

3408 and 3412 DIESEL MARINE PROPULSION ENGINES

Maintenance Intervals

Taller MQ-JL

Excerpted from Operation & Maintenance Manual (SEBU6728-02-01)

3408 Marine Engine Maintenance Schedule

NOTE: For all marine transmission lubrication and maintenance activities, refer to your marine transmission or vessel OEM literature.

Use fuel consumption, service hours, or calendar time, whichever occurs first, to determine maintenance intervals. Experience has shown that maintenance intervals are most accurately scheduled on the basis of fuel consumed rather than service hours.

Daily

Walk-Around Inspection – Inspect engine for leaks and loose connections	71
Engine Crankcase – Check oil level	72
Cooling System – Check coolant level	73
Air Cleaner – Check service indicator/Service air cleaner when needed	73
Air Starter (If Equipped) – Check lubricator oil level	75
Clutch (If Equipped) – Check/Adjust/Lubricate	76
Marine Transmission – Check oil level	76

Every 2550 L (675 gal) of Fuel or 50 Hours

Zinc Rods – Inspect/Replace	77
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First 12,750 L (3375 gal) of Fuel or 250 Hours

¹ Valve Lash – Check/Adjust (at the first oil change interval)	99
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Every 12,750 L (3375 gal) of Fuel or 250 Hours or Yearly

¹ Scheduled Oil Sampling (S•O•S) – Obtain Sample and analysis	78
¹ Engine Crankcase – Replace oil and filter(s)	79
¹ Crankcase Breathers – Clean	82
Fuel System – Clean primary fuel filter (if equipped)/Replace final fuel filter	82
Fuel Tank – Drain water and sediment	85
Cooling System (Conventional HD Coolant Only)– Test for SCA concentration OR obtain Level I coolant analysis/Add SCA if necessary	86
Air Cleaner – Clean/Replace air filter elements	88
Belts – Check/Adjust/Replace	90
Hoses and Clamps – Inspect/Replace	91
Batteries – Clean/Check (if required)	92

Every 51,000 L (13,500 gal) Of Fuel Or 1000 Hours

Engine Protection Devices – Inspect/Check	94
Magnetic Pickup – Inspect/Adjust	94

Every 153,500 L (40,500 gal) Of Fuel Or 3000 Hours

Water Temperature Regulators (Thermostats) – Replace	95
Cooling System (Extended Life Coolant Only) – Add Extender	96
² Cooling System (Conventional HD Coolant Only) – Drain/Clean/Replace coolant	96
Engine Mounts – Inspect	98
Crankshaft Vibration Damper – Inspect	99
Valve Lash, Valve Rotators – Check/Adjust	99
Fuel Ratio Control, Set Point, and Low Idle – Check/Adjust	100
PAR Analysis – Obtain	101

Every 256,000 L (67,500 gal) Of Fuel Or 5000 Hours

Fuel Injection Nozzles – Test/Exchange	102
Jacket Water Pump – Inspect/Rebuild or Exchange	103
Raw/Sea Water Pump – Inspect/Rebuild or Exchange	103
Alternator – Inspect/Rebuild or Exchange	103
Starting Motor – Inspect/Rebuild or Exchange	103
Air Compressor (If Equipped) – Inspect/Rebuild or Exchange	103
Turbocharger – Clean/Inspect/Check	104

Every 6000 Hours Or Four Years

Cooling System (Extended Life Coolant Only) – Drain/Flush/Replace Coolant	105
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Overhaul

Overhaul Considerations	106
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¹ 3408 Marine Engines that are equipped with the deep oil sump [87 L (92 qt)] may perform this maintenance after 25,500 L (6750 gal) of fuel or 500 Hours.

² If a commercial HD coolant/antifreeze meeting ASTM D4985 specifications is used, or if a mixture of commercial SCA and water is used, this maintenance should be performed at a maximum of One Year.

3412 Marine Engine Maintenance Schedule

NOTE: For all marine transmission lubrication and maintenance activities, refer to your marine transmission or vessel OEM literature.

Use fuel consumption, service hours, or calendar time, whichever occurs first, to determine maintenance intervals. Experience has shown that maintenance intervals are most accurately scheduled on the basis of fuel consumed rather than service hours.

Daily

Walk-Around Inspection – Inspect engine for leaks and loose connections	71
Engine Crankcase – Check oil level	72
Cooling System – Check coolant level	73
Air Cleaner – Check service indicator/Service air cleaner when needed	73
Air Starter (If Equipped) – Check lubricator oil level	75
Clutch (If Equipped) – Check/Adjust/Lubricate	76
Marine Transmission – Check oil level	76

Every 3800 L (1000 gal) of Fuel or 50 Hours

Zinc Rods – Inspect/Replace	77
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Every 19,000 L (5,000 gal) Of Fuel Or 250 Hours or Yearly

Fuel System – Clean primary fuel filter (if equipped)/Replace final fuel filter	82
Fuel Tank – Drain water and sediment	85
Cooling System (Conventional HD Coolant Only)– Test for SCA concentration, OR obtain Level I coolant analysis/Add SCA if necessary	86
Air Cleaner – Clean/Replace air filter elements	88
Belts – Check/Adjust/Replace	90
Hoses and Clamps – Inspect/Replace	91
Batteries – Clean/Check (if required)	92

First 38,000 L (10,000 gal) of Fuel or 500 Hours

Valve Lash – Check/Adjust (at the first oil change interval)	99
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Every 38,000 L (10,000 gal) of Fuel or 500 Hours

Scheduled Oil Sampling (S•O•S) – Obtain Sample and analysis	93
Engine Crankcase – Replace oil and filter(s)	93
Crankcase Breathers – Clean	93

Every 76,000 L (20,000 gal) Of Fuel Or 1000 Hours

Engine Protection Devices – Inspect/Check	94
Magnetic Pickup – Inspect/Adjust	94

Every 227,500 L (60,000 gal) Of Fuel Or 3000 Hours

Water Temperature Regulators (Thermostats) – Replace	95
Cooling System (Extended Life Coolant Only) – Add Extender	96
¹ Cooling System (Conventional HD Coolant Only) – Drain/Clean/Replace coolant	96
Engine Mounts – Inspect	98
Crankshaft Vibration Damper – Inspect	99
Valve Lash, Valve Rotators – Check/Adjust	99
Fuel Ratio Control, Set Point, and Low Idle – Check/Adjust	100
PAR Analysis – Obtain	101

Every 379,000 L (100,000 gal) Of Fuel Or 5000 Hours

Fuel Injection Nozzles – Test/Exchange	102
Jacket Water Pump – Inspect/Rebuild or Exchange	103
Raw/Sea Water Pump – Inspect/Rebuild or Exchange	103
Alternator – Inspect/Rebuild or Exchange	103
Starting Motor – Inspect/Rebuild or Exchange	103
Air Compressor (If Equipped) – Inspect/Rebuild or Exchange	103
Turbocharger – Clean/Inspect/Check	104

Every 6000 Hours Or Four Years

Cooling System (Extended Life Coolant Only) – Drain/Flush/Replace Coolant	105
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Overhaul

Overhaul Considerations	106
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¹ If a commercial HD coolant/antifreeze meeting ASTM D4985 specifications is used, or if a mixture of commercial SCA and water is used, this maintenance should be performed at a maximum of One Year.

