection .....                                | 97 |

## Initial 250 Service Hours

|  |    |
|--|----|
| Accumulator - Check .....                | 49 |
| Crankcase Blowby - Measure/Record .....  | 58 |
| Crankcase Pressure - Measure .....       | 59 |
| Cylinder Pressure - Measure/Record ..... | 60 |
| Engine Oil Sample - Obtain .....         | 72 |

## Initial 1000 Service Hours

|  |    |
|--|----|
| Cooling System Coolant Sample (Level 1) - Obtain ..... | 56 |
|--|----|

|   |    |
|---|----|
| Cooling System Supplemental Coolant Additive (SCA) - Test/Add ..... | 57 |
| Engine Speed/Timing Sensor - Clean/Inspect .....                    | 73 |
| Valve Stem Projection - Measure/Record .....                        | 96 |

## Every 1000 Service Hours

|  |    |
|--|----|
| Accumulator - Check .....                        | 49 |
| Aftercooler Condensation - Drain .....           | 50 |
| Alternator - Inspect .....                       | 51 |
| Belts - Inspect/Adjust/Replace .....             | 52 |
| Crankcase Pressure - Measure .....               | 59 |
| Crankshaft Vibration Damper - Inspect .....      | 59 |
| Engine Crankcase Breather - Clean .....          | 67 |
| Engine Oil - Change .....                        | 68 |
| Engine Oil Filter - Change .....                 | 69 |
| Engine Oil Sample - Obtain .....                 | 72 |
| Engine Valve Lash and Bridge - Adjust .....      | 74 |
| Exhaust Piping - Inspect .....                   | 75 |
| Gas Pressure Regulator Condensation - Drain .... | 77 |
| Hoses and Clamps - Inspect/Replace .....         | 77 |
| Ignition System Timing - Check/Adjust .....      | 85 |
| Inlet Air System - Inspect .....                 | 85 |
| Oxygen Sensor - Calibrate .....                  | 93 |

## Every 2000 Service Hours

|   |    |
|---|----|
| Cooling System Coolant Sample (Level 1) - Obtain .....              | 56 |
| Cooling System Supplemental Coolant Additive (SCA) - Test/Add ..... | 57 |
| Engine Speed/Timing Sensor - Clean/Inspect .....                    | 73 |

## Every 3000 Service Hours

|  |    |
|--|----|
| Ignition System Spark Plugs - Inspect/Adjust/Replace ..... | 79 |
| Ignition System Spark Plugs - Inspect/Replace ....         | 82 |

## Every 4000 Service Hours

|   |    |
|---|----|
| Air Starting Motor Lubricator Bowl - Clean .....  | 50 |
| Compressor Bypass - Check .....                   | 53 |
| Compressor Bypass - Check .....                   | 53 |
| Crankcase Blowby - Measure/Record .....           | 58 |
| Cylinder Pressure - Measure/Record .....          | 60 |
| Driven Equipment - Check .....                    | 61 |
| Electrohydraulic System Oil - Change .....        | 62 |
| Electrohydraulic System Oil Filter - Change ..... | 63 |
| Engine Mounts - Check .....                       | 67 |
| Engine Protective Devices - Check .....           | 72 |
| Exhaust Bypass - Inspect .....                    | 74 |
| Fuel Metering Valve - Check .....                 | 75 |
| Fuel Metering Valve Screen - Check .....          | 75 |
| Starting Motor - Inspect .....                    | 94 |
| Valve Stem Projection - Measure/Record .....      | 96 |
| Water Pump - Inspect .....                        | 98 |

## Every 8000 Service Hours

|  |    |
|--|----|
| Cooling System Coolant Sample (Level 2) - Obtain ..... | 57 |
|--|----|

|   |    |
|---|----|
| Fumes Disposal Filter Element - Replace ..... | 76 |
| Turbocharger - Inspect .....                  | 95 |
| Water Temperature Regulator - Replace .....   | 98 |

**Between 10 000 and 20 000 Service Hours**

|                          |    |
|--------------------------|----|
| Overhaul (Top End) ..... | 89 |
|--------------------------|----|

**Every 24 000 Service Hours or 3 Years**

|  |    |
|--|----|
| Cooling System Coolant (DEAC) - Change ..... | 54 |
|--|----|

**Between 30 000 and 60 000 Service Hours**

|                           |    |
|---------------------------|----|
| Overhaul (In-Frame) ..... | 86 |
|---------------------------|----|

**Between 50 000 and 100 000 Service Hours**

|                        |    |
|------------------------|----|
| Overhaul (Major) ..... | 87 |
|------------------------|----|

i01923134

## Accumulator - Check

SMCS Code: 1320

S/N: GET1-Up

Table 14

| Tools Needed  | Qty |
|---|-----|
| 175 - 5507 Nitrogen Charging Group  | 1   |
| 8T - 0862 Pressure Gauge (-100 to 500 kPa (-15 to 72 psi)) <sup>(1)</sup> | 1   |
| 8T - 0863 Pressure Gauge (0 to 250 kPa (0 to 36 psi)) <sup>(1)</sup>      | 1   |

<sup>(1)</sup> The procedure does not require two pressure gauges. Either pressure gauge may be used.

**Note:** Because the accumulator operates with a low pressure, a low pressure gauge is needed for this procedure.

Periodic measuring of the accumulator's pressure can help detect wear of the accumulator's seals.

If oil leaks past the piston's O-ring seal into the upper portion of the accumulator, the pressure in the upper portion will increase.

If nitrogen gas leaks past the piston's O-ring seal into the lower portion of the accumulator, the pressure in the lower portion will decrease. Low pressure can also be caused by nitrogen gas that leaks from the seals for the gas valve and/or for the end caps.

### Checking the Pressure

**Note:** The Tool Operating Manual, NEHS0742 is provided with the tool.

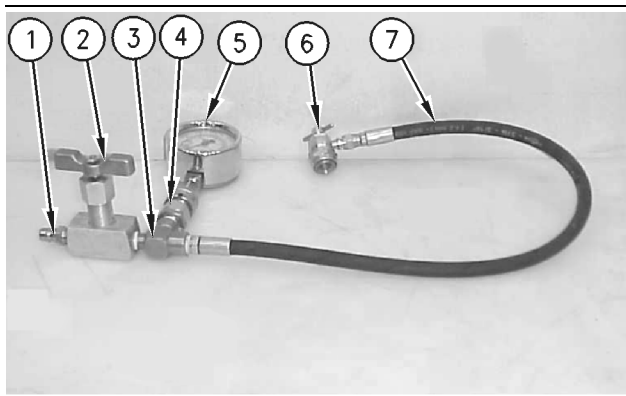


Illustration 24

g00995703

1. Assemble the following parts according to Tool Operating Manual, NEHS0742: nipple (1), needle valve (2), pipe tee (3), coupling (4), low pressure gauge (5), chuck (6), and hose (7). Make sure that needle valve (2) is closed.

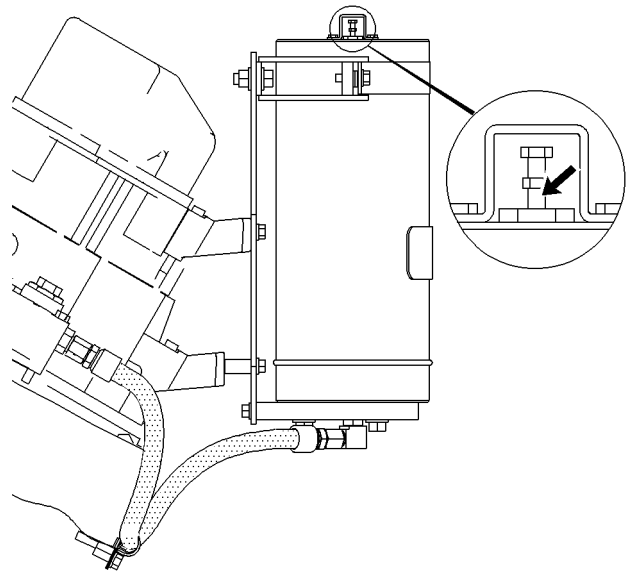


Illustration 25

g00995678

Gas valve

2. Remove the guard and the cap in order to access the gas valve.
3. Connect chuck (6) to the gas valve. Turn the chuck's handle in order to open the gas valve.
4. Wait until the low pressure gauge stabilizes. Read the gauge.

For the correct pressure, refer to the engine's Specifications manual.

If the pressure is correct, proceed to Step 5.

If the pressure is too low, refer to Systems Operation/Testing and Adjusting, RENR2268, "Charging the Accumulator".

5. Turn the chuck's handle in order to close the gas valve. Open needle valve (2) in order to purge the nitrogen gas from the tooling.
6. Remove the tooling from the gas valve. Install the cap and the guard over the gas valve.

i01919357

## Aftercooler Condensation - Drain

**SMCS Code:** 1063

Condensation can form in the housing of the aftercooler. A drain fitting is provided for draining the condensation.

**Note:** An automatic drain is available for use with 32° C (90 °F) separate circuit aftercoolers. Consult your Caterpillar dealer for details.

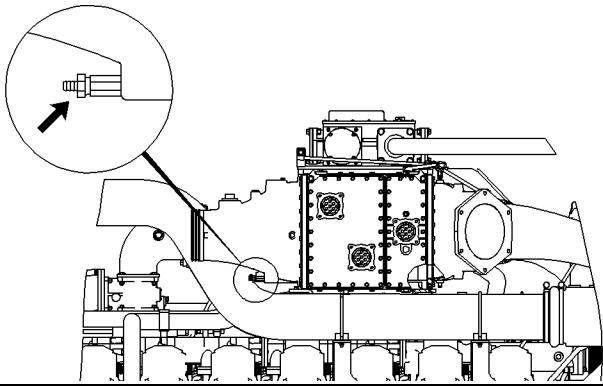


Illustration 26

g00998902

On some applications, the drain fitting is connected to the aftercooler by an elbow. Open the drain fitting. Drain the moisture into a suitable container. Close the drain fitting.

i01924136

## 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.

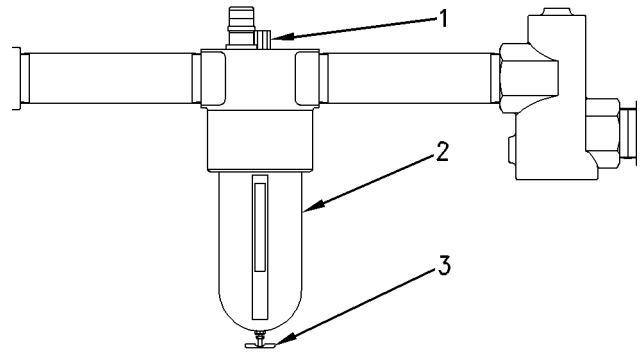


Illustration 27

g00745554

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

Dispose of all fluids according to local regulations and mandates.

- 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.
- 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.

i01924142

## 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.

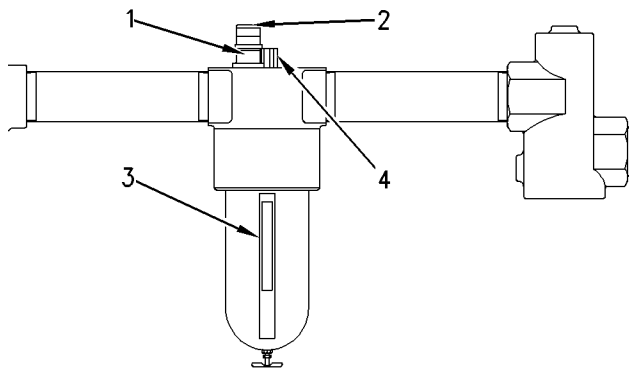


Illustration 28

g00745561

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 "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.

i02084374

## Alternator - Inspect

SMCS Code: 1405-040

Inspect the alternator for the following conditions:

- Proper connections

- Clean ports for cooling airflow
- Proper charging of the battery

Observe the ammeter during engine operation in order to ensure proper battery performance and/or proper performance of the electrical system.

Make repairs, if necessary. See the Service Manual for service procedures. Consult your Caterpillar dealer for assistance.

i02154849

## Belts - Inspect/Adjust/Replace

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

### Inspection

Inspect the alternator belt and the fan drive belts for wear and for cracking. Replace the belts if the belts are not in good condition.

Check the belt tension according to the information in the Service Manual, "Specifications".

Slippage of loose belts can reduce the efficiency of the driven components. Vibration of loose belts can cause unnecessary wear on the following components:

- Belts
- Pulleys
- Bearings

If the belts are too tight, unnecessary stress is placed on the components. This reduces the service life of the components.

## Adjusting the Alternator Belt

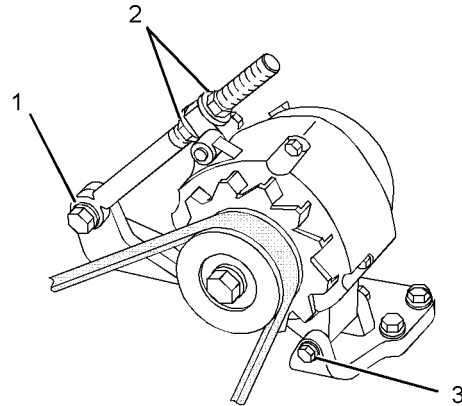


Illustration 29

g01092641

- (1) Mounting bolt
- (2) Adjusting nuts
- (3) Mounting bolt

1. Remove the drive belt guard.
2. Loosen mounting bolt (1), adjusting nuts (2) and mounting bolt (3).
3. Turn adjusting nuts (2) in order to increase or decrease the drive belt tension.
4. Tighten adjusting nuts (2). Tighten mounting bolt (3). Tighten mounting bolt (1). For the proper torque, see the Service Manual, "Specifications" module.
5. Reinstall the drive belt guard.

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

## Adjusting the Fan Drive Belt

1. Loosen the mounting bolt for the pulley.
2. Loosen the adjusting nut for the pulley.
3. Move the pulley in order to adjust the belt tension.
4. Tighten the adjusting nut.
5. Tighten the mounting bolt.



## Replacement

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

i01948109

## Compressor Bypass - Check

**SMCS Code:** 1050-535

**S/N:** BGW1-Up

**S/N:** CEY1-Up

**S/N:** 7EZ1-Up

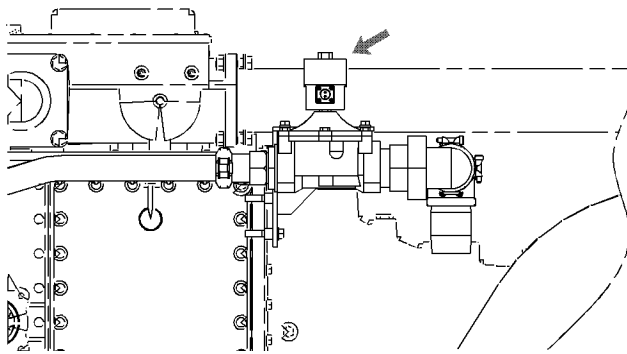


Illustration 30

g01014067

Check for leaks. If necessary, remove the valve according to the instructions in the Disassembly and Assembly manual. Ensure that the valve operates properly.

Inspect the gaskets for wear or damage. If necessary, replace the gaskets. Reinstall the valve according to the instructions in the Disassembly and Assembly manual.

i02136217

## Compressor Bypass - Check

**SMCS Code:** 1050-535

**S/N:** GET1-Up

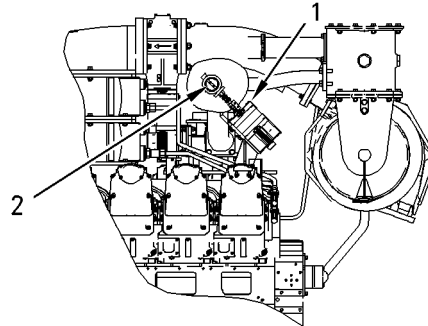


Illustration 31

g01007433

Check for leaks. If necessary, remove the actuator according to the instructions in the Disassembly and Assembly manual. Inspect the throat for wear marks. Check for free movement of the butterfly valve. If necessary, replace the valve.

Inspect the gaskets for wear or damage. If necessary, replace the gaskets. Reinstall the actuator according to the instructions in the Disassembly and Assembly manual.

i01762721

## Control Panel - Inspect

**SMCS Code:** 4490-040; 7451-040

Inspect the condition of the panel. If a component is damaged, ensure that the component is repaired or that the component is replaced. If equipped, ensure that the electronic displays are operating properly.

Inspect the wiring for good condition. Ensure that the wiring connections are secure.

## Record the Data and Review the Data

If equipped, check the gauges and check the indicators frequently 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 with the gauge.

i02064876

## Cooling System Coolant (DEAC) - 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.
- The oil 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.

## Draining the Cooling System

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

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

### 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.

## Draining the Jacket Water

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

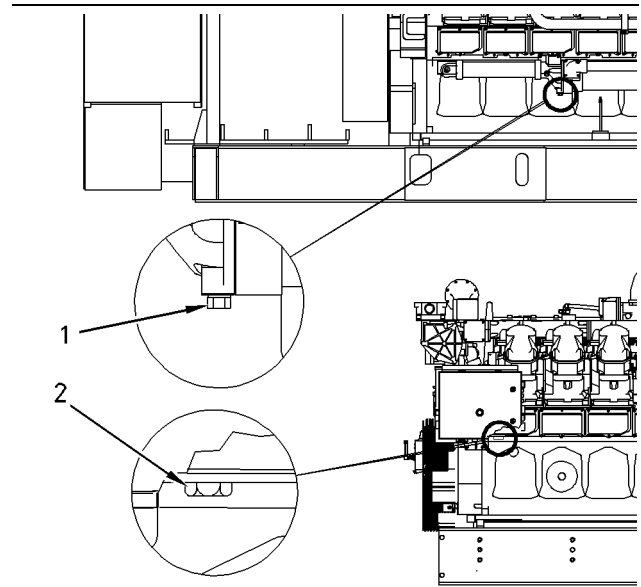


Illustration 32

g00760198

Locations of the drain plugs

- (1) Oil cooler
- (2) Cylinder block

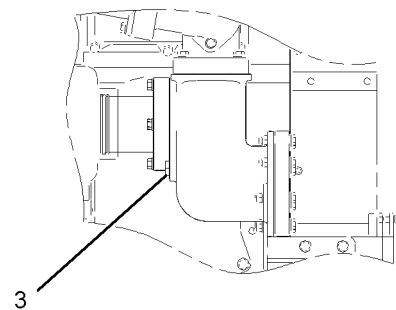


Illustration 33

g01014186

- (3) Drain plug in the elbow before the water pump

**Note:** If the engine is equipped with a jacket water heater, a water line will be installed in the location of drain plug (2).

2. Open the cooling system drain valves (if equipped). If the cooling system is not equipped with drain valves, remove drain plugs (1), (2), and (3).

Drain the coolant from the bottom of the jacket water heater (if equipped).

## Draining the Separate Circuit

1. Remove the cooling system filler cap.
2. Drain the water from the heat exchanger or the radiator.

## Clean the Cooling System

1. After the cooling system has been drained, flush the cooling system with clean water in order to remove any debris.
2. Close the cooling system drain valves (if equipped). Clean the drain plugs and install the 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 54 °C (129 °F).
5. Stop the engine and allow the engine to cool. For the jacket water and the separate circuit, 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 drain plugs. Allow the cleaning solution to drain.

---

### 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.

---

6. Flush the cooling system with clean water until the water that drains is clean. Close the cooling system drain valves (if equipped). Clean the drain plugs and install the 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. After the cooling system has been drained, flush the cooling system with clean water in order to remove any debris.

2. Close the cooling system drain valves (if equipped). Clean the drain plugs and install the drain plugs.
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 54 °C (129 °F).
5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the cooling system drain valves (if equipped) or remove the drain plugs. Allow the cleaning solution to drain.

---

### 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.

---

6. Flush the cooling system with clean water until the water that drains is clean. Close the cooling system drain valves (if equipped). Clean the drain plugs and install the 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.

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**Note:** For information about the proper coolant to use, and for the capacity of the cooling system, refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" (Maintenance Section).

1. Fill the cooling system with coolant/antifreeze. Do not install the cooling system filler cap yet.
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.
5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i02017615

## 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.

### NOTICE

Overfilling the overflow tank (if equipped) will result in damage to the cooling system.

If the cooling system has an overflow tank, maintain the coolant level in the tank below 1/2 full in order to avoid damage to the cooling system.

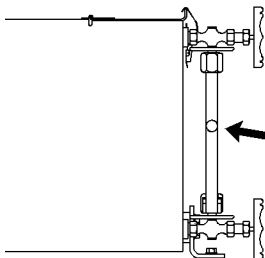


Illustration 34

g00760290

Normal position of the coolant in the sight gauge during rated operation

Observe the coolant level in the sight gauge (if equipped). When the engine is running at normal operating temperature, the coolant should be in the upper half of the sight gauge. If the coolant level is low, add the proper coolant mixture.

## Add Coolant

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

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.

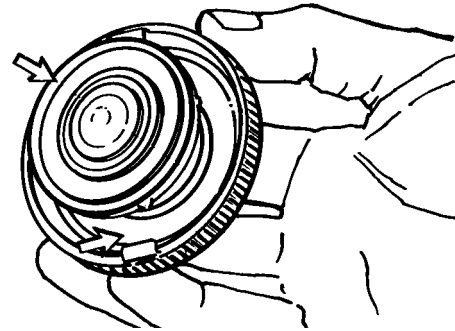


Illustration 35

g00103639

Filler cap 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.

i02064894

## 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.

i02064898

For conventional heavy-duty coolant/antifreeze, check the concentration of supplemental coolant additive (SCA) regularly. The concentration of SCA can be checked with an S-O-S coolant analysis (Level 1).

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.
- Keep the unused sampling bottles stored in plastic bags.
- Keep the lids on empty sampling bottles until you are ready to collect the sample.
- Complete the information on the label for the sampling bottle before you begin to take the samples.
- Obtain coolant samples directly from the coolant sample port. You should not obtain the samples from any other location.
- In order to avoid contamination, immediately place the sample in the tube that is provided for mailing.

Submit the sample for Level 1 analysis.

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

For additional information about coolant analysis, see the Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel and Coolant Recommendations" or consult your Caterpillar dealer.

## 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, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations" or consult your Caterpillar dealer.

i02017557

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

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

### WARNING

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

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

## Test the Concentration of the SCA Coolant/Antifreeze and SCA

### NOTICE

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

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

## Water and SCA

### NOTICE

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

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Use the instructions that follow:

1. Fill the syringe to the "1.0 ml" mark with the coolant.
2. Dispense the 1.0 mL coolant sample from the syringe into the empty mixing bottle.
3. Add tap water to the mixing bottle in order to bring the level up to the "10 ml" mark. Place the cap on the bottle and shake the bottle.
4. Add 2 to 3 drops of the "NITRITE INDICATOR SOLUTION B" to the mixing bottle. Move the bottle in a circular motion in order to mix the solution.
5. Add 1 drop of "NITRITE TEST SOLUTION A" to the mixing bottle. Move the bottle in a circular motion in order to mix the solution.
6. Repeat 5 until the solution changes color from red to light gray, green, or blue. Record the number of drops of "NITRITE TEST SOLUTION A" that were required to cause the color change.
7. Use Table 15 to interpret the results.

Table 15

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

## Add the SCA, If Necessary

### WARNING

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

1. Remove the cooling system filler cap slowly.

**Note:** Always dispose of fluids according to local regulations.

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

### NOTICE

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

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

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

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

i01935045

## Crankcase Blowby - Measure/Record

**SMCS Code:** 1317

Measure the crankcase blowby of new engines. Record the data. Continue to periodically measure the blowby. Comparing the recorded data to the new data provides information about the condition of the engines.

i01601829

**Note:** Crankcase blowby is one of the three factors that help to determine the in-frame overhaul interval. For more information, see this Operation and Maintenance manual, “Overhaul (In-Frame)” topic.

After a new engine is used for a short time, the blowby can decrease as the piston rings are seated. The blowby will gradually increase as the following components show wear:

- Piston rings
- Cylinder liners

**Note:** A problem with the piston rings causes the oil to deteriorate rapidly. Information regarding the condition of the piston rings can be obtained from the measurement of the blowby and the results of oil analysis.

The blowby of a worn engine may exceed the blowby of a new engine by two times or more.

A sudden increase in blowby could indicate a broken piston ring. The following conditions are other potential sources of blowby:

- Worn valve guides
- A turbocharger seal that leaks

A rebuilt engine can have a high blowby due to the following factors:

- The piston rings are not seated properly.
- Worn parts such as valve guides were not replaced.

Excessive blowby may indicate the need for an overhaul. By keeping a record of the results, a gradual increase in the amount of the blowby will be noted until the amount has become excessive.

To measure the blowby, use the 1U-8860 Large Engine Blowby Pickup Group with the 8T-2701 Blowby Indicator. For instructions, see Special Instruction, SEHS8984, “Using the 1U-8860 Large Engine Blowby Pickup Group” and Special Instruction, SEHS8712, “Using the 8T-2700 Blowby/Air Flow Indicator”.

For assistance, consult your Caterpillar dealer.

## Crankcase Pressure - Measure (Engines with Fumes Disposal Filters)

**SMCS Code:** 1074

Measure the crankcase pressure during normal operation.

With a fumes disposal filter that is properly installed, the crankcase pressure will be within 0.25 kPa (1 inch of H<sub>2</sub>O) of the atmospheric pressure.

i01949731

## 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 is due to excessive torsional vibration. Monitor the temperature of the damper during operation.

The 8T-2821 Temperature Indicator or the 8T-2822 Temperature Indicator are recommended for monitoring the temperature of the damper. Evenly space four of the adhesive indicators around the outer diameter of the damper.

**Note:** If you use an infrared thermometer to monitor the temperature of the damper, use the thermometer during operation with similar loads and speeds. Keep a record of the data. If the temperature begins to rise, reduce the interval for inspecting the damper.

If the temperature of the damper reaches 110 °C (230 °F), consult your Caterpillar dealer.

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

If a fluid leak is found, repair the damper or replace the damper. The fluid in the damper is silicone. Silicone has the following characteristics: transparent, viscous, smooth, and sticky.

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.
- An analysis of the oil has revealed that the front bearing of the crankshaft is badly worn.
- There is a large amount of gear train wear that is not caused by a lack of oil.

## Removal and Installation

Refer to the Service Manual, "Disassembly and Assembly" or consult your Caterpillar dealer for information about damper replacement.

i01664707

## Cylinder Pressure - Measure/Record

**SMCS Code:** 1223-082-CC; 1223; 7450-082

Measure the cylinder pressure of new engines. Record the data. Continue to periodically measure the cylinder pressure. Comparing the recorded data to the new data provides information about the condition of the engine.

Cylinder pressure can be measured during inspection of the spark plugs. Use the following guidelines for checking the cylinder pressure:

- Remove all of the spark plugs.
- Fully open the throttle plate.
- Minimize the cranking time to 3 or 4 revolutions. This will enable a maximum consistent cranking speed for the check. Also, the battery power will be conserved.

A loss of cylinder pressure or a change of pressure in one or more cylinders may indicate the following conditions. These conditions may indicate a problem with lubrication:

- Excessive deposits
- Guttering of valves
- A broken valve
- A piston ring that sticks

- A broken piston ring
- Worn piston rings
- Worn cylinder liners

If the cylinder pressure has risen by one or more compression ratios, the engine needs a top end overhaul in order to remove deposits. Failure to remove the deposits will increase the chance for detonation. Severe guttering of the valves will occur.

To measure the cylinder pressure, use the 193-5859 Cylinder Pressure Gauge Gp. Follow the procedure in the Special Instruction, NEHS0798 that is included with the gauge group. Record the pressure for each cylinder. Use the Operation and Maintenance Manual, "Valve Data Sheet" (Reference Materials Section).

Illustration 36 is a graph of typical cylinder pressures for engines with different compression ratios.