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Maintenance Section
Notes

Notes

Taller MQ-JL

Daily

You must read and understand the warnings and instructions contained in the Safety section of this manual, before performing any operation or maintenance procedures.

Walk-Around Inspection

Inspect Engine for Leaks and Loose Connections

A walk-around inspection should only take a few minutes of your time. By taking the time to make these checks, costly repairs and accidents can be avoided and your equipment will be ready to run should the need arise.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil or coolant leaks, loose bolts, worn fan belts, loose connections and trash build-up. Remove trash build-up and have repairs made as needed.

- All guards must be in place. Repair or replace missing or damaged guards.
- Wipe all fittings, caps and plugs before servicing to reduce the chance of system contamination.

NOTICE

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

NOTICE

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

- Make sure cooling lines are properly clamped and tight. Check for loose fittings or leaks. Check the condition of all pipes and fittings.
- Check the marine transmission oil level. Refer to the marine transmission OEM literature or refer to the vessel OEM literature.
- Inspect water pump(s) for coolant leaks.

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

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

- Inspect the lube system for leaks at the front and rear crankshaft seals, the oil pan, the oil filters, and the valve covers.

NOTICE

Fuel line clamps should not be over torqued. Over torquing causes the clamps to butterfly, which results in low clamping force, fuel line vibration and eventual failure. Refer to the Torque Specifications in this manual.

- Inspect the fuel system for leaks. Look for loose fuel line clamps and fittings.
- Inspect the air inlet system piping and elbows for cracks and loose clamps.
- Inspect the alternator belt and the accessory drive belts for cracks, breaks or other damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt of a two or three belt set is replaced, it will carry more of a load than the belts not replaced since the older belts are stretched. The additional load on the new belt could cause it to break.

- Drain water and sediment from fuel tanks on a daily basis to ensure only clean fuel enters the fuel system.
- Inspect the wiring and the wiring harnesses for loose connections and worn or frayed wires.

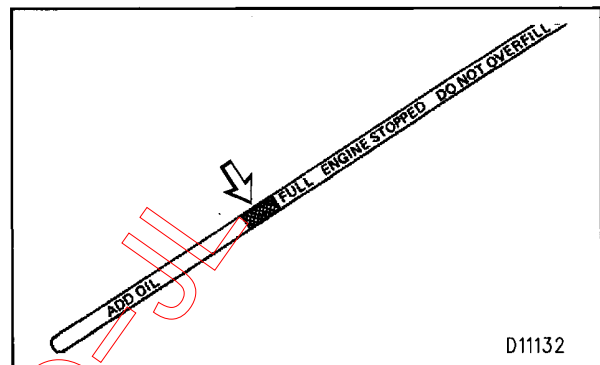
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Maintenance Section
Daily

- Inspect the engine ground strap for good connection and condition.
- Disconnect any battery chargers that are not protected against the starter current drain. Check the condition and the electrolyte level of batteries, unless equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges which are cracked or cannot be calibrated.

Engine Crankcase

Check Oil Level

The preferred time to check the oil level is when the engine is stopped. This maintenance should be performed on as level a surface as possible.



1. Maintain the oil level between the ADD and FULL marks on the ENGINE STOPPED side of the dipstick. Do not fill the crankcase above the FULL mark.

NOTICE

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

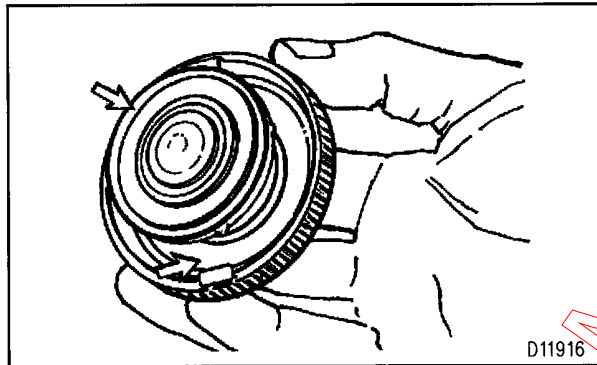
2. Remove the oil filler cap and add oil if necessary. Clean the cap. Clean the cap receptacle. Install the cap.

Cooling System

Check Coolant Level

Check the coolant level with the engine stopped and cool.

1. Remove the cooling system filler cap slowly to relieve any pressure.
2. Maintain the coolant level within 13 mm (½ inch) below the bottom of the fill pipe or to the proper level on the sight glass (if equipped).

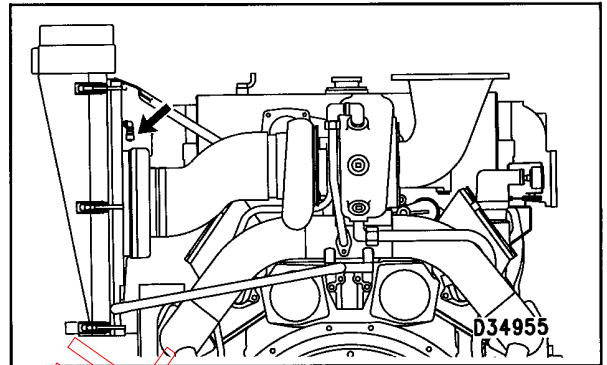


Typical filler cap gaskets.

3. Clean the filler cap. Inspect the filler cap gaskets. Replace the cap if the gaskets are damaged. Clean the filler cap receptacle. Install the cap.
4. Inspect for leaks.

Air Cleaner

Check Service Indicator

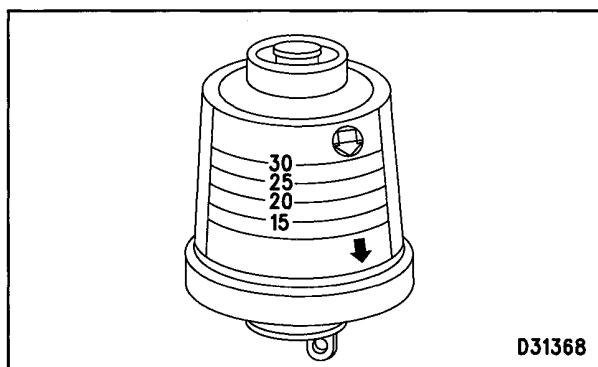


Typical service indicator, mounted on the air cleaner housing.

Your engine may be equipped with a different indicator.

Some vessels are equipped with an inlet air pressure differential gauge. The gauge reads the difference between inlet air pressure before and after the air cleaner. As the air cleaner filter element becomes dirty, the pressure differential rises. If your vessel is equipped with a gauge or some other type of air cleaner service indicator, follow the vessel or air cleaner OEM recommendations for servicing the air cleaner.

A service indicator may be mounted on the air cleaner or in a remote location. A colored piston showing in the window indicates the need for servicing the air cleaner.



Typical service indicator.

Observe the air cleaner service indicator. Clean or replace the air cleaner filter element when the yellow diaphragm enters the red zone or the red piston locks in the visible position. If the air cleaner indicator shows red at any time, clean the filter element or install a new element.

Test Service Indicator

Air cleaner service indicators are inexpensive but important instruments.

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

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

Severely dusty environments may require frequent indicator replacements. Replace the indicator yearly, regardless of operating conditions. Replace the indicator at Overhaul, and whenever major engine components are replaced.

NOTE: When you install a new indicator, excessive force may crack the top of the indicator. Tighten the indicator to a torque of 2 N•m (18 lb in).

Service Air Cleaner

NOTICE

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

NOTICE

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

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

If the air cleaner indicator shows red at any time, clean the filter element or install a new element. Clean or replace air cleaner filter elements at least Every 250 Hours. Severely dusty environments may require more frequent air cleaner service.

Refer to the Air Cleaner topic in the Every 250 Hours section of this manual.

Air Starter

Check Lubricator Oil Level

NOTICE

Never allow the lubricator bowl (if equipped) to become empty. The starting motor will be damaged by lack of proper lubrication.

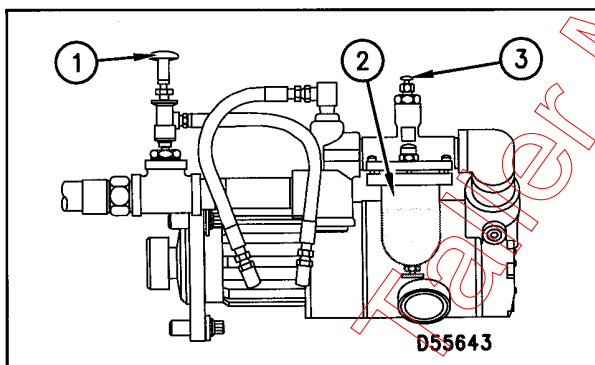
If no mist is observed, or if the mist is excessive: rotate the adjustment knob in $\frac{1}{16}$ turn increments to increase or decrease the oil mist. Repeat the starter cranking and observation until the mist is satisfactory.

NOTE: Drip rates should only be made under an average steady flow condition. Once established, the lubricator will automatically adjust the drip rate proportionally to variations in air flow.

The vanes of the starting motor are lubricated with a fine mist of oil from the motor lubricator. Check the level of oil in the lubricator bowl. If the bowl is less than half full, add lubricant. Use non detergent 10W engine oil for temperatures that are greater than 0°C (32°F). Use air tool oil for temperatures below 0°C (32°F).

Oiler Feed Adjustment

If necessary, adjust the lubricator to release approximately two drops of fluid per 30 seconds into the starting motor air stream.



Air start valve (1), lubricator bowl (2), and adjustment knob (3).

Be sure there is NO fuel supply to the engine.

1. Turn the adjustment knob CW until the knob locks.
2. Turn the adjustment knob CCW $\frac{1}{4}$ turn.
3. Crank the starter motor for ten seconds and observe the exhaust air from the starter motor mufflers. Look for oil mist. You should see a slight oil mist. The mist should be barely visible.

Clutch

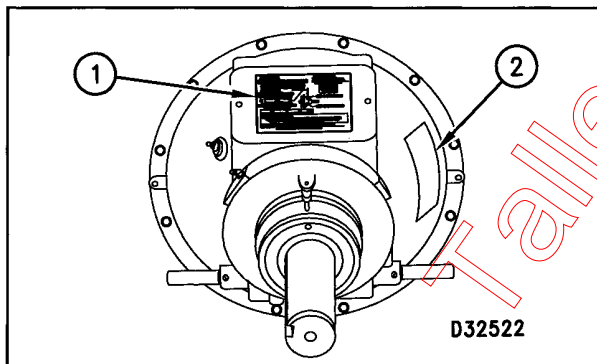
Check/Adjust/Lubricate

NOTICE

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

Clutch adjustment should be checked regularly after "wear in." Heavy duty applications which have frequent engagements and relatively long periods of clutch slip require more frequent adjustment than light duty applications. Operating torque should be measured to determine if clutch adjustment is required.

Refer to the clutch OEM service instructions and the clutch instruction plate for lubrication, adjustment, and other service recommendations. Perform the maintenance specified on the instruction plate.



Typical clutch Instruction Plate (1) and Serial Number Plate (2) locations.

⚠ WARNING

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

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

Marine Transmission

Check Oil Level

Marine Transmission Operation, Maintenance, Warranty, and Parts Support

Caterpillar encourages customers to refer to their Caterpillar dealer and/or marine transmission OEM dealer for information regarding operation and maintenance for the marine transmission.

All warranty and parts support for the marine transmission (including installation and service problem resolution) will be the responsibility of the selling dealer.

For the lubrication and maintenance requirements of your marine transmission model, refer to the OEM recommendations on the nameplate or owners' manual.

Every 50 Hours

You must read and understand the warnings and instructions contained in the Safety section of this manual, before performing any operation or maintenance procedures.

Zinc Rods

Corrosion in sea water circuits can result in premature deterioration of system components, leaks, and possible cooling system contamination. The cause for the accelerated corrosion may be the lack of sacrificial zinc anodes (rods) in the sea water system.

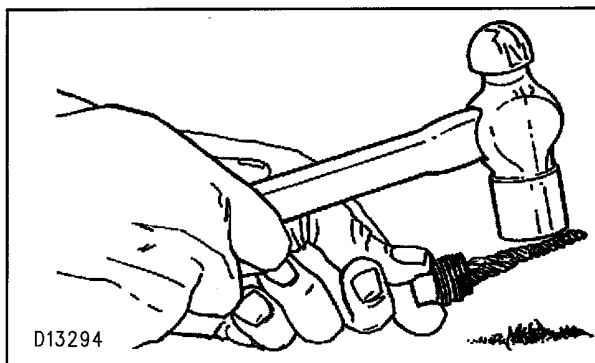
Zinc rods are inserted in the engine's sea water cooling system to help prevent the corrosive action of salt (sea) water. The reaction of the zinc to the sea water causes the rods to deteriorate, instead of more critical engine cooling system parts. Rapid deterioration of zinc rods may indicate the presence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

The zinc rods must be inspected every 50 service hours and replaced when they have deteriorated.

The location and number of zinc rods depends on the individual engine and the engine's attachments. Zinc rods are located in: the heat exchanger bonnet, the aftercooler lines, the raw/sea water heat exchanger bonnet, the raw/sea water pump, and the raw/sea water lines.

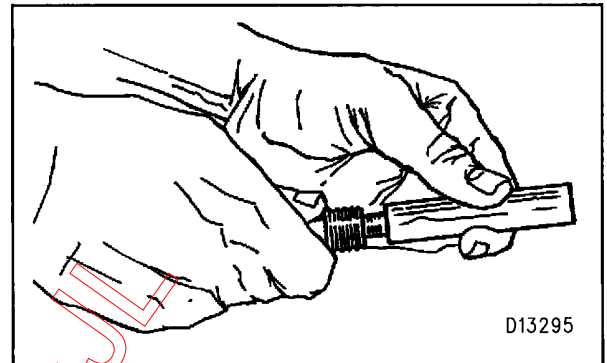
Inspect

1. Remove all the zinc rod assemblies. The assembly plugs are painted red for easy identification.



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

Replace



- 1.** Unscrew or drill the old rod from the plug. Clean the plug.
- 2.** Apply 9S-3263 Compound to the shoulder of a new rod. Apply the compound **only to the shoulder of the rod**. Install the rod into the plug.
- 3.** Coat the external threads of the plug with 5P-3413 Pipe Sealant. Install the zinc rod assembly. Refer to the Torque Specifications in this manual.