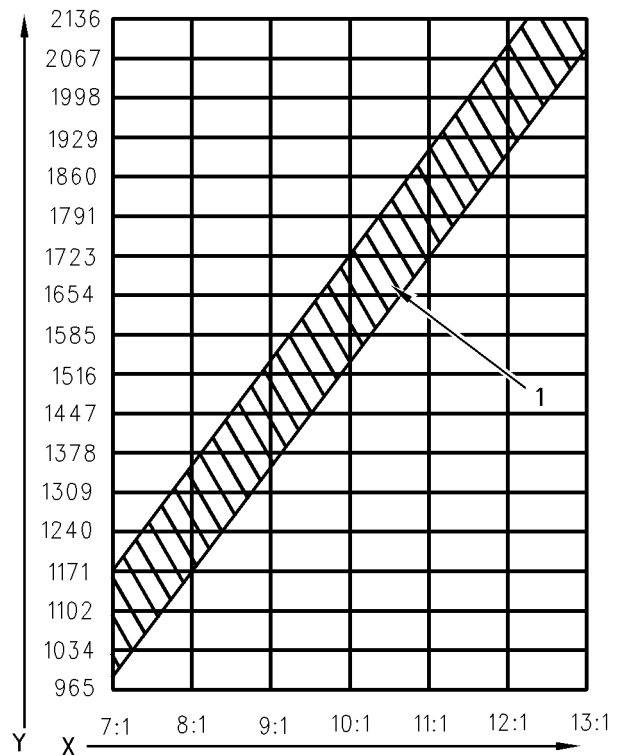


Illustration 36

g00828960

(Y) Cylinder pressure in kPa  
(X) Compression ratio  
(1) Normal range for cylinder pressure



i00449093

## 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 instructions that are provided by the following manufacturers:

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

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

i01619721

## Electrohydraulic System - Inspect

**SMCS Code:** 1716-040

**S/N:** BGW1-Up

**S/N:** CEY1-Up

**S/N:** 7EZ1-Up

Inspect the conditions of these items for the electrohydraulic system:

- Oil level
- Filter indicator
- Hoses, lines, connections, and components

## Check the Oil Level

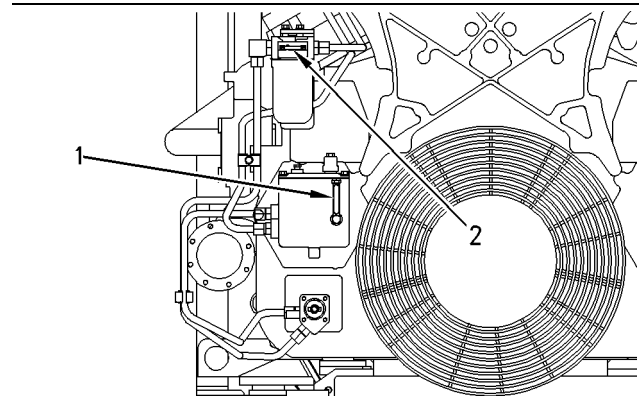


Illustration 37

g00760558

- (1) Sight gauge  
(2) Indicator

### 1. Check the oil level in sight gauge (1).

The oil should be between the “ADD” and “FULL” marks on the tank.

**Note:** For the proper oil to use, refer to this Operation and Maintenance Manual, “Hydraulic Oil” topic (Maintenance Section).

### 2. If necessary, remove the filler cap. Pour the correct oil into the oil filler.

### 3. Clean the filler cap. Install the filler cap.

## Inspect the Filter Indicator

A plugged filter will have excessive differential pressure. The pressure will cause indicator (2) to enter the red zone.

Inspect the indicator. If the indicator is in the red zone, change the filter. For instructions, refer to this Operation and Maintenance Manual, "Electrohydraulic System Oil Filter - Change" topic (Maintenance Section).

## Inspect the Lines, Connections, and Components

### WARNING

The linkage can move and form a pinch point which can cause personal injury. Keep hands away from the linkage.

Inspect the hoses and lines for wear and leaks. Ensure that the hoses and lines are properly clamped. Inspect the connections for leaks. Ensure that the connections are secure.

Inspect the following items for leaks and good condition:

- Actuator
- Pressure relief valve
- Pump

Make repairs, if necessary.

## Electrohydraulic System Oil - Change

**SMCS Code:** 1716-510-OC

**S/N:** BGW1-Up

**S/N:** CEY1-Up

**S/N:** 7EZ1-Up

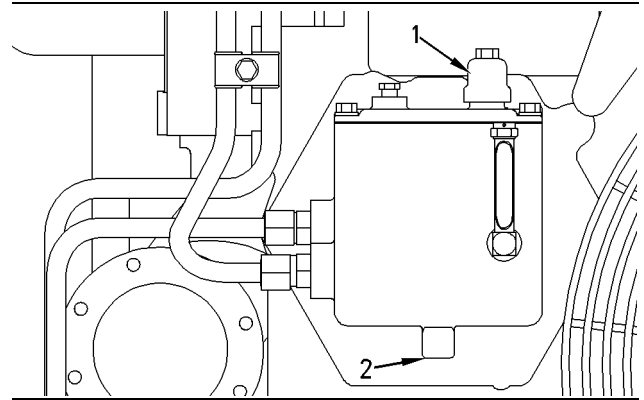


Illustration 38

g00760543

- (1) Filler cap  
(2) Drain plug

**Note:** Some applications now have a drain valve instead of the plug.

1. Remove filler cap (1).

### NOTICE

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

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

2. Determine whether your application has a drain plug or a drain valve.
  - a. If your application has a drain plug, place a suitable container under plug (2). Remove the plug. After the oil has drained, clean the plug. Install the plug.

- b. If your application has a drain valve, install a suitable hose over the connector. Place a suitable container under the other end of the hose. Open the drain valve. After the oil has drained, close the valve.

**Note:** For the proper oil to use, refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section).

3. Pour the proper oil into the oil filler. Clean the oil filler cap. Install the oil filler cap.
4. Clean up any oil that may have spilled.

## Electrohydraulic System Oil Filter - Change

**SMCS Code:** 1716-510-FI

**S/N:** BGW1-Up

**S/N:** CEY1-Up

**S/N:** 7EZ1-Up

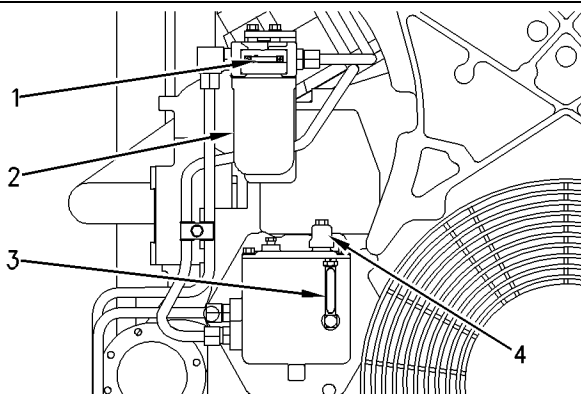


Illustration 39

g00760549

- (1) Indicator
- (2) Filter
- (3) Sight gauge
- (4) Filler cap

A plugged filter will have excessive differential pressure. The pressure will cause indicator (1) to enter the red zone. If the indicator is in the red zone, change the filter.

1. Remove filter (2) with a 1U-8760 Chain Wrench.
2. Clean the sealing surface of the filter mounting base. Ensure that all of the old filter gasket is removed.

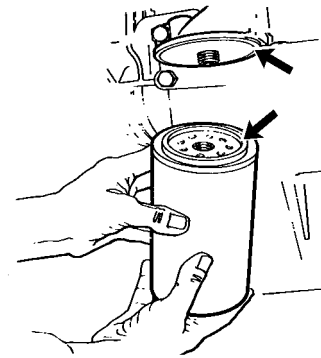


Illustration 40

g00103713

Typical filter mounting base and gasket

**Note:** For the proper oil to use, refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section).

3. Apply clean oil to the new filter gasket.
4. Install the filter by hand. Tighten the filter until the gasket contacts the mounting base. Tighten the filter according to the instructions that are shown on the filter. Do not overtighten the filter.
5. Start the engine. Check the oil level in sight gauge (3). The oil should be between the "ADD" and "FULL" marks on the tank. If necessary, remove filler cap (4). Pour the correct oil into the oil filler. Clean the filler cap. Install the filler cap.

i01749609

## Engine Air Cleaner Element - Replace

**SMCS Code:** 1051-510; 1054-510

### NOTICE

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

### NOTICE

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

## Servicing the Air Cleaner Elements

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

The air cleaner may be mounted high above the engine. If necessary, use a ladder or a platform to reach the air cleaner.

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

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

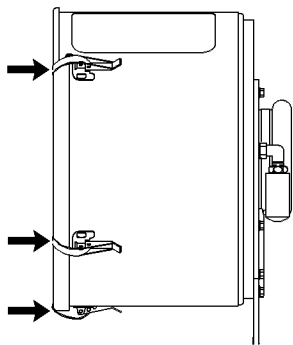


Illustration 41  
Fasteners for the air cleaner cover

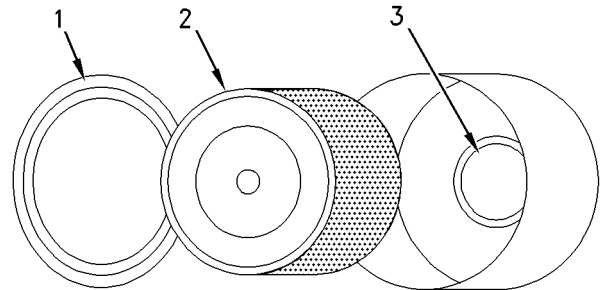


Illustration 42

g00781084

- (1) Cover
- (2) Element
- (3) Air inlet

1. Release the fasteners for cover (1).
2. Remove the cover and element (2).
3. Cover air inlet (3) with tape in order to keep dirt out.
4. Clean the inside of the cover and the body with a clean, dry cloth.
5. Remove the tape for the air inlet. Install a new element or a clean element.
6. Install the cover.
7. If necessary, reset the air cleaner service indicator.

## Cleaning the Primary Air Cleaner Elements

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

Use clean elements while dirty elements are being cleaned.

### NOTICE

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

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

Air cleaner elements can be cleaned with pressurized air and with a vacuum.

### Pressurized Air

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

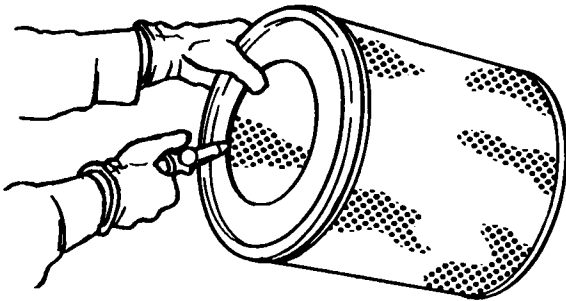


Illustration 43

g00281692

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

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

**Note:** Refer to “Inspecting the Primary Air Cleaner Elements”.

### Vacuum Cleaning

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

**Note:** Refer to “Inspecting the Primary Air Cleaner Elements”.

### Inspecting the Primary Air Cleaner Elements

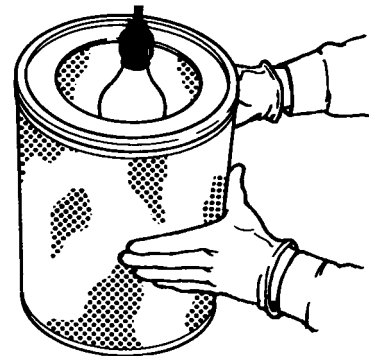


Illustration 44

g00281693

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

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

### Storing Primary Air Cleaner Elements

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

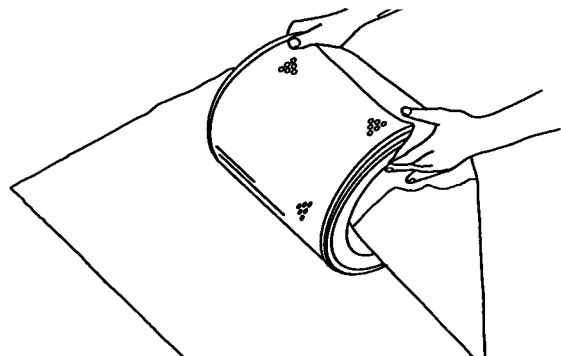


Illustration 45

g00281694

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

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

- Date of cleaning
- Number of cleanings

Store the container in a dry location.

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

i01665086

## Engine Air Cleaner Service Indicator - Inspect

**SMCS Code:** 7452-040

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

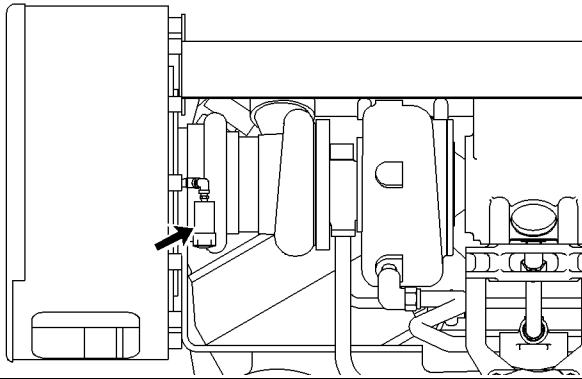


Illustration 46  
Service indicator

g00760342

Some engines may be equipped with a different service indicator.

Observe the service indicator. Clean the air cleaner element or replace the element when any of the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.
- The air restriction reaches 3.75 kPa (15 inch of H<sub>2</sub>O).

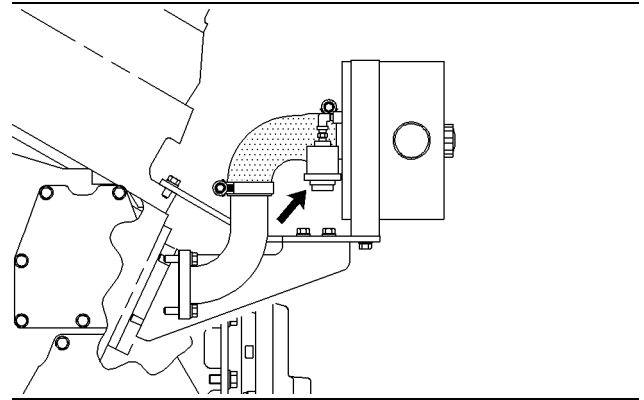


Illustration 47

g00760341

Service indicator on an air cleaner for crankcase ventilation

Some engines are equipped with an air cleaner for crankcase ventilation. The air cleaner is mounted on a camshaft cover. Clean the air cleaner element or replace the element when any of the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.
- The air restriction reaches 0.25 kPa (1 inch of H<sub>2</sub>O).
- The air cleaner is saturated with oil.

Inspect the service indicator daily for cracks, holes, or loose fittings. If any of these conditions are present, replace the service indicator.

### Test the Service Indicator

Service indicators are important instruments.

- Apply vacuum (suction) to the service indicator.
- Reset the service indicator.

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

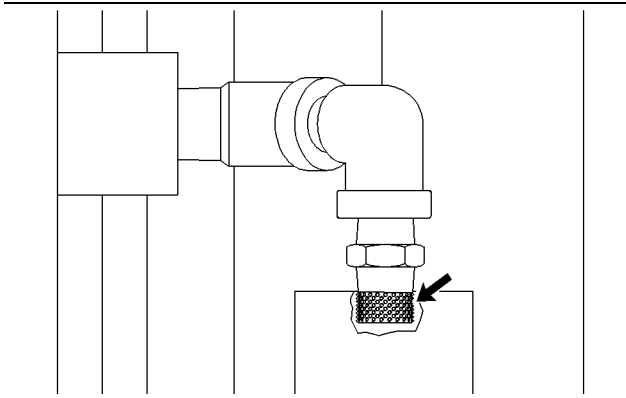


Illustration 48  
Porous filter  
g00351792

A porous filter is part of the fitting that is used for mounting of the service indicator. Inspect the filter for cleanliness. Clean the filter, if necessary. Use compressed air or a clean, nonflammable solvent.

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

Replace the service indicator annually regardless of the operating conditions.

i01949781

## Engine Crankcase Breather - Clean

**SMCS Code:** 1317-070

Clean the crankcase breather regularly in order to prevent excessive crankcase pressure that will damage the engine's seals.

Perform this maintenance when the engine is stopped.

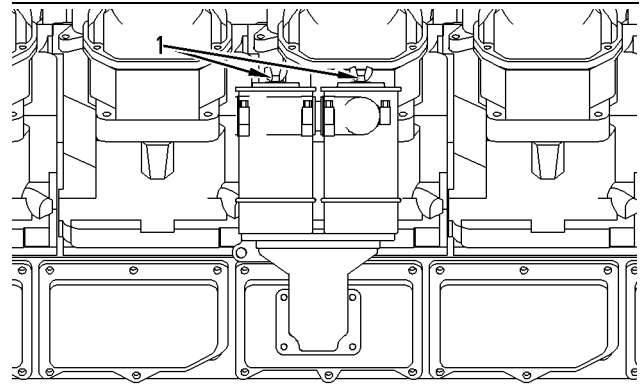


Illustration 49  
Crankcase breather  
(1) Wing nuts  
g00760351

1. Remove wing nuts (1) and the covers.
2. Remove the elements and discard the elements.
3. Clean the inside of the breathers' bodies and the covers. Inspect the covers' gaskets for good condition.
4. Install new elements.
5. Install the covers with wing nuts (1).

i02017664

## Engine Mounts - Check

**SMCS Code:** 1152-535

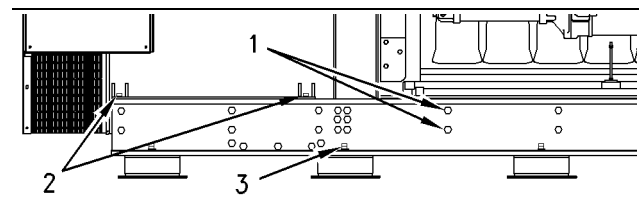


Illustration 50  
(1) Mounting bolts for the engine  
(2) Mounting bolts for the generator  
(3) Levelling bolts for the isolators  
g00736591

Misalignment of the engine and the driven equipment will cause extensive damage. Excessive vibration can lead to misalignment. Excessive vibration of the engine and the driven equipment can be caused by the following conditions:

- Improper mounting
- Loose bolts
- Deterioration of the isolators

Ensure that the mounting bolts are tightened to the proper torque. For standard torques, see Specifications, SENR3130, "Torque Specifications".

Ensure that the isolators are free of oil and contamination. Inspect the isolators for deterioration. Ensure that the bolts for the isolators are tightened to the proper torque.

Replace any isolator that shows deterioration. For more information, see the literature that is provided by the OEM of the isolators. Also see the Application and Installation Guide for the engine. Consult your Caterpillar dealer for assistance.

i02017618

## Engine Oil - Change

**SMCS Code:** 1348-044; 1348

### **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, immediately after the engine is stopped. 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.

**Note:** Drain the oil into a suitable container. Dispose of fluids according to local regulations.

2. Drain the oil by using one of the following methods. Use the method that corresponds to the equipment on the engine.

**Note:** If a suction device is used in order to remove the oil from the oil pan, ensure that the suction device is clean. This will prevent dirt from entering into the oil pan. Be careful not to strike the engine oil suction tubes or the piston cooling jets.

- a. If the engine has an oil drain valve, open the valve in order to drain the oil. After the oil has drained, close the valve.
- b. If the engine has a pump for removing dirty oil, connect a hose to the outlet of the pump. Place the hose in a suitable container. Open the valve for the drain line. Operate the pump until the crankcase is empty. Close the valve to the drain line. Disconnect the hose.
- c. If the oil drain valve has a "quick connect" coupling, attach the coupling. Open the drain valve in order to drain the crankcase. After the oil has drained, close the drain valve. Disconnect the coupling.
- d. If the engine does not have a drain valve or a pump, remove an oil drain plug. Allow the oil to drain. After the oil has drained, clean the drain plug and clean the fitting for the drain plug. Install the drain plug. Tighten the drain plug to  $145 \pm 15 \text{ N}\cdot\text{m}$  ( $105 \pm 10 \text{ lb ft}$ ).

**Note:** Ensure that the dirty oil is thoroughly drained from the pan. Caterpillar recommends a thorough cleaning of the oil pan with a vacuum and with rags in order to completely remove all of the old oil. This will help prevent inaccurate oil analysis results and/or shortened life of the oil.

3. Replace the engine oil filter elements before filling the crankcase with new oil.
  - a. For the procedure to change the engine oil filters, refer to the Operation and Maintenance Manual, "Engine Oil Filter - Change" topic (Maintenance Section).



101453731

#### NOTICE

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

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

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

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

**Note:** For the appropriate oil to use, and for the amount of oil to use, refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" article (Maintenance Section).

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

#### NOTICE

To prevent crankshaft damage and to prevent bearing damage, manually operate the prelube pump or crank the engine with the fuel supply line closed for 15 to 30 seconds. This will ensure that all of the oil filters are filled with oil before the engine is started.

5. Close the fuel supply line. Crank the engine until the oil pressure gauge indicates 70 kPa (10 psi). Open the fuel supply line. Allow the starting motor to cool for two minutes before cranking again.
6. Follow this Operation and Maintenance Manual, "Starting The Engine" procedure (Operation Section). Operate the engine at low idle for two minutes. This will ensure that the lubrication system and the oil filters are filled with oil. Inspect the engine for oil leaks. Ensure that the oil level is between the "ADD" and the "FULL" marks on the "LOW IDLE" side of the oil level gauge.
7. Stop the engine and allow the oil to drain back into the sump for a minimum of ten minutes.
8. Remove the oil level gauge and check the oil level. Maintain the oil level between the "ADD" and the "FULL" marks on the "ENGINE STOPPED" side of the oil level gauge.

## Engine Oil Filter - Change

**SMCS Code:** 1308-510; 1308

Replace the engine oil filters when any of the following conditions are met:

- Every oil change
- The engine oil filter differential pressure reaches 100 kPa (15 psi).
- The engine oil filters have been used for 1000 operating hours.

Service tools are available to aid in the service of oil 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 Engine Oil Filters With the Engine Stopped

#### 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 has been drained.

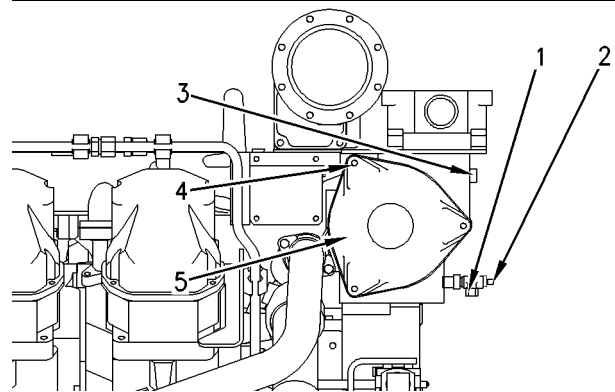


Illustration 51

g00760383

- (1) Drain
- (2) Drain valve
- (3) Plug
- (4) Bolts
- (5) Cover

1. Connect a hose to drain (1). Place the other end of the hose into a suitable container in order to collect the oil.
2. Open drain valve (2). Remove plug (3). Allow the oil to drain. Clean the plug and install the plug. Close the drain valve. Remove the hose from the 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 (5) is removed. Prepare to catch the oil in a suitable container. Clean up any spilled oil with absorbent pillows or towels. DO NOT use absorbent particles to clean up the oil.

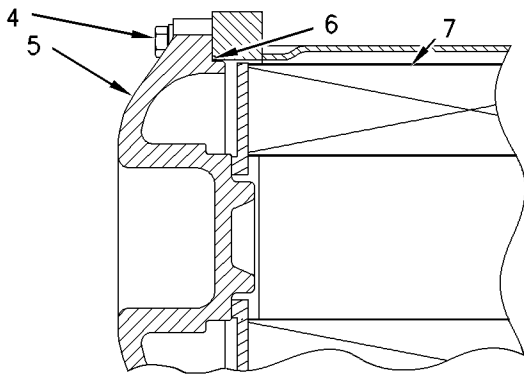


Illustration 52

g00760382

Section view

- (4) Bolt
- (5) Cover
- (6) O-ring seal
- (7) Oil filter element

3. Remove Bolts (4) and the washers in order to remove cover (5) and O-ring seal (6). Remove oil filter elements (7).
4. Clean cover (5), O-ring seal (6), and the inside of the oil filter housing.

#### NOTICE

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

5. Ensure that the new oil filter elements are in good condition. Install the new oil filter elements.
6. Inspect O-ring seal (6). Ensure that the surfaces for the O-ring seal are clean. Install a new O-ring seal if the old O-ring seal is damaged or deteriorated.

7. Install cover (5) and O-ring seal (6). Ensure that the cover's retainer is properly seated.
8. Start the engine. Check for oil leaks.
9. Check the oil level on the "LOW IDLE" side of the oil level gauge. Maintain the oil level between the "ADD" and "FULL" marks on the "LOW IDLE" side of oil level gauge.

## Replacing the Engine Oil 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.**

If the engine is equipped with duplex oil filters, the engine oil filter elements can be changed while the engine is operation. This is useful if the oil filter elements require more frequent replacement than the engine oil.

1. Move the control valve to the "AUX RUN" position in order to change the main oil filter elements. Move the selector valve to the "MAIN RUN" position in order to change the auxiliary oil filter elements.
2. Allow the oil pressure gauge for the oil filter that is being changed to reach a "ZERO" pressure reading.
3. Perform Step 1 through Step 7 of "Replacing the Engine Oil Filters With the Engine Stopped".
4. Open the "FILL" valve for a minimum of five minutes in order to fill the new oil filter elements.
5. Close the "FILL" valve. Rotate the control valve to the "RUN" position for the oil filter that was serviced.

## Inspect the Used Oil Filter Elements

Cut the used oil filter element open with a utility knife. 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 the cast iron parts of the engine. Nonferrous metals may indicate wear on the aluminum parts, the brass parts, or the bronze parts of the engine. Parts that may be affected include the following components: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

Pieces of aluminum may indicate problems with the bearings of the front gear train or the rear gear train. If aluminum is found inspect the vibration damper and the idler gear bearings.

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.

i02017693

## Engine Oil Level - Check

**SMCS Code:** 1348-535-FLV

The most accurate check of the engine oil level is obtained when the engine is stopped.

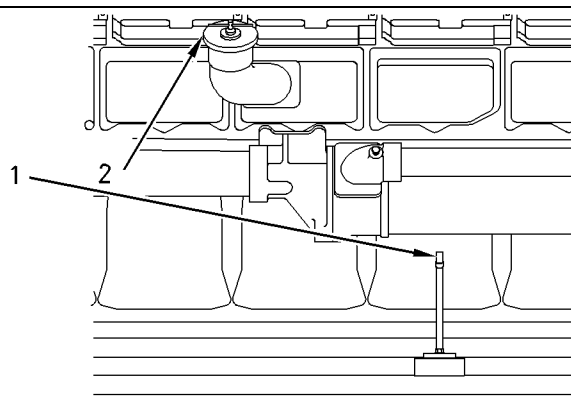


Illustration 53

g00760401

- (1) Engine oil level gauge (dipstick)
- (2) Filler cap

1. Remove filler cap (2) in order to ensure that the crankcase pressure is equal to the atmospheric pressure.

Excess pressure or a slight vacuum will affect engine oil level that is measured.

2. Ensure that engine oil level gauge (1) is seated.

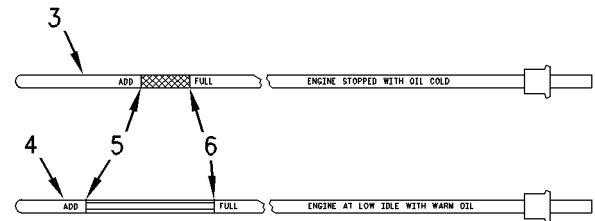


Illustration 54

g00735162

- (3) "ENGINE STOPPED WITH OIL COLD" side
- (4) "ENGINE AT LOW IDLE WITH WARM OIL" side
- (5) "ADD" mark
- (6) "FULL" mark

- a. If the engine is stopped, remove the engine oil level gauge. Observe the engine oil level on "ENGINE STOPPED WITH OIL COLD" side (3).
- b. If the engine is operating, reduce the engine speed to low idle. Remove the engine oil level gauge and observe the engine oil level on "ENGINE AT LOW IDLE WITH WARM OIL" side (4).

The engine oil level should be between "ADD" mark (5) and "FULL" mark (6).

### NOTICE

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

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

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

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

3. If necessary, add engine oil. For the correct engine oil to use, refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section). Do not fill the crankcase above the "FULL" mark on the engine oil level gauge. Clean the filler cap (2). Install the filler cap.
4. Record the amount of engine oil that is added. For the next engine oil sample and analysis, include the total amount of engine oil that has been added since the previous oil change. This will help to provide the most accurate analysis.

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.

i02074911

## Engine Protective Devices - Check

**SMCS Code:** 7400-535

### Visual Inspection

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

### Calibration Check

#### NOTICE

During testing, abnormal operating conditions must be simulated.

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

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. 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.

i02015492

## Engine Speed/Timing Sensor - Clean/Inspect

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

An engine speed/timing sensor is mounted in the flywheel housing. The speed/timing sensor provides information about engine speed and the position of the crankshaft to the ECM.

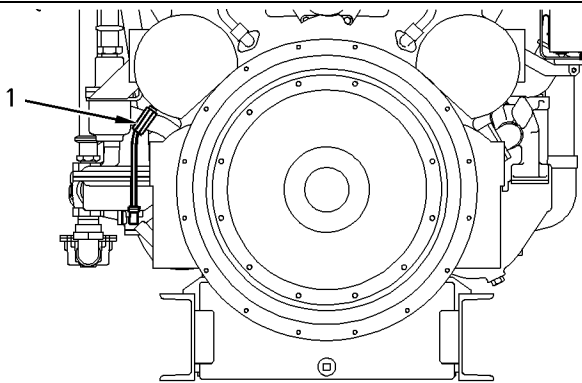


Illustration 55

g00760464

1. Remove engine speed/timing sensor (1). Inspect the condition of the end of the magnet. Look for signs of wear and contaminants.
2. Clean any debris from the face of the magnet.

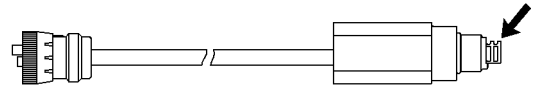


Illustration 56

g00931748

3. Check the tension of the sliphead. Gently extend sliphead (2) for a minimum of 4 mm (0.16 inch). Then push back the sliphead.