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Maintenance Section
Every 250 Hours

Every 250 Hours

You must read and understand the warnings and instructions contained in the Safety section of this manual, before performing any operation or maintenance procedures.

Scheduled Oil Sampling (S•O•S) Analysis

For the 3408 deep sump engines and for the 3412 engines, this maintenance can be performed Every 500 Hours.

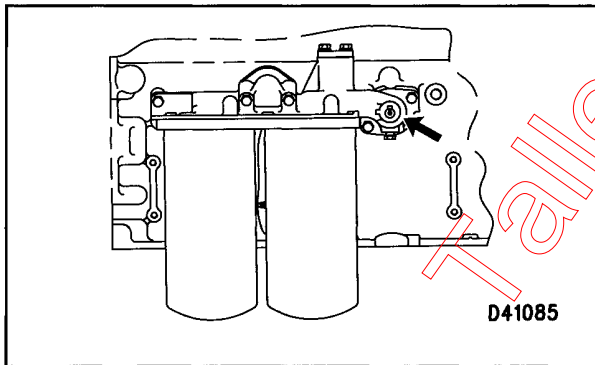
Obtain Sample and Analysis

To complement a good preventive maintenance program, Caterpillar recommends using S•O•S oil analysis at regular scheduled intervals to monitor the condition and maintenance requirements of your engine.

Each oil sample should be taken when the oil is warm and well mixed to ensure that the sample is representative of the oil in the crankcase.

Caterpillar recommends using the first or second method. If these methods are not feasible, then use the drain stream method. When using the drain stream method to obtain the oil sample, do not sample from the first or final draining. The oil at the beginning or end of the drain stream is not mixed well enough to be representative of the oil in the crankcase.

Consult with your Caterpillar dealer for complete information and assistance in establishing an S•O•S program for your engine.



Typical oil sampling valve.

To obtain S•O•S samples:

- Use the oil sampling valve (if equipped)
- Use a sampling gun inserted into the sump
- Use the drain stream when changing oil

Engine Crankcase

For the 3408 deep sump engines and for the 3412 engines, this maintenance can be performed Every 500 Hours.

This maintenance should be performed on as level a surface as possible.

Replace Oil and Filter(s)

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

Failure to follow this recommended procedure would result in these waste particles being recirculated through your engine lubrication system with the new oil.

Drain Oil

NOTICE

Do not allow the oil to drain into the bilge sump.

After the engine has been run at normal operating temperature, STOP the engine. The method you use to drain your engine's crankcase oil depends on your engine equipment.

- If equipped with a drain valve, turn the valve knob counterclockwise (CCW) to drain the oil. After the oil has drained, turn the valve knob clockwise (CW) to close the drain.
- If not equipped with a drain valve, remove the oil drain plug(s) and allow the oil to drain. After the oil has drained, clean the oil drain plug(s). Clean the oil drain plug fitting(s). Install the oil drain plug(s). Tighten the plug(s) to $80 \pm 11 \text{ N}\cdot\text{m}$ ($60 \pm 8 \text{ lb ft}$).

- If a sump pump is used:

1. Connect a suitable drain line to the pump outlet. Ensure that the oil will drain into a suitable container.
2. With the engine stopped and the oil warm, open the sump pump valve to the engine crankcase drain line. The two marks on the valve must be turned so that one mark points to the pump, and the second mark points to the engine crankcase drain line.
3. Operate the pump handle until the crankcase is empty.
4. Close the pump valve to the engine crankcase drain line.

Replace Filters

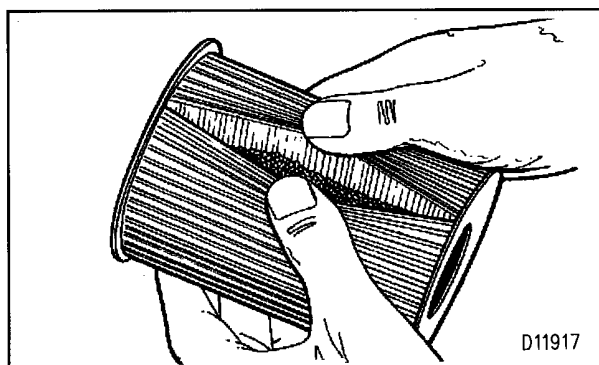
Replace the oil filters at every oil change. Make sure to use the correct oil filters for your engine arrangement.

NOTE: Refer to the Duplex Oil Filters topic in this publication if your engine is equipped with duplex oil filters.

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 your engine bearings, crankshaft, etc., as a result of the larger debris particles from unfiltered oil entering your engine lubricating system. Only use oil filters recommended by Caterpillar.

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



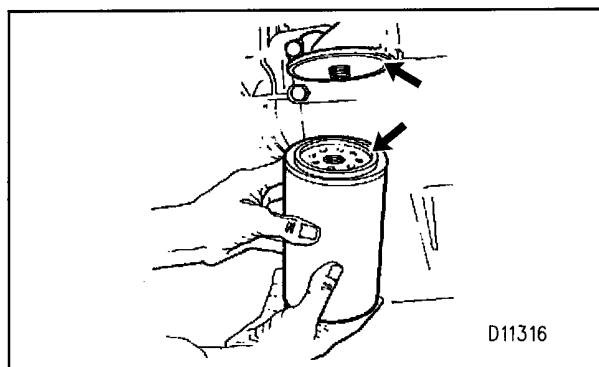
Element with debris.

2. Cut the oil filter open with a 4C-5084 Oil Filter Cutter. Spread the pleats apart and inspect the element for metal debris. An excessive amount of debris in the oil filter element may indicate early wear or a pending failure.

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

Non-ferrous metals may indicate wear on the aluminum, brass or bronze parts of your engine, such as main and rod bearings, turbocharger bearings and cylinder heads.

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



Typical filter mounting base and filter gasket.

- 3.** Clean the sealing surface of the filter mounting base. Make sure all of the old gasket is removed.
- 4.** Apply clean engine oil to the new filter gasket.

NOTICE

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

- 5.** Place the filter in position. Tighten the filter until the gasket contacts the base. Tighten the filter $\frac{3}{4}$ of a turn more (270 degrees) by hand. Do not over tighten.

Fill Crankcase

- 1.** Remove the oil filler cap. Refer to Lubricant Specifications for the proper oil to use for this engine. Fill the crankcase with the proper amount of oil (refer to the Refill Capacities chart).

NOTICE

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

NOTICE

To prevent crankshaft or bearing damage, crank engine to fill all filters **BEFORE** starting. Do Not crank engine for more than 30 seconds.

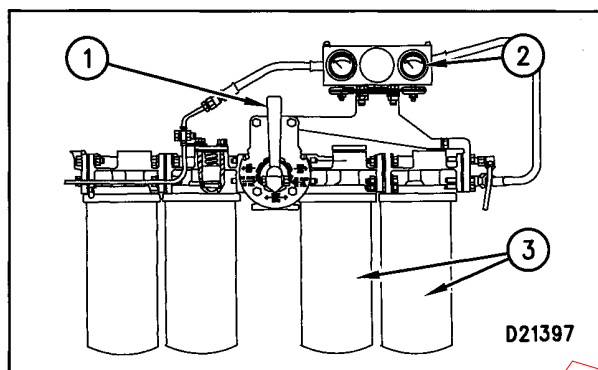
- 2.** Start and run the engine at LOW IDLE for two minutes to ensure the lube system (including auxiliary filters, etc.) has oil and the oil filter(s) are filled. Inspect for oil leaks.
- 3.** Stop the engine and allow the oil to drain back to the sump for a minimum of ten minutes.
- 4.** Remove the dipstick to check the oil level. Maintain the oil level between the ADD and FULL marks on the ENGINE STOPPED side of the dipstick.

Duplex Oil Filters

The duplex oil filter system allows the oil filters to be replaced without stopping the engine.

WARNING

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



Duplex oil filter components: lever (1), right side oil pressure gauge (2), and right side oil filters (3).

To service the right side oil filters:

1. Move lever (1) to the AUX RUN position.
2. When the right side oil pressure gauge (2) shows zero pressure, remove the two right side filters (3).
3. Clean the sealing surface of the filter mounting base. Make sure all of the old gasket material is removed.
4. Apply clean engine oil to the new filter gaskets.

NOTICE

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

5. Place the filter in position. Tighten the filter until the gasket contacts the base. Tighten the filter $\frac{3}{4}$ of a turn more (270 degrees) by hand. Do not over tighten.

6. Move the lever to the LH FLOW-RH FILL position. This will fill the two right side filters with oil and bleed out the air.

7. When the right oil pressure gauge stops rising and stabilizes, the left side filters can be serviced.

To service the left side oil filters:

8. Move the lever to the MAIN RUN position.

9. When the left side oil pressure gauge shows zero pressure, remove the two left side filters.

10. Repeat Steps 3, 4, and 5.

11. Move the lever to RH FLOW-LH FILL position. This will fill the two left filters with oil and bleed out the air.

12. When the left side oil pressure gauge stops rising and stabilizes, move the selector lever to FLOW-BOTH position. The engine oil will flow through all the filters. Inspect the filters for leaks.

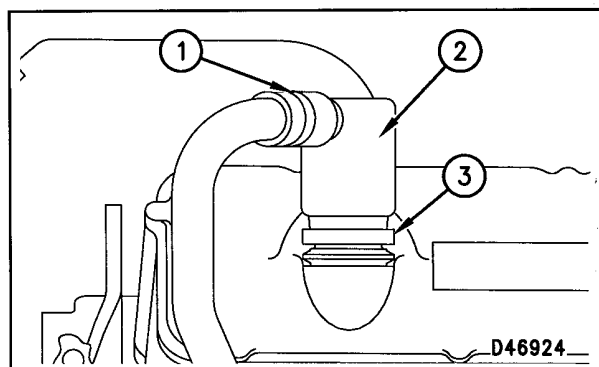
Crankcase Breathers

For the 3408 deep sump engines and for the 3412 engines, this maintenance can be performed Every 500 Hours.

NOTICE

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

Clean



Hose clamp (1), breather assembly (2), and retaining clamp (3).

1. Loosen hose clamp (1). Slide the hose from breather assembly (2).
2. Loosen retaining clamp (3). Remove breather assembly (2). Remove the crankcase breather seal.
3. Wash the breather element in clean, nonflammable solvent. Allow the breather element to dry before installation.
4. Inspect the seal for cracks or damage. Replace the seal if necessary. Install the seal. Apply clean engine oil or petroleum jelly on the rubber parts to make installation easier.
5. Install the breather assembly, hose, and clamps in reverse order of removal. Be sure to install the components in the original position.
6. Tighten retaining clamp (3) to a torque of 4.5 ± 0.6 N•m (40 ± 5 lb in). Refer to the Torque Specifications section in this manual for hose clamp (1) torque.

Fuel System

Clean/Replace Fuel Filters

! WARNING

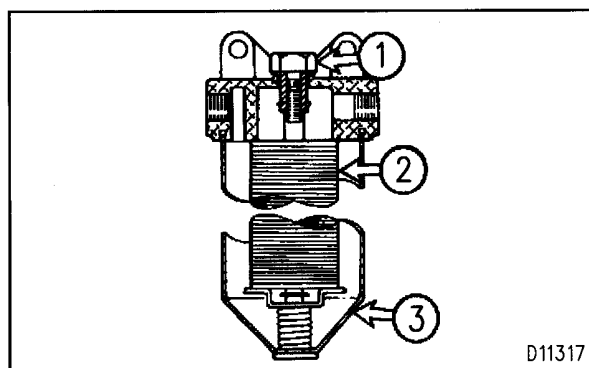
Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To prevent possible injury, turn the start switch OFF when changing fuel filters or water separator elements. Clean up fuel spills immediately.

- Stop the engine.
- Turn the START switch OFF or disconnect the battery (or starting motor) when performing maintenance on fuel filters.
- Shut off the fuel tank supply valve to the engine.

Clean Primary Fuel Filter

NOTICE

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



Typical primary fuel filter section view: bolt (1), element (2), and case (3).

1. Loosen bolt (1) and remove case (3).
2. Remove element (2). Wash the element in clean, nonflammable solvent. Allow the element to dry.
3. Install element (2) and case (3). Tighten bolt (1) to a torque of 24 ± 4 N•m (18 ± 3 lb ft).

Replace Final Fuel Filter

NOTE: Refer to the Duplex Fuel Filter topic in this publication if your engine is equipped with duplex fuel filters.

NOTICE

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

1. Remove the fuel filter with a 1U-8760 Chain Wrench.
2. Clean the gasket sealing surface of the filter base. Make sure all of the old gasket is removed.
3. Apply clean diesel fuel to the new filter gasket.

NOTICE

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

4. Place the filter in position. Tighten the filter until the gasket contacts the base. Tighten the filter $\frac{3}{4}$ turn more (270 degrees) by hand. Do not over tighten.
5. Prime the fuel system.

Priming the Fuel System

WARNING

Fuel leaked or spilled on to hot surfaces or electrical components can cause a fire. Clean up fuel spills immediately.

Prime the fuel system to fill dry fuel filters and purge trapped air. The fuel system requires priming after:

- being run dry
- storage
- fuel filter cleaning/replacement

NOTE: If the engine does not have a fuel priming pump, go to step 4.

1. Unlock and operate the priming pump until a resistance is felt. A considerable number of pump strokes may be required.
2. Push in and hand-tighten the plunger.
3. Crank the engine. If the engine starts, but runs rough, continue running the engine at low idle until the engine runs smoothly.