When the sliphead has the correct tension, at least 22 N (5 lb) of force is required to push in the sliphead from the extended position.

### NOTICE

The sliphead must be fully extended when the speed/timing sensor is installed so that the sensor maintains the correct clearance with the speed-timing wheel. If the correct clearance is not maintained, the signal from the sensor will not be generated.

Do not install the sensor between the teeth of the speed-timing wheel. Damage to the sensor would result. Before installing the sensor, ensure that a tooth of the wheel is visible in the mounting hole for the sensor.

4. Install the engine speed/timing sensor.
  - a. Ensure that a tooth on the speed-timing wheel is visible in the mounting hole for the sensor.
  - b. Extend sliphead (2) by a minimum of 4 mm (0.16 inch).
  - c. Coat the threads of the sensor with 4C-5597 Anti-Seize Compound.

**Note:** The sliphead is designed to contact a tooth during the first revolution of the speed-timing wheel. For the maximum allowable clearance between the sliphead and the tooth, refer to the engine's Specifications manual.

- d. Install the sensor. Tighten the locknut to  $40 \pm 5$  N·m ( $30 \pm 4$  lb ft).

i02151241

## Engine Valve Lash and Bridge - Adjust

**SMCS Code:** 1102-025; 1102

### **WARNING**

**Ignition systems can cause electrical shocks. Avoid contacting the ignition system components and wiring.**

**Do not attempt to remove the valve covers when the engine is operating. The transformers are grounded to the valve covers. Personal injury or death may result and the ignition system will be damaged if the valve covers are removed during engine operation. The engine will not operate without the valve covers.**

---

For procedures on adjusting the valve bridge and the engine valve lash, refer to the following publications:

- Special Instruction, REHS0128, "Using the 147-5482 Indicator Gauge for Valve Lash and Valve Bridge Adjustment"
- The Systems Operation/Testing and Adjusting manual for the engine
- The Specifications manual for the engine

Consult your Caterpillar dealer for assistance.

### Valve Bridge

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 for each cylinder is satisfactory, measure the valve lash.

### Engine Valve Lash

---

#### NOTICE

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

Operation of Caterpillar engines with improper valve adjustments can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life. Improper valve lash may also lead to valve failure, and result in catastrophic failure.

---

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

Perform valve lash adjustment if the dimension is not within the tolerance. The 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.

For the valve lash setting, refer to this Operation and Maintenance Manual, "Specifications" section and/or the Specifications manual for the engine.

i01491702

## Exhaust Bypass - Inspect

**SMCS Code:** 1057-040

### **WARNING**

**The exhaust bypass valve cover is under spring compression. To prevent personal injury, use caution when removing the cover.**

---

The exhaust bypass valve must be removed in order to be inspected. For instructions on removal and assembly, see the engine's Disassembly and Assembly and Specifications.

Inspect the exhaust bypass valve for binding and excess play. Inspect the valve stem and valve guide for wear. Inspect the diaphragm for good condition. Clean the breather with nonflammable solvent. If any parts are worn or damaged, replace the parts.

After assembly and installation of the exhaust bypass, adjust the exhaust bypass according to the engine's Testing and Adjusting instructions in order to help obtain the desired turbocharger boost pressure.

Consult your Caterpillar dealer for assistance.

i01003546

## Exhaust Piping - Inspect

SMCS Code: 1061-040

### WARNING

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

Inspect the components of the exhaust system. Repair the components or replace the components for any of the following conditions:

- Damage
- Cracks
- Leaks
- Loose connections

For information on removal and installation, see the Service Manual, "Disassembly and Assembly" module. Consult your Caterpillar dealer for assistance.

i02138365

## Fuel Metering Valve - Check (Raptor)

SMCS Code: 1741-535

S/N: GET1-Up

S/N: BGW1-Up

S/N: CEY1-Up

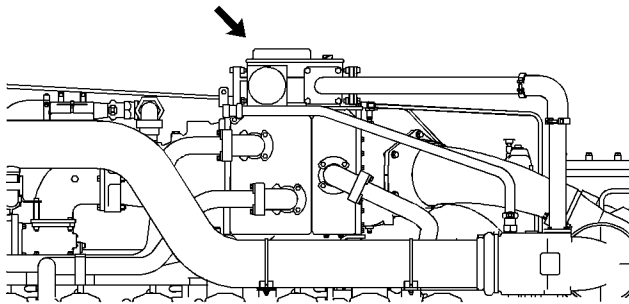


Illustration 57

g01090000

For information regarding the fuel metering valve, refer to Installation and Operation Manual, SEBU7630, "Raptor Gas Regulation and Metering Valve/Actuator System for Caterpillar".

i01949861

## Fuel Metering Valve Screen - Check

SMCS Code: 1741-535

S/N: 7EZ1-Up

1. Turn OFF the gas supply.

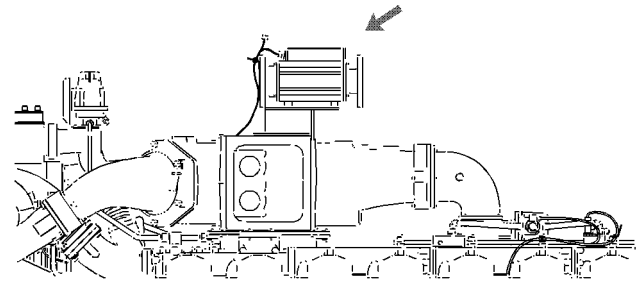


Illustration 58

g01014733

### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

2. Remove the pipe from the inlet of the fuel metering valve.
3. Visually inspect the screen at the inlet of the fuel metering valve. Clean the screen, if necessary.

Usually, contamination can be removed with a soft brush and a vacuum. Make sure that no debris will enter the fuel metering valve.

If necessary, use internal retaining ring pliers in order to remove the screen for cleaning. Reinstall the screen after cleaning.

4. Attach the pipe to the inlet of the fuel metering valve.
5. Turn ON the gas supply.

i01949940

## Fuel System Fuel Filter Differential Pressure - Check

**SMCS Code:** 1261-535

A fuel filter differential pressure gauge must be installed in order to determine when the fuel filter requires service. This gauge and the fuel filter are supplied by the customer.

A fuel filter differential pressure gauge indicates the difference in fuel pressure between the inlet side and the outlet side of the fuel filter. The differential pressure increases as the fuel filter becomes plugged.

Operate the engine at the rated rpm and at the rated load. Check the fuel filter differential pressure. Service the fuel filter when the fuel filter differential pressure reaches 1.7 kPa (0.25 psi).

For instructions, refer to Special Instruction, SEHS9298, "Installation and Maintenance of Gaseous Fuel Filters". Consult your Caterpillar dealer for assistance.

i01601766

## Fumes Disposal Filter Differential Pressure - Check

**SMCS Code:** 1074

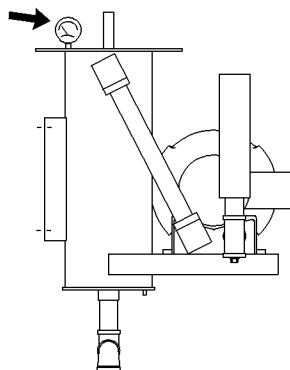


Illustration 59

g00829797

Pressure gauge on top of the filter

Check the differential pressure across the filter element. Observe the pressure that is indicated by the pressure gauge on top of the filter. Record the measurement.

The restriction of a new element is approximately 1.7 kPa (7 inches of H<sub>2</sub>O).

The normal restriction of the element is approximately 5.7 to 9.95 kPa (23 to 40 inches of H<sub>2</sub>O).

- Replace the filter element when the differential pressure reaches 11.2 kPa (45 inches of H<sub>2</sub>O).
- Replace the element after every year regardless of the differential pressure.

i01749518

## Fumes Disposal Filter Element - Replace

**SMCS Code:** 1074

### **WARNING**

**Hot oil and components can cause personal injury.**

**Do not allow hot oil or components to contact skin.**

**Note:** Always disconnect power to the fumes collector prior to servicing. The motor is protected by a thermal protector. If the motor is shut down due to excessive heat, the motor will automatically restart when the protector resets.

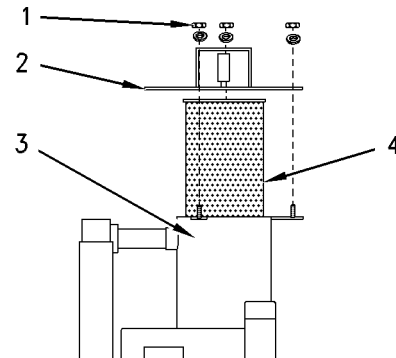


Illustration 60

g00763796

- (1) Nuts and washers
- (2) Cover
- (3) Body
- (4) Filter element

**Note:** The filter element is mounted above the engine. A ladder or a platform will be required for servicing the element.

1. Remove three nuts and washers (1) in order to remove cover (2) from body (3).
2. Remove element (4).
3. Clean the inside of cover (2) and body (3).



i01819486

4. Install new element (4) into body (3).
5. Place cover (2) in position and install three nuts and washers (1).

i01950516

## Gas Pressure Regulator Condensation - Drain

**SMCS Code:** 1270-543

**S/N:** GET1-Up

To collect condensation, drip legs should be installed in the following locations:

- Supply line for the gas pressure regulator
- Balance line for the gas pressure regulator
- Supply line to the gas shutoff valve

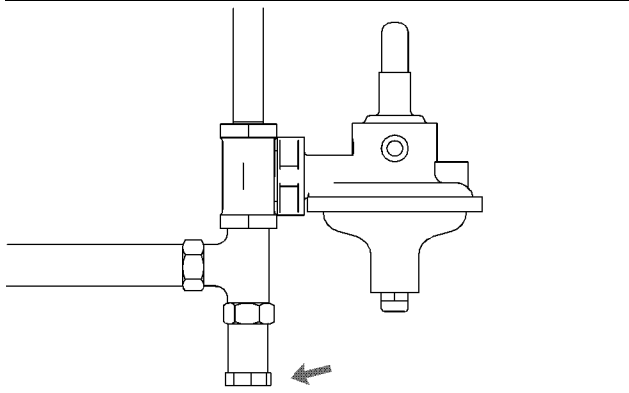


Illustration 61

g01014926

Cap on the drip leg for the gas supply line to the gas pressure regulator

1. Close the main gas supply valve.
2. Remove the caps from the drip legs.
3. Allow the moisture to drain into a suitable container. Inspect the drip legs for debris. Clean the drip legs, if necessary.
4. Clean the caps. Install the caps.
5. Open the main gas supply valve.

## Hoses and Clamps - Inspect/Replace

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

Inspect all hoses. Leaks can be caused by the following conditions:

- Cracking
- Softness
- Loose clamps

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

### NOTICE

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

Check for the following conditions:

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

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

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

## Replace the Hoses and the Clamps

1. Service the hoses and clamps according to the system:

**NOTICE**

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

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

**⚠ 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.**

- a. Before servicing a coolant hose, stop the engine. Allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.

**⚠ WARNING**

**Hot oil and components can cause personal injury.**

**Do not allow hot oil or components to contact skin.**

- b. Before servicing an oil hose, stop the engine. Allow the engine to cool. Drain the oil from the system to a level that is below the hose that is being replaced.

**⚠ 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.**

- c. Before servicing a pressurized air hose, stop the engine. Ensure that the air supply to the hose is OFF. Slowly release pressure from the system.
2. Remove the hose clamps.
  3. Disconnect the old hose. Discard the hose.
  4. Install a new hose.
  5. Install the hose clamps with a torque wrench. For torques on hose clamps, see Specifications, SENR3130, "Torque Specifications", "Hose Clamps".
  6. After servicing the hose, restore the system to an operational state according to the requirements of the system:
    - a. If a coolant hose was serviced, refill the cooling system. Install the cooling system filler cap. Start the engine. Inspect the cooling system for leaks.
    - b. If an oil hose was serviced, refill the system to the proper level. Start the engine. Inspect the system for leaks.

**⚠ WARNING**

**Personal injury or death can result from improperly checking for a leak.**

**Always use a board or cardboard when checking for a leak. Escaping air or fluid under pressure, even a pin-hole size leak, can penetrate body tissue causing serious injury, and possible death.**

**If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.**

- c. If a pressurized air hose was serviced, restore air pressure to the system. Check for air leaks.

i01920021

## Ignition System Spark Plugs - Inspect/Adjust/Replace (Spark Plugs with Adjustable Electrode Gaps)

SMCS Code: 1555-040

S/N: GET1-Up

### WARNING

Ignition systems can cause electrical shocks. Avoid contacting the ignition system components and wiring.

Do not attempt to remove the valve covers when the engine is operating. The transformers are grounded to the valve covers. Personal injury or death may result and the ignition system will be damaged if the valve covers are removed during engine operation. The engine will not operate without the valve covers.

Maintenance of the spark plugs is required in order to achieve the following benefits:

- Normal fuel consumption
- Normal level of emissions
- Maximum service life of the spark plugs

The service life of the spark plugs is affected by fouling due to deposits from the oil and by peak voltage. Maintenance of the ignition system is also affected by voltage. Higher voltage is required by higher inlet manifold air pressure and a higher compression ratio. Higher voltage reduces the service life of components such as spark plugs, wires, and transformers.

## Removing the Spark Plug

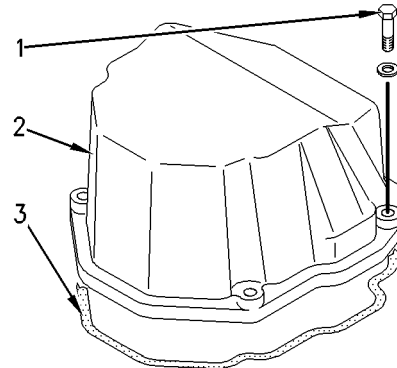


Illustration 62

g00787369

- (1) Bolt
- (2) Valve cover
- (3) O-ring seal

1. Remove bolts (1). Remove valve cover (2). Inspect O-ring seal (3). If the seal appears to be worn or damaged, discard the seal and use a new seal for assembly.

### NOTICE

Pulling on the wiring harness may break the wires. Do not pull on the wiring harness.

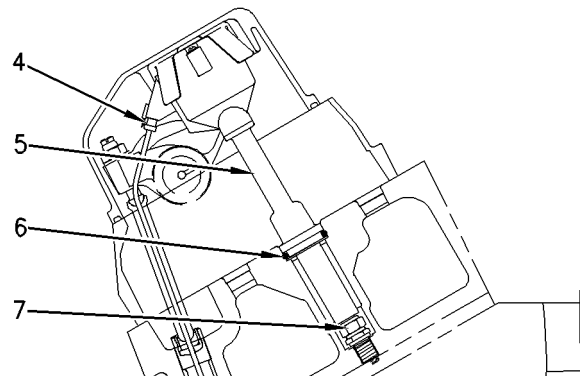


Illustration 63

g00787367

- (4) Wiring harness
- (5) Transformer
- (6) Lip seal
- (7) Spark plug

2. Disconnect wiring harness (4) from transformer (5). Be careful to completely depress the retainer clip away from the connector. Pull transformer (5) straight away from the cylinder head.
3. Inspect lip seal (6). If the seal is worn or damaged, discard the seal and use a new seal for assembly.