NOTICE

Do not crank the engine for more than 30 seconds. If the engine does not start, allow the starter motor to cool for two minutes before cranking again.

NOTE: If the engine will not start, or once started, continues to misfire or smoke, further priming is necessary. Repeat steps 1 through 3. If operating problems persist after repeating steps 1 through 3, further priming is necessary.

4. Open the vent valve (if equipped) on the fuel injection pump housing.

NOTICE

DO NOT remove the plug in the fuel filter base (for the fuel pressure sending unit [if equipped]) to purge air from the fuel system. Periodic removal of the plug will result in increased wear of the threads in the fuel filter base and lead to fuel leakage.

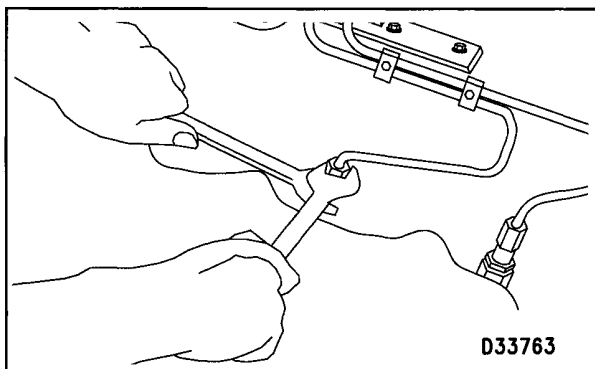
5. Operate the priming pump until the flow of fuel from the vent valve is continuous and free of air bubbles. If the engine does not have a fuel priming pump, crank the engine until the fuel flows free of air bubbles. Do not crank the engine for more than 30 seconds. Allow the starter to cool for two minutes before cranking again.

6. Close the vent valve. Push in and hand-tighten the plunger.

7. Crank the engine. If the engine starts, but runs rough, continue running the engine at low idle until the engine runs smoothly.

NOTE: If the engine will not start, or once started, continues to misfire or smoke, further priming is necessary.

8. Loosen the fuel line nuts, one at a time, at the valve cover base.



NOTICE

A fuel injection nozzle will be damaged if the top of the nozzle turns in the body. The engine will be damaged if a defective fuel injection nozzle is used because the fuel spray pattern that comes out of the nozzle will be incorrect. Fuel injection nozzles can be permanently damaged by twisting if only one wrench is used to loosen or tighten the fuel line nuts. Do NOT let the tops of the fuel nozzles turn when the fuel lines are loosened. Use one wrench to hold the nozzle and another to loosen the fuel line nut.

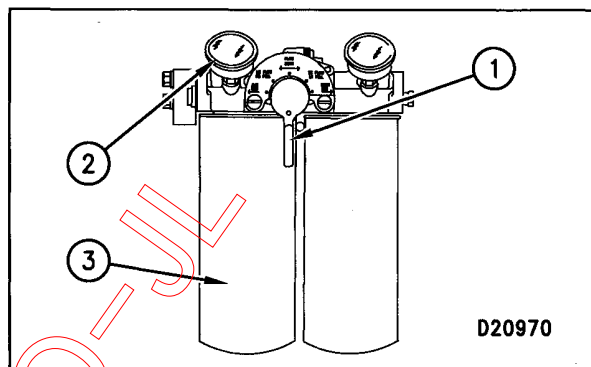
Operate the priming pump plunger until the flow of fuel from the fuel line is continuous and free of air bubbles. Push the plunger in and tighten by hand. If the engine does not have a fuel priming pump, crank the engine.

Tighten each fuel line nut before the next fuel line nut is loosened. Tighten the fuel line nuts to $40 \pm 7 \text{ N}\cdot\text{m}$ ($30 \pm 5 \text{ lb}\cdot\text{ft}$). Continue the procedure until all of the fuel lines have been cleared of air. Make sure the fuel line nuts are tightened and the priming pump is locked before starting the engine.

Duplex Fuel Filters

Replace the fuel filters when the fuel pressure gauge is in the OUT (red) range (less than 140 kPa [20 psi], on a calibrated gauge).

Perform the following steps in order to replace the duplex fuel filters.



Duplex fuel filter components: lever (1), left fuel pressure gauge (2), and left fuel filter (3).

1. Move lever (1) to the MAIN RUN position. Fuel will flow through the right filter only.
2. When left fuel pressure gauge (2) is to the extreme left edge of the OUT (red) range, remove and discard left fuel filter (3).
3. Clean the gasket sealing surface of the filter mounting base. Make sure all of the old gasket material is removed.
4. Apply clean diesel fuel to the new filter gasket.

NOTICE

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

5. Install the new filter until the gasket contacts the base. Hand tighten the filter an additional $\frac{3}{4}$ of a turn (270 degrees). Do not over tighten. Use the rotation index marks on the filter as a guide for proper tightening.

6. Move the lever to RH FLOW-LH FILL position. This will fill the left filter with fuel and bleed out the air.
7. When the left fuel pressure gauge indicator is in the NORMAL (green) range, move the lever to the FLOW BOTH position for one minute.
8. Move the lever to the AUX RUN position. Fuel will flow through the left filter only.
9. When the right fuel pressure gauge is to the extreme left edge of the OUT (red) range, remove and discard the right fuel filter.
10. Perform steps 3, 4, and 5.
11. Move the lever to LH FLOW-RH FILL position. This will fill the right filter with fuel and bleed out the air.
12. When the right fuel pressure gauge is in the NORMAL (green) range, move the lever to the BOTH FLOW position. Fuel will flow through both filters. Inspect the fuel system for leaks.

Fuel Tank

Fuel quality is critical to engine component performance and durability. Any water in the fuel can cause a failure. Condensation occurs as fuel is heated when passing through the fuel system and cools when returned to the fuel tank. This causes water to accumulate in fuel storage tanks. Water can be eliminated by draining the fuel tank regularly and by obtaining fuel from reliable sources.

Drain Water and Sediment

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

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

Check the fuel level daily. Drain the water and sediment from the fuel tank at the start of a day or after the fuel tank has been filled and allowed to stand for five to ten minutes.

Fill the engine's fuel tank at the end of each day of operation to drive out moist air and to prevent condensation. Do not fill the tank to the top. Fuel expands as it gets warm and may overflow.

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

Fuel Storage Tanks

Drain water and sediment from the fuel storage tank weekly, at the oil change, and before the tank is refilled. This will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank.

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

Every 250 Hours

Cooling System (Conventional HD Coolant Only)

Test for SCA Or Obtain Level I Analysis

Check the cooling system only after the engine is stopped and cool. Remove the filler cap slowly to relieve pressure. To prevent engine damage, never add cooling system products to an overheated engine. Allow the engine to cool first.

The use of Caterpillar SCA will prevent internal damage to the engine, such as liner or block pitting. If the SCA concentration is too low, pitting of the cylinder wall may occur, which can lead to costly engine damage.

If the SCA concentration is too high, sludge and mud-like deposits may form in the cooling system. This adversely affects engine performance and can also lead to costly repairs of the engine and cooling system.

NOTICE

The over concentration of a supplemental coolant additive will result in deposits on the higher temperature surfaces of the cooling system and create a barrier that reduces the engine's heat transfer characteristics.

Reduced heat transfer could cause cracking of the cylinder head and other high temperature components. Excessive concentrations of additive could also accelerate water pump seal wear.

Use the 4C-9301 Test Kit or use the 8T-5296 Test Kit to check for SCA concentration. Add SCA if the concentration is too low. If the SCA concentration is excessive, drain half the coolant, and replace with the proper water/antifreeze mixture.

NOTE: You may test your coolant SCA concentration OR have the SCA concentration tested as part of a S•O•S Coolant Analysis (Level I).
Obtain Level I Analysis

S•O•S Coolant Analysis is the best way to monitor the condition of your coolant and your cooling system.

Level I: Basic Coolant Maintenance Check

Checks for correct chemical balance for proper heat and corrosion control. Tests for:

- glycol
- SCA concentrations
- pH
- conductivity

S•O•S Coolant Analysis reports results and makes recommendations, usually within 24 hours. Consult with your Caterpillar dealer for more information.

Add Liquid Supplemental Coolant Additive (SCA)

NOTICE

Only add SCA if required by SCA test results.

NOTICE

Excessive and continuous over concentration of SCA (greater than the recommended 6 percent initial fill), together with antifreeze concentrations greater than 60 percent, can result in deposits on the higher temperature surfaces of the cooling system, accelerated water pump seal wear, and radiator tube blockage, forming a barrier that reduces the engine's heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components.

To prevent over inhibiting the engine's cooling system, never use both SCA liquid AND the SCA element (if equipped) at the same time.

1. Loosen the cooling system filler cap slowly to relieve pressure. Remove the cap.
2. It may be necessary to drain enough coolant from the cooling system to allow for the addition of the liquid SCA.

3. Add liquid SCA according to the requirements for your engine's cooling system capacity. Refer to the Refill Capacities chart in this manual for your engine's cooling system capacity. Refer to the Coolant Specifications in this manual for the Caterpillar SCA Requirements chart.

4. Clean the filler cap. Inspect the filler cap gaskets. Replace the cap if the gaskets are damaged. Clean the filler cap receptacle. Install the cap.

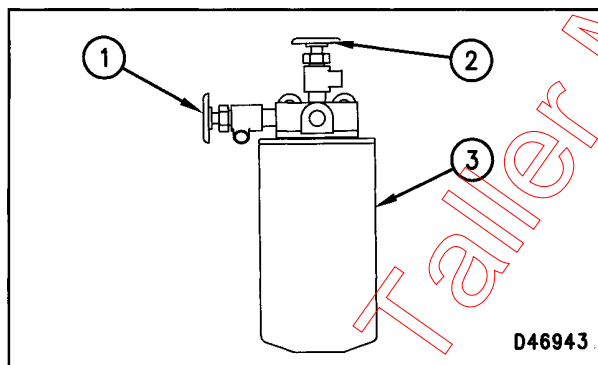
Replace SCA Element (If Equipped)

NOTICE

ONLY replace the SCA element if required by the SCA test results.

NOTICE

DO NOT use SCA and coolant additive elements together. Doing so would result in an over concentration of additive. Use one method or the other exclusively.



1. Close coolant additive element inlet valve (1) and outlet valve (2). Remove and discard coolant additive element (3).

2. Clean the element mounting base. Make sure all of the old gasket is removed.

3. Refer to the Cooling System Specifications in this manual for the proper SCA element for your system. Coat the gasket of the new SCA element with coolant.

4. Place the element in position. Tighten the element until the seal contacts the base. Tighten the element $\frac{3}{4}$ turn more (270 degrees) by hand. Do not over tighten.

5. Open inlet valve (1) and outlet valve (2).

6. Remove the cooling system filler cap. Start the engine and check for leaks. Allow the coolant level to stabilize.

7. Add the proper premixed coolant/water, if necessary, to bring the coolant to within 13 mm ($\frac{1}{2}$ inch) below the bottom of the fill pipe or to the proper level on the sight glass, if equipped.

8. Clean the filler cap. Inspect the filler cap gaskets. Replace the cap if the gaskets are damaged. Clean the filler cap receptacle. Install the cap.

Air Cleaner

Clean/Replace Air Filter Elements

NOTICE

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

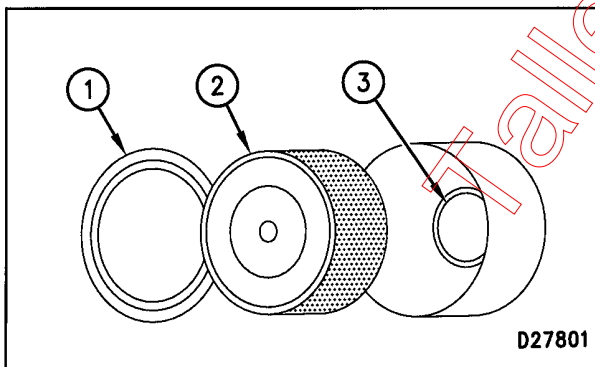
If your air cleaner element becomes plugged, the air can split the element filter material. Unfiltered air will drastically accelerate internal engine wear. Your Caterpillar dealer has air filter elements to service this unit. Contact your Caterpillar dealer for the correct filter element.

Clean or replace the air cleaner filter elements:

- at intervals recommended by the vessel or air cleaner OEM
- when required by the inlet air pressure differential gauge readings (if equipped)
- when required by the service indicator (if equipped)
- at least Every 250 Hours

Severely dusty environments may require more frequent air cleaner service.

Single Element Air Cleaner



1. Remove the air cleaner cover (1) and element (2).
2. Seal the turbocharger air inlet (3) so that debris can not enter the inlet. Use tape, or secure a clean cloth over the opening.
3. Clean the inside of the air cleaner cover and body.
4. Inspect the replacement element for damage, dirt or debris.

5. Remove the seal from the turbocharger inlet.
6. Install a clean, undamaged element.
7. Install the air cleaner cover.
8. Reset the service indicator.

Cleaning Air Filter Elements

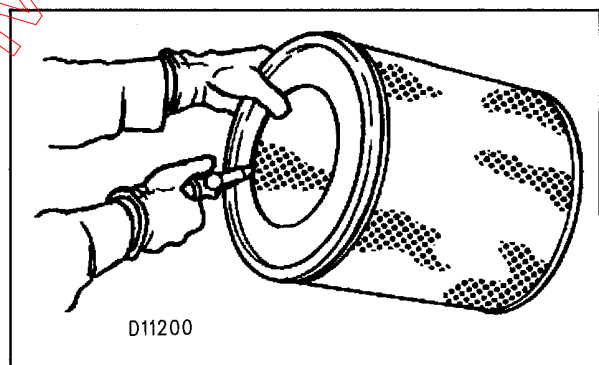
The primary element (Caterpillar air filters) can be cleaned several times before replacement. The element, when cleaned, should be thoroughly checked for rips or tears in the filter material.

Replace the primary element at least every year regardless of the number of operating hours the element has accumulated.