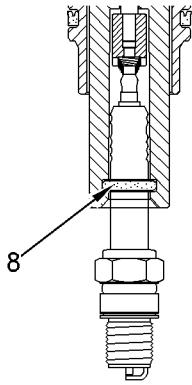


Illustration 64

g00787371

(8) O-ring seal

4. Inspect O-ring seal (8). If the seal is hard, cracked, or melted, install a new seal.

**⚠ WARNING**

**Pressurized air can cause personal injury. When pressurized air is used for cleaning, wear a protective face shield, protective clothing, and protective shoes.**

**Note:** Excessive buildup of oil in the spark plug well is an indication of a damaged lip seal on the transformer. If this condition is found, clean the surface of the seal groove. Replace seal (6).

5. Debris may have collected in the spark plug well. Thoroughly remove any debris. Use compressed air. The maximum air pressure for cleaning purposes must be below 207 kPa (30 psi). Ensure that the area around the spark plug is clean and free of dirt and debris.
6. Use a 177.8 mm (7/8 inch), 4C-4601 Spark Plug Socket, an extension, and a breaker bar to loosen spark plug (7). After the spark plug has been loosened, use the socket and extension to remove the spark plug by hand in order to detect problems with the threads. After the spark plug has been removed, discard the used spark plug gasket.

If the spark plug resists removal by hand, apply penetrating oil to the threads. To help the oil penetrate the threads, turn the spark plug back and forth until the spark plug is loose.

If the spark plug cannot be removed by hand, clean the threads with 9U-7511 Spark Plug Seat Cleaner. This tool scrapes debris from the seat and from the threads in the cylinder head. Be sure to clean any debris from the cylinder.

**NOTICE**

Do not use a thread tap. A thread tap will remove metal unnecessarily. The threads could be stripped and the cylinder head could be damaged.

## Inspecting the Spark Plug

Inspect the spark plug closely for damage. The condition of the spark plug can indicate the operating condition of the engine.

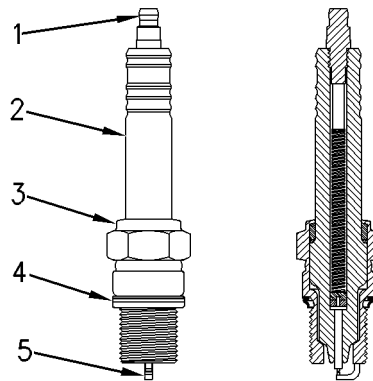


Illustration 65

g00838300

- (1) Terminal post
- (2) Insulator
- (3) Shell
- (4) Gasket
- (5) Electrode

Terminal post (1) must not move. If the terminal post can be moved by hand, carefully tighten the post into the threads of the insulator. If the post cannot be tightened, discard the spark plug.

Inspect insulator (2) for cracks. If a crack is found, discard the spark plug.

Faint marks may extend from shell (3) onto the insulator. The marks may be a result of corona that forms at the top of the shell. The conductor will develop a corona when a very high voltage potential ionizes the air. This is a normal condition. This is not an indication of leakage between the shell and the insulator.

Inspect shell (3) for damage. Cracks can be caused by overtightening the spark plug. Overtightening can also yield the metal which loosens the shell. Discard any spark plug that has a shell that is cracked or loose.

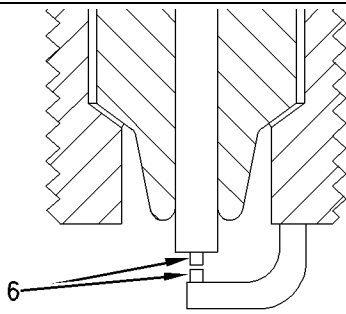


Illustration 66

g00787372

(6) Precious metal tips on the electrode and the ground strap

Caterpillar spark plugs have precious metal tips (6) on the electrode and the ground strap. This material will gradually erode. Use extreme care when you set the electrode gap. Maintain even spacing and proper alignment between the two precious metal surfaces.

Replace the spark plug if the precious metal is worn off.

A light brown deposit or a beige deposit around the electrode is produced by normal operation.

Deposits that are gray or black may be caused by the following substances:

- Excessive oil
- Use of the wrong oil
- A substance that is introduced through the fuel system or the air system
- Poor combustion because of a rich air/fuel mixture

A spark plug can operate despite a buildup of ash. However, a buildup of ash can cover the electrode gap. This will cause misfire. Large deposits may retain heat which can cause premature fuel ignition. This can lead to uncontrollable detonation.

## Cleaning the Spark Plug

Thoroughly clean the spark plug. Do not use a wire brush. Glass beads are the preferred method for cleaning.

Follow these guidelines for using glass beads:

- Always use clean glass beads.
- Only use glass beads on the electrode and the insulator near the electrode.

- Do not use glass beads on any other area of the spark plug.
- Clean the rest of the spark plug with nonflammable solvent.

## Installing the Spark Plug

**Note:** Use the 9U-7516 Spark Plug Gauge to measure the electrode gap. Do not use a flat feeler gauge for measuring the electrode gap of used spark plugs. A feeler gauge will incorrectly measure the actual electrode gap because the used precious metal tips are curved.

1. Before installing the spark plug, set the electrode gap according to the engine's Specifications manual.

Adjust the electrode gap, if necessary. Bend the ground strap at the existing bend. Then bend the strap near the weld in order to achieve proper alignment and even spacing between the two precious metal surfaces. Measure the electrode gap after the alignment. Correct the electrode gap, if necessary.

**Note:** Do not use anti-seize compound on spark plugs. Most of the heat is transferred through the threads and the seat area of the spark plug. Contact of the metal surfaces must be maintained in order to provide the heat transfer that is required.

2. Ensure that the spark plug is clean and free of dirt and oil.
3. Always use a new gasket when a spark plug is installed. If a used spark plug is installed, place a new 9Y-6792 Spark Plug Gasket on the spark plug. Orient the tabs of the gasket toward the spark plug's electrode gap. Otherwise, the gasket may not seat properly. If a gasket for a spark plug is installed incorrectly, do not increase the torque on the spark plug in order to improve the seal. Do not reuse the gasket. Install a new gasket.

### NOTICE

Do not overtighten the spark plug. The shell can be cracked and the gasket can be deformed. The metal can deform and the gasket can be damaged. The shell can be stretched. This will loosen the seal that is between the shell and the insulator, allowing combustion pressure to blow past the seal. Serious damage to the engine can occur.

Use the proper torque.

4. Install the spark plug by hand until the spark plug bottoms out. Tighten the spark plug according to the engine's Specifications manual.

5. Ensure that the transformer and the extension are clean and free from dirt and oil. Lubricate O-ring seal (8) (Illustration 64) with one of the following lubricants:

- 4C-9504 Dielectric Grease
- 5N-5561 Silicone Lubricant
- 8T-9020 Dielectric Grease

6. Install the transformer. Orient the transformer toward the wiring harness. Carefully align the socket of the transformer with the wiring harness connector. Connect the wiring harness.

**Note:** If the connector's locking tab or the transformer's connector are damaged, install a retainer onto the transformer's connector for the wiring harness. For connectors with a width of 22.3 mm (0.88 inch), use the 178-0565 Retainer. For connectors with a width of 17.1 mm (0.67 inch), use the 179-1500 Retainer.

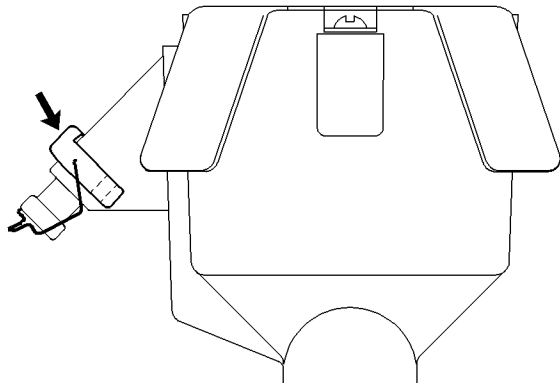


Illustration 67

g00838130

Retainer on the transformer's connector for the wiring harness

7. Install the valve cover.

## Ignition System Spark Plugs - Inspect/Replace (Spark Plugs that have Precombustion Chambers)

**SMCS Code:** 1555-040

**S/N:** BGW1-Up

**S/N:** CEY1-Up

**S/N:** 7EZ1-Up

**The use of spark plugs with precombustion chambers is restricted to generator set applications.**

**Note:** Condensation can form in spark plugs that have precombustion chambers. This can cause difficulty for cold start-ups. To avoid condensation, maintain the coolant in the cylinder block at a minimum temperature of 43 °C (110 °F) continuously.

The service life of the spark plugs is affected by fouling due to deposits from the oil and by peak voltage. Maintenance of the ignition system is also affected by voltage. Higher voltage is required by higher inlet manifold air pressure, a higher compression ratio, or retardation of the timing. Higher voltage reduces the service life of components such as spark plugs, wires, and transformers.

The service life of the spark plug is different for different applications. The service life of the spark plug is approximately 3000 service hours. The spark plug may be good for a considerable period beyond 3000 service hours. To help predict the spark plug's service life, use Caterpillar Electronic Technician (ET) to monitor the "Cylinder #X Transformer Secondary Output Voltage Percentage" parameter. The value of this parameter will increase as the spark plug gap wears over time. Experience at the particular site will help to determine the proper interval for replacement of the spark plugs.

If a diagnostic code is generated for the ignition transformer's secondary circuit, the spark plug may need to be replaced. Misfire and a cold cylinder are other indications of a worn spark plug. Use Cat ET to monitor the exhaust port temperatures in order to locate a cold cylinder.

## Removing the Spark Plug

### **WARNING**

Ignition systems can cause electrical shocks. Avoid contacting the ignition system components and wiring.

Do not attempt to remove the valve covers when the engine is operating. The transformers are grounded to the valve covers. Personal injury or death may result and the ignition system will be damaged if the valve covers are removed during engine operation. The engine will not operate without the valve covers.

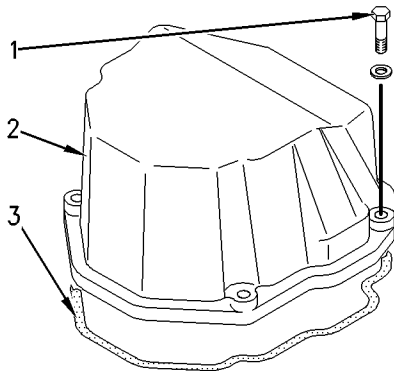


Illustration 68

g00760567

- (1) Bolt
- (2) Valve cover
- (3) O-ring seal

1. Remove bolts (1). Remove valve cover (2). Inspect O-ring seal (3). If the seal appears to be worn or damaged, discard the seal and use a new seal for assembly.

### **NOTICE**

Pulling on the wiring harness may break the wires. Do not pull on the wiring harness.

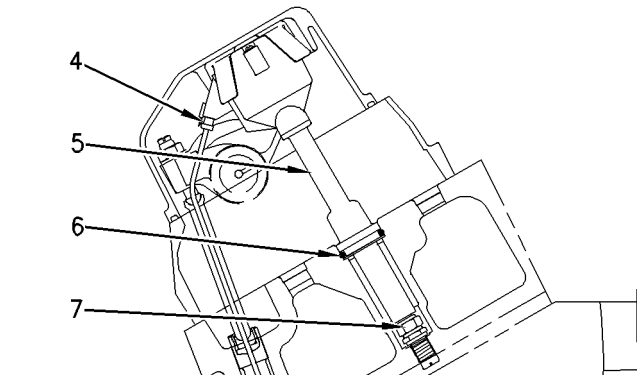


Illustration 69

g00760565

- (4) Wiring harness
- (5) Transformer
- (6) Lip seal
- (7) Spark plug

2. Disconnect wiring harness (4) from transformer (5). Be careful to completely depress the retainer clip away from the connector. Remove transformer (5).
3. Inspect lip seal (6). If the seal is worn or damaged, discard the seal and install a new seal.

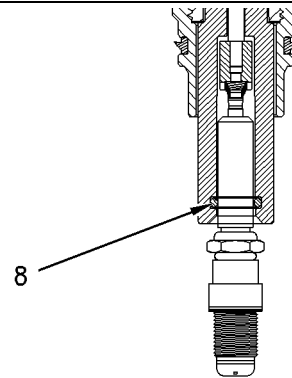


Illustration 70

g00760568

- (8) O-ring seal

4. Inspect O-ring seal (8). If the seal is hard, cracked, or melted, install a new seal.

### **WARNING**

Pressurized air can cause personal injury. When pressurized air is used for cleaning, wear a protective face shield, protective clothing, and protective shoes.

**Note:** Excessive buildup of oil in the spark plug well is an indication of a damaged lip seal on the transformer. If this condition is found, clean the surface of the seal groove. Replace seal (6).

5. Debris may have collected in the spark plug well. Thoroughly remove any debris. Use compressed air. The maximum air pressure for cleaning purposes must be below 207 kPa (30 psi). Ensure that the area around the spark plug is clean and free of dirt and debris.
6. Use a 20.638 mm (13/16 inch) deep well socket, an extension, and a breaker bar to loosen spark plug (7). After the spark plug has been loosened, use the socket and extension to remove the spark plug by hand in order to detect problems with the threads. After the spark plug has been removed, discard the used spark plug gasket.

If the spark plug resists removal by hand, apply penetrating oil to the threads. To help the oil penetrate the threads, turn the spark plug back and forth until the spark plug is loose.

If the spark plug could not be removed by hand, clean the threads with the 9U-7511 Spark Plug Seat Cleaner. This tool scrapes debris from the seat and from the threads in the cylinder head. Be sure to clean any debris from the cylinder.

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#### NOTICE

Do not use a thread tap. A thread tap will remove metal unnecessarily. The threads could be stripped and the cylinder head could be damaged.

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## Inspecting the Spark Plug

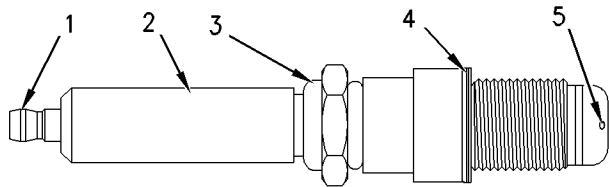


Illustration 71

g00838122

- (1) Terminal post
- (2) Insulator
- (3) Shell
- (4) Gasket
- (5) Hole in the spark plug's precombustion chamber

Inspect the spark plug closely for damage. The condition of the spark plug can indicate the operating condition of the engine.

Terminal post (1) must not move. If the terminal post can be moved by hand, carefully tighten the post into the threads of the insulator. If the post cannot be tightened, discard the spark plug.

Insulator (2) is covered with Teflon. If the cover is cracked or loose, discard the spark plug.

Faint marks may extend from shell (3) onto the insulator. The marks may be a result of a corona that forms at the top of the shell. The conductor will develop a corona when a very high voltage potential ionizes the air. This is a normal condition. This is not an indication of leakage between the shell and the insulator.

Inspect shell (3) for damage. Cracks can be caused by overtightening the spark plug. Overtightening can also yield the metal which loosens the shell. Discard any spark plug that has a shell that is cracked or loose.

Inspect the spark plug's precombustion chamber for deposits. Make sure that holes (5) in the spark plug's precombustion chamber are not blocked.

A light brown deposit or a beige deposit is produced by normal operation.

Deposits that are gray or black may be caused by the following substances:

- Excessive oil
- Use of the wrong oil
- A substance that is introduced through the fuel system or the air system
- Poor combustion because of a rich air/fuel mixture

A spark plug can operate despite a buildup of ash. Large deposits may retain heat which can cause premature fuel ignition. This can lead to uncontrollable detonation.

## Cleaning the Spark Plug

**Do not use glass beads to clean the spark plug.** The beads could enter the precombustion chamber through the holes. The beads could clog the holes in the spark plug's precombustion chamber.

Use a brass wire brush to clean the spark plug. Be careful not to damage the Teflon cover.

## Installing the Spark Plug

**Note:** Do not use anti-seize compound on spark plugs. Most of the heat is transferred through the threads and the seat area of the spark plug. Contact of the metal surfaces must be maintained in order to provide the heat transfer that is required.

1. Ensure that the spark plug is clean and free of dirt and oil.



2. Always use a new gasket when a spark plug is installed. If a used spark plug is installed, place a new 9Y-6792 Spark Plug Gasket on the spark plug. Orient the tabs of the gasket toward the spark plug's precombustion chamber. Otherwise, the gasket may not seat properly. If a gasket for a spark plug is installed incorrectly, do not increase the torque on the spark plug in order to improve the seal. Do not reuse the gasket. Install a new gasket.

#### NOTICE

Do not overtighten the spark plug. The shell can be cracked and the gasket can be deformed. The metal can deform and the gasket can be damaged. The shell can be stretched. This will loosen the seal that is between the shell and the insulator, allowing combustion pressure to blow past the seal. Serious damage to the engine can occur.

Use the proper torque.

3. Install the spark plug by hand until the spark plug contacts the gasket. Tighten the spark plug according to the engine's Specifications manual.
4. Ensure that the transformer and the extension are clean and free from dirt and oil. Lubricate O-ring seal (8) (Illustration 70) with one of the following lubricants:
  - 4C-9504 Dielectric Grease
  - 5N-5561 Silicone Lubricant
  - 8T-9020 Dielectric Grease
5. Install the transformer. Orient the transformer toward the wiring harness. Carefully align the socket of the transformer with the wiring harness connector. Connect the wiring harness.

**Note:** If the connector's locking tab or the transformer's connector are damaged, install a 178-0565 Retainer on the transformer's connector for the wiring harness.

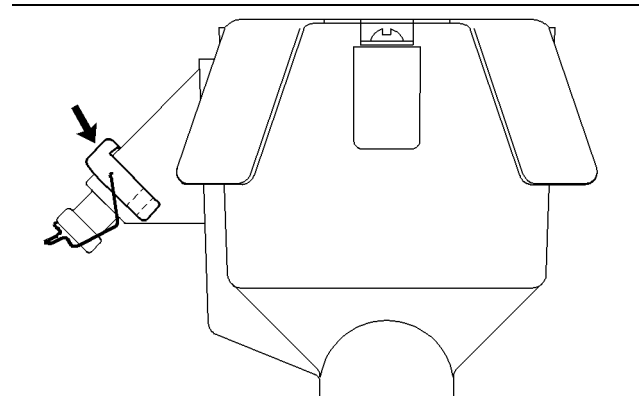


Illustration 72

g00838130

178-0565 Retainer on the transformer's connector for the wiring harness

6. Install the valve cover.

i01950691

## Ignition System Timing - Check/Adjust

**SMCS Code:** 1550-025; 1550-535

After maintenance has been performed on the ignition system, check the timing of the ignition system. Adjust the timing, if necessary.

Ignition timing for gas engines varies with the gas chemistry. Obtain a fuel analysis in order to determine if the timing for the ignition system is correct. Enter the data from the fuel analysis into the Caterpillar Software Program, LEKQ6378, "Methane Number Program". Alternatively, you may provide the results of a gas analysis to your Caterpillar dealer for assistance in determining the correct timing for your application.

Use the Caterpillar Electronic Technician (ET) to adjust the timing. Adjust the timing according to the instructions in Special Instruction, "Installation and Initial Start-Up Procedures For G3500B Engines". Consult your Caterpillar dealer for assistance.

i01492320

## Inlet Air System - Inspect

**SMCS Code:** 1058-040; 1071-040; 1087-040

Inspect the components of the air inlet system for the following conditions:

- Cracks
- Leaks

- Loose connections

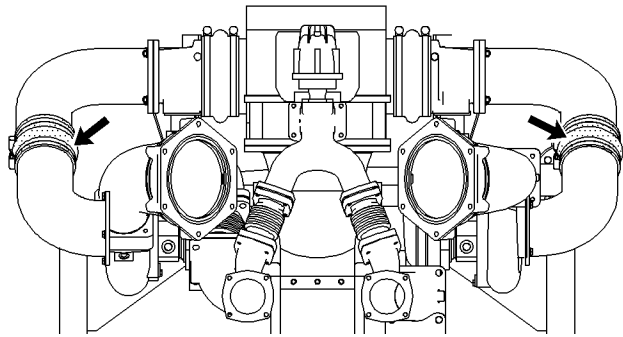


Illustration 73  
Rubber hoses in the air lines of a G3516B Engine

Inspect the following components:

- Piping between the air cleaner and the turbocharger
- Rubber hoses in the air lines
- Turbocharger
- Piping between the turbocharger and the aftercooler
- Aftercooler
- Connection of the aftercooler to the air plenum
- Connection of the air plenum to the cylinder head

Ensure that all of the connections are secure. Ensure that the components are in good condition.

Make repairs, if necessary. For information regarding removal and installation of the components, refer to Service Manual, "Disassembly and Assembly". Consult your Caterpillar dealer for assistance.

i02136614

## Overhaul (In-Frame)

**SMCS Code:** 1000-020

### Scheduling an In-Frame Overhaul

Generally, an in-frame overhaul is performed for every third top end overhaul. Scheduling an in-frame overhaul normally depends on the following three conditions:

- An increase of oil consumption
- An increase of crankcase blowby

- A decrease and a variation of cylinder compression

Each individual condition may not indicate a need for an overhaul. However, evaluating the three conditions together is the most accurate method of determining when an overhaul is necessary.

The engine does not require an overhaul if the engine is operating within acceptable limits for oil consumption, crankcase blowby, and cylinder compression.

Periodically measure each of the three conditions. The first measurement should occur during the engine commissioning. This establishes a baseline for future measurements. Additional measurements are scheduled at regular intervals in order to determine a schedule for the next in-frame overhaul.

The following changes in the three conditions normally require a scheduled overhaul:

- A 300 percent increase in oil consumption
- A 200 percent increase in crankcase blowby
- A 20 percent loss of cylinder compression

**Note:** These indications do not require an engine to be shut down for service. These indications only mean that an engine should be scheduled for service in the near future. If the engine operation is satisfactory, an immediate overhaul is not a requirement.

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

Usually, an in-frame overhaul does not require removal of the engine. Instead, the service is performed with the engine in place. If the customer requires a minimum disruption in the production of power, the engine can be replaced with a rebuilt model of identical specifications.

**Note:** The generator or the driven equipment may also require service when the engine overhaul is performed. Refer to the literature that is provided by the OEM of the driven equipment.

### In-Frame Overhaul Information

An in-frame overhaul includes all of the work that is done for a top end overhaul. Additionally, some other components that wear are replaced. The condition of components is inspected. Those components are replaced, if necessary.

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 can be 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. 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 16.

Table 16

| In-Frame Overhaul             |                              |
|-------------------------------|------------------------------|
| Clean                         | Oil suction screen           |
| Clean<br>Inspect<br>Test      | Aftercooler core             |
| Inspect<br>Rebuild<br>Replace | Compressor bypass valve      |
|                               | Fuel metering valve          |
|                               | Electrohydraulic actuator    |
|                               | Electronic throttle          |
|                               | Hydraulic oil pump           |
|                               | Oil cooler                   |
|                               | Oil pump                     |
|                               | Pistons                      |
|                               | Transformers                 |
| Rebuild                       | Exhaust bypass               |
|                               | Prelube pump                 |
|                               | Starting motor               |
|                               | Turbochargers                |
|                               | Water pumps                  |
| Replace                       | Connecting rod bearings      |
|                               | Cylinder head assemblies     |
|                               | Cylinder liners              |
|                               | Main bearings                |
|                               | Oil temperature regulators   |
|                               | Piston rings                 |
|                               | Water temperature regulators |

i02136709

## Overhaul (Major)

SMCS Code: 7595-020-MJ

### Scheduling a Major Overhaul

Generally, a major overhaul is performed for every fifth top end overhaul. The need for a major overhaul is determined by several factors. Some of those factors are the same factors that determine the in-frame overhaul:

- 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:

- Power output
- The service hours of the engine
- Reduced oil pressure
- 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 generator or 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.

## Major Overhaul Information

A major overhaul includes all of the work that is done for top end overhauls and in-frame overhauls. A major overhaul includes additional parts and labor. Additional parts and labor are required in order to completely rebuild the engine. In some cases, the engine is relocated for disassembly.

For the major overhaul, all of the bearings, seals, gaskets, and components that wear are disassembled. The parts are cleaned and 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 can be 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 toward 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 17. Your Caterpillar dealer can provide these services and components.

Table 17

| Major Overhaul                |                              |
|-------------------------------|------------------------------|
| Clean                         | Oil suction screen           |
| Clean<br>Inspect<br>Test      | Aftercooler core             |
| Inspect<br>Rebuild<br>Replace | Camshafts                    |
|                               | Camshaft followers           |
|                               | Connecting rods              |
|                               | Crankshaft                   |
|                               | Fuel metering valve          |
|                               | Gear train                   |
|                               | Electrohydraulic actuator    |
|                               | Electronic throttle          |
|                               | Hydraulic oil pump           |
|                               | Inlet air piping             |
|                               | Oil cooler                   |
|                               | Oil pump                     |
|                               | Pistons                      |
|                               | Throttle valve               |
| Transformers                  |                              |
| Rebuild                       | Exhaust bypass               |
|                               | Prelube pump                 |
|                               | Starting motor               |
|                               | Turbochargers                |
|                               | Water pumps                  |
|                               | Vibration damper             |
| Replace                       | Camshaft bearings            |
|                               | Connecting rod bearings      |
|                               | Coupling (tandem engines)    |
|                               | Cylinder liners              |
|                               | Gaskets and seals            |
|                               | Gear train bushings          |
|                               | Main bearings                |
|                               | Oil temperature regulators   |
|                               | Piston rings                 |
|                               | Water temperature regulators |
|                               | Wiring harnesses             |

## Overhaul (Top End)

**SMCS Code:** 7595-020-TE

### Scheduling a Top End Overhaul

Top end overhauls are scheduled according to the recession of the exhaust valve stems. This measurement provides an accurate indication of the rate of valve wear. This measurement can be used to predict when a cylinder head requires replacement.

To determine a baseline, measure the projection of the exhaust valve stems after 100 to 250 service hours. The baseline is a reference for subsequent measurements. Continue to periodically measure the projection.

Plan for the top end overhaul as the valve stem projection approaches the maximum limit. Perform the top end overhaul when the valve stem projection has increased by a total of 2.3 mm (.09 inch). Do not allow the projection of the exhaust valve stems to exceed this limit.

**Note:** Generally, cylinder heads wear out at different rates. In some cases, servicing the cylinder heads at different times may be the most economic decision. This depends on the valve stem projection of the individual cylinders. However, this decision must include the costs of additional downtime that is caused by this procedure. Perform an economic analysis in order to determine if cylinder heads should be serviced as a group or divided into smaller groups.

**Note:** The generator or the driven equipment may also require service when the engine overhaul is performed. Refer to the literature that is provided by the OEM of the driven equipment.

### Top End Overhaul Information

A top end overhaul involves servicing the cylinder heads and turbochargers. Also, some other engine components are inspected.

Top end overhauls require more tools than preventive maintenance. The following tools are needed for restoring the engine to factory specifications:

- Torque wrenches
- Dial indicators
- Accurate measurement tools
- Cleaning equipment
- Rebuilding equipment

Caterpillar dealers are equipped with these tools. Caterpillar dealers can provide a flat rate price for a top end overhaul.

Unexpected problems may be found during a top end overhaul. Plan to correct these problems, if necessary.

- Buildup in the cylinders from excessive oil consumption
- Buildup in the cylinders from contamination of the fuel
- Plugging of the aftercooler from coolant that is poorly maintained
- Plugging of the aftercooler from contamination of the inlet air
- Degradation of the oil cooler from hydrogen sulfide in the fuel

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 can be 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. 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 18. Your Caterpillar dealer can provide these services and components. Your Caterpillar dealer can ensure that the components are operating within the appropriate specifications.

Table 18

| Top End Overhaul         |                                     |
|--------------------------|-------------------------------------|
| Clean                    | Oil suction screen                  |
| Clean<br>Inspect<br>Test | Aftercooler core<br>Oil cooler core |
| Inspect                  | Electrohydraulic actuator           |
|                          | Bypass valve                        |
|                          | Hydraulic oil pump                  |
|                          | Transformers                        |
| Rebuild                  | Exhaust bypass                      |
|                          | Prelube pump                        |
|                          | Starting motor                      |
|                          | Turbochargers                       |
|                          | Water pumps                         |
| Replace                  | Cylinder head assemblies            |
|                          | Oil temperature regulators          |
|                          | Water temperature regulators        |

## Cleaning and Inspection of Components

### Aftercooler and Oil Cooler

Clean the aftercooler core and the oil cooler core. Pressure test the components. Replace the components, if necessary.

**Note:** If the cooling system is not properly maintained, cleaning of the aftercooler can be difficult. The tank that is opposite of the inlet port and the outlet port can not be removed for cleaning.

**Note:** This procedure may be used for cleaning both the aftercooler core and the oil cooler core.

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

#### NOTICE

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

3. Back flush the core with cleaner.

Caterpillar recommends the use of Hydrosolv liquid cleaner. Consult your Caterpillar dealer for part numbers and sizes of containers.

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

4. Steam clean the core in order to remove any residue. Flush the fins of the 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.

**Note:** The test pressure for the oil cooler is 790 kPa (115 psi). The maximum differential pressure of water for the aftercooler is 44 kPa (6 psi). The maximum differential pressure of air for the aftercooler is 5.1 kPa (0.74 psi).

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

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

**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 after the engine oil pan has been drained.

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

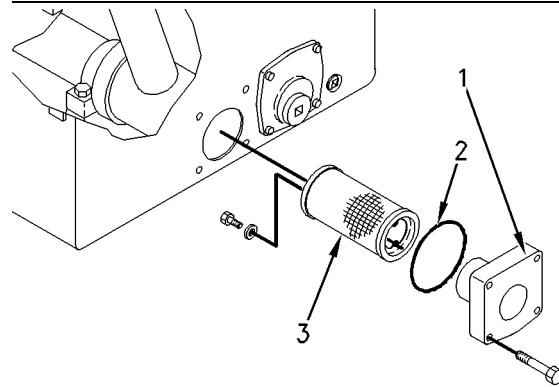


Illustration 74

g00760655

- (1) Cover
- (2) O-ring seal
- (3) Screen assembly

1. Loosen the bolts from cover (1). Remove cover (1) and O-ring seal (2). Discard the seal. Remove screen assembly (3).
2. Wash screen assembly (3) in clean nonflammable solvent. Allow the screen assembly to dry before installation.
3. Clean the engine oil sump. Remove the side covers in order to gain access to the sump. After the sump is clean, install the side covers.
4. Inspect screen assembly (3) for good condition. Obtain a new screen assembly, if necessary. Install the screen assembly. Install a new O-ring seal (2). Install cover (1).

**Transformers**

The transformers produce a voltage increase. For good operation, the connections must be clean and secure. Inspect the transformers for the following conditions:

- Damaged O-rings
- Dirty insulator
- Loose connections
- Loose connector
- Loose screws in the top ground spring
- Moisture

Measure the voltage of the diode for the primary circuit and measure the resistance of the secondary circuit according to Troubleshooting, RENR2270, "G3500B Engines". Consult your Caterpillar dealer for assistance.

i01950926

## Overhaul Considerations

**SMCS Code:** 7595-043

### Overhaul Information

An overhaul is replacing the major worn components of the engine. An overhaul 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 the Operation and Maintenance Manual. 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

Top end overhauls are determined by the projection of exhaust valve stems. In-frame overhauls are determined by cylinder compression, crankcase blowby, and oil consumption. Major overhauls are determined by the in-frame tests, and by results of S·O·S oil analysis.

Some other 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

**Note:** To avoid oil problems, engines that are turbocharged and aftercooled must be operated at a minimum of 60 percent of rated load.

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.

### 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. New parts are not necessary if the old parts can be reused, repaired, or salvaged.



If the parts are not within the inspection specifications, the parts should be salvaged, repaired, replaced, or exchanged. 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.

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:

- Alternators
- Connecting rods
- Crankshafts
- Cylinder heads
- Oil Pumps
- Starting motors
- 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.

i01951469

## Oxygen Sensor - Calibrate (If Equipped)

**SMCS Code:** 1096

The oxygen sensor is very important for these considerations:

- Control of emissions
- Engine performance

### **WARNING**

**During operation, the oxygen sensor may reach temperatures that exceed 700 °C (1292 °F). Severe personal injury and property damage will result from contact with a hot oxygen sensor.**

**Do not touch the sensor during engine operation, calibration, or testing. Allow the sensor to cool before moving the sensor. Wear gloves that resist heat. Do not place the sensor on or near any flammable material or any surface that can be damaged by high temperatures.**

The sensor must be calibrated periodically in order to ensure proper operation. If a new sensor will be installed, calibrate the new sensor before installation.

During calibration, the sensor must be temporarily removed from the exhaust system. It is necessary to expose the sensor to clean air.

**Note:** When you reinstall an oxygen sensor, always use a new 9Y-6792 Spark Plug Gasket.

DO NOT calibrate the sensor in an environment with the following conditions:

- The ambient temperature is greater than 38 °C (100 °F).
- The relative humidity is greater than 90 percent.

For instructions, refer to Service Manual, RENR2270, "Troubleshooting".

i01113939

## Starting Motor - Inspect

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

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

The starting 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 starting motor pinion does not engage the flywheel ring gear. The teeth of the starting 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 starting 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 starting motor pinion and the flywheel ring gear must be replaced.

## Electric Starting Motor

**Note:** Problems with the electric starting motor can be caused by the following conditions: malfunction of the solenoid and malfunction of the electric starting system.

Inspect the electrical system for the following conditions:

- Loose connections
- Corrosion
- Wires that are worn or frayed
- Cleanliness

Make repairs, if necessary.

## Air Starting Motor

### **WARNING**

**Personal injury or death can result from improperly checking for a leak.**

**Always use a board or cardboard when checking for a leak. Escaping air or fluid under pressure, even a pin-hole size leak, can penetrate body tissue causing serious injury, and possible death.**

**If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.**

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

If the teeth of the starting motor pinion and/or the flywheel ring gear are damaged, the air circuit for the starting motor must be examined in order to determine the cause of the problem.

## Removal and Installation of the Starting Motor

Refer to the Service Manual, "Disassembly and Assembly" module for information on removing the starting motor and installing the starting motor.

Consult your Caterpillar dealer for assistance.

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## Throttle Control Valve - Check

**SMCS Code:** 1269-535

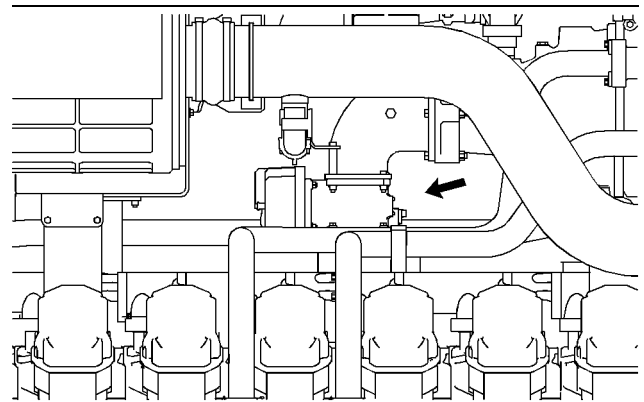


Illustration 75

g01090077

Check the throttle for leaks. If necessary, remove the throttle according to the instructions in the Disassembly and Assembly manual. Inspect the throat of the throttle for wear marks. Check for free movement of the butterfly valve. If necessary, replace the bearings.

Inspect the gaskets for wear or damage. If necessary, replace the gaskets. Reinstall the throttle according to the instructions in the Disassembly and Assembly manual.

i01454354

## Turbocharger - Inspect

**SMCS Code:** 1052-040

Periodic inspection and cleaning is recommended for the turbocharger. Fouling of the turbine wheels can contribute to loss of engine power 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. Also, the chance for potential damage to other engine parts is reduced.

**Note:** Turbocharger components require clearances that are precise. The turbocharger cartridge must be balanced due to high rpm.

The following conditions can cause the turbocharger to be out-of-balance:

- The buildup of deposits

- Chipping and/or flaking of deposits

If the turbocharger must be removed for inspection, use caution. Do not break deposits from the turbine wheel. Do not attempt to clean the turbine wheel. For options regarding removal, installation, repair and replacement, see the Service Manual or consult your Caterpillar dealer.

1. Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil.
2. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger should be reconditioned.
3. Check the compressor wheel for cleanliness. If only the inlet 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 result from restriction of the inlet air (plugged air filters). This causes oil to leak past the seal for the turbocharger compressor.

If oil is found on the compressor wheel and/or at the air inlet, the source of the oil is the fuel compressor or the PCV system.

**Note:** Deposits of ash and silicone can accumulate on the turbine wheel. Turbine wheel will become unbalanced when the deposits flake off. The turbocharger cartridge must be replaced when this occurs. However, remove deposits from the housing. This will prevent wear on the blades of the new turbine wheel.

4. Inspect the turbine wheel and the nozzle for deposits of ash and silicone. If deposits of 1.6 mm (0.06 inch) thickness are found or if the turbine is in contact with the housing, the turbocharger must be disassembled and cleaned. Removal of the deposits can be difficult.
5. Inspect the bore of the turbine housing for corrosion and deposits.
6. Clean the turbocharger compressor housing with standard shop solvents and a soft bristle brush.

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

i01966163

## Valve Stem Projection - Measure/Record

**SMCS Code:** 1105-082

**Valve Recession** – The valves and the valve seats are worn over time. This causes the valves to recede into the cylinder head. This condition is called “valve recession”.

The exhaust valves and valve seats show the greatest wear. The top end overhaul is scheduled according to the recession of the exhaust valves.

It is difficult to measure the actual valve recession in the cylinder head. A simpler method is used to determine the valve recession:

- Measure the projection of the valve rotator above the cylinder head. It is not necessary to remove the rocker arms in order to obtain this measurement.

Measure the projection of the exhaust valve rotators with a 155 - 1536 Valve Recession Tool Group. Follow the instructions that are provided with the tool group.

Record the measurements on the Operation and Maintenance Manual, “Valve Data Sheet” (Reference Materials Section).

- Measure the projection of the exhaust valve rotators after 250 service hours. This measurement is the baseline. The baseline is a reference for subsequent measurements.
- Measure the projection of the exhaust valve rotators at the first 1000 service hours. Illustration 76 shows schedules for determining subsequent intervals.
- After 70 percent of the maximum limit has been reached, measure the projection of the exhaust valve rotators at every 1000 hours of operation. The 70 percent is 1.60 mm (0.063 inch).
- Plan for the top end overhaul as the projection of the valve rotator approaches the maximum limit. Perform the top end overhaul when the projection of the valve rotator has increased by a total of 2.3 mm (0.09 inch). **Do not allow the recession of the exhaust valves to exceed this limit.** The valve head can break. This will cause severe damage in the combustion chamber.

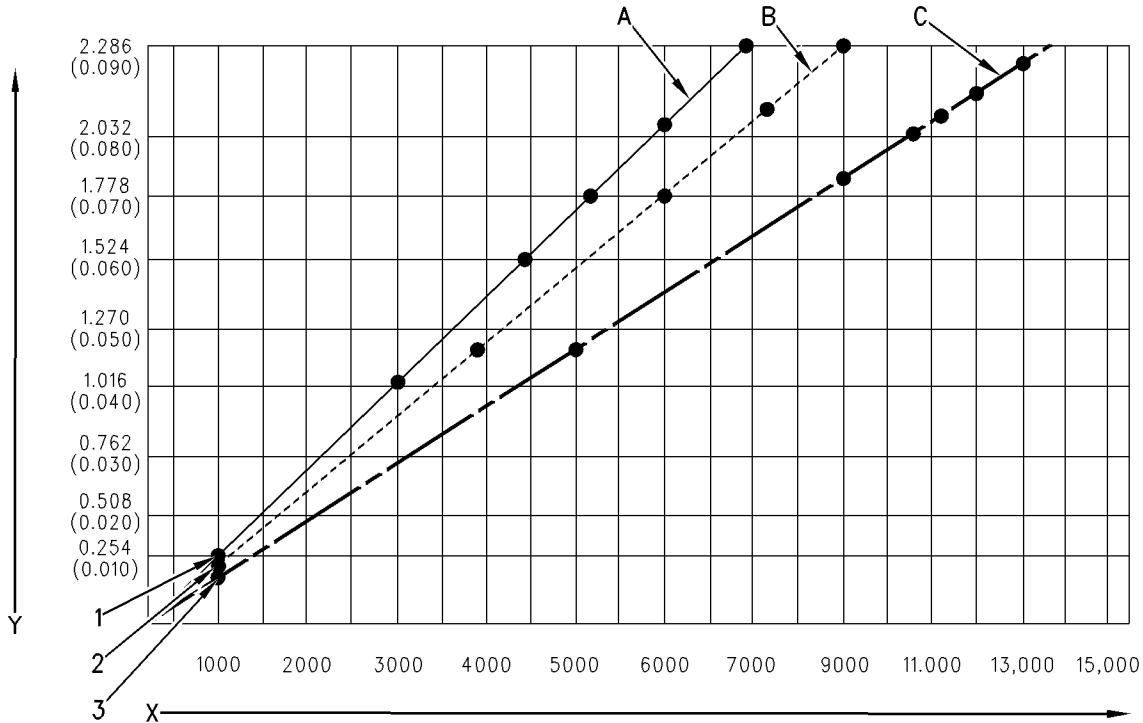


Illustration 76

g00792504

- |   |                            |
|---|----------------------------|
| (A) Schedule                                | (X) Hours of operation     |
| (B) Schedule                                | (1) 0.254 mm (0.0100 inch) |
| (C) Schedule                                | (2) 0.218 mm (0.0086 inch) |
| (Y) Valve recession in millimeters (inches) | (3) 0.152 mm (0.0060 inch) |

To determine intervals, use the point on the graph in Illustration 76 that is closest to the measurement for each cylinder.

i01492446

For example, suppose that the measurement that was obtained at the initial 1000 hours shows a valve recession of approximately 0.152 mm (0.0060 inch). According to Schedule (C), the next interval for measuring that cylinder is at 5000 service hours. Another cylinder may have a valve recession of approximately 0.254 mm (0.0100 inch). According to Schedule (A), the next interval for measuring that cylinder is at 3000 service hours.

Consult your Caterpillar dealer for assistance.

## 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 room 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, clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

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NOTICE

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

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- Ensure that cooling lines are properly clamped. 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 instructions on removal and installation of water pumps and/or seals, refer to the Service Manual, "Disassembly and Assembly" module 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 covers.

 **WARNING**

**NEVER use a flame to check for gas leaks. Use a gas detector.**

**An open flame can ignite mixtures of air and fuel. This will cause explosion and/or fire which could result in severe personal injury or death.**

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- Check the fuel system for leaks. Look for loose fuel line clamps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground straps for good connections 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. If a leak is found, make repairs.

i00524084

## 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 the Service Manual for the disassembly and assembly procedure.

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

i01023425

## Water Temperature Regulator - Replace

**SMCS Code:** 1355-510

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

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

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

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner. Also, a low temperature can allow moisture to condense in the oil. This can form damaging acids.

---

NOTICE

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

Never operate the engine without the water temperature regulators installed.

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

---

For the procedure to replace the water temperature regulators, see the Service Manual, "Disassembly and Assembly" module. Consult your Caterpillar dealer for assistance.

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