NOTICE

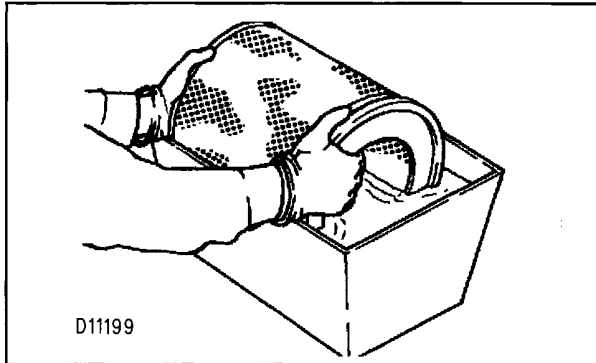
Do not clean filter elements by bumping or tapping.

Do not use filter elements with damaged pleats, gaskets or seals. Engine damage could result.

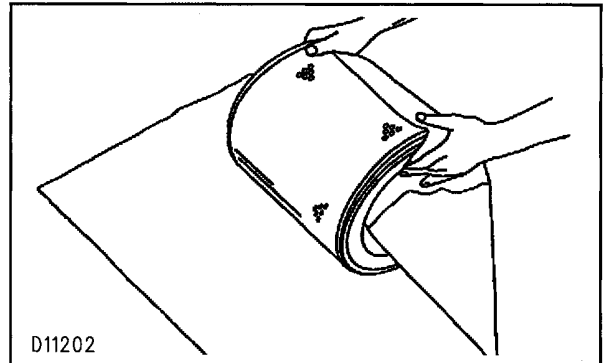


Filter elements can be cleaned with air pressure, 205 kPa (30 psi) maximum, or water pressure, 280 kPa (40 psi) maximum, or detergent washing. Have spare elements on hand to use while cleaning used elements.

- Direct air or water along the length of the pleats inside and outside of filter element.

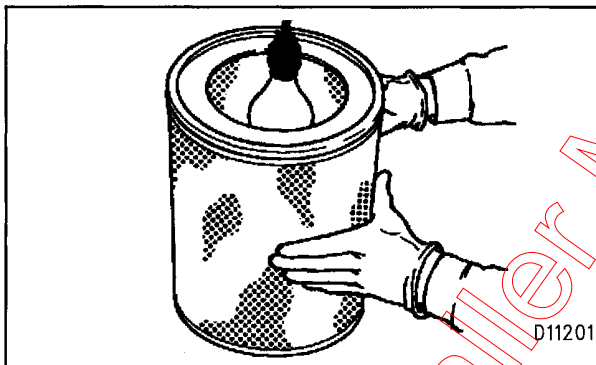


The element can be washed in warm water and nonsudsing household detergent, such as automatic dishwasher detergent. Rinse inside and outside the pleats. The filter should then be thoroughly air dried and inspected.



- Wrap and store the clean filter elements in a clean, dry place.

For more information on air cleaner element cleaning, refer to SEBF-8062, Guideline for Reusable Parts—Cleaning and Inspection of Air Filters.



- Inspect the filter elements after cleaning for any rips, tears or damage. Insert a light inside of the clean, dry element. Do not use a filter element with damaged pleats, gaskets or seals. Discard the element if damaged.

Belts

Check/Adjust

Inspect the condition and adjustment of alternator and accessory drive belts. Examine all drive belts for wear and replace if they show any signs of wear. Loose or worn pulley grooves cause belt slippage and low accessory drive speed. If belts are too loose, they vibrate enough to cause unnecessary wear on the belts and pulleys and possibly slip enough to cause overheating.

If belts are too tight, unnecessary stresses are placed upon the pulley bearings and belts which might shorten the life of both.

If one belt in a set requires replacement, always install a new matched set of belts. Never replace just the worn belt. If only the worn belt is replaced, the new belt will carry all the load, as it will not be stretched as much as the older belts. All the belts will fail in rapid succession.

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

To check the belt tension, apply 110 Newton (25 lb) force, perpendicular to the belt, midway between the driving and driven pulley. Measure the belt deflection. Correctly adjusted belts will deflect 15 to 20 mm ($\frac{9}{16}$ to $\frac{7}{8}$ inch).

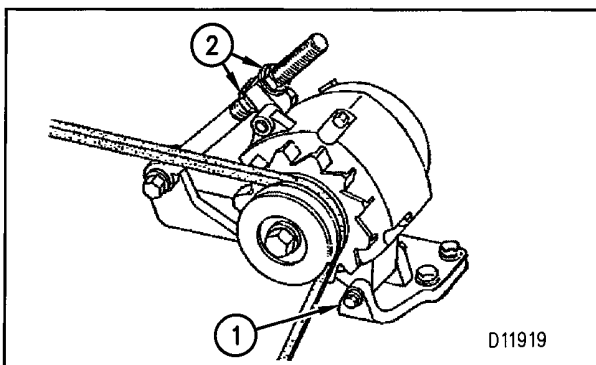
If the belt does not require replacement or adjustment, install the belt guard. If the belt requires adjustment or replacement, perform the following procedure to adjust the belt tension.

1. Loosen the mounting bolt (1) and the locknut on the adjusting bolt.
2. Turn the adjusting nuts (2) to increase or decrease the belt tension.
3. Tighten the adjusting bolt locknut. Tighten the mounting bolts. Refer to the Torque Specifications in this manual.
4. Install the belt guard.

Replace

Refer to the Service Manual for belt replacement information. Consult with your Caterpillar dealer for assistance.

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



Typical belt assembly mounting bolt (1) and adjusting nuts (2).

Hoses and Clamps

Inspect

- Inspect all hoses for leaks due to cracking, softness and loose clamps. Replace hoses that are cracked or soft and tighten 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:

- End fittings damaged, leaking or displaced
- Outer covering chafed or cut and wire reinforcing exposed
- Outer covering ballooning locally
- Evidence of kinking or crushing of the flexible part of the hose
- Armoring embedded in the outer cover

A constant torque hose clamp can be used in place of any standard hose clamp. Make sure the constant torque hose clamp is the same size as the standard clamp. Due to extreme temperature changes, hose will heat set. Heat setting causes hose clamps to loosen. Loose hose clamps can result in leaks. A constant torque hose clamp will help prevent loose hose clamps.

Each installation application can be different depending on the type of hose, fitting material and anticipated expansion or contraction of the hose and fittings. A torque wrench should be used for proper installation of the constant torque hose clamps.

Replace

The engine should be stopped and cold before performing this procedure.

1. Loosen the cooling system filler cap slowly to relieve any pressure and remove the cap.
2. Drain the coolant from the cooling system to a level below the hose being replaced.

3. Remove the hose clamps, disconnect the old hose and replace with a new hose.

4. Install hose clamps. Refer to the Torque Specifications section in this manual.

5. Add the proper coolant mixture to the cooling system. Refer to the Cooling System Specifications section in this manual. Fill the system to the proper level.

6. Clean the filler cap. Inspect the filler cap gaskets. Replace the cap if the gaskets are damaged. Clean the filler cap receptacle. Install the cap. Start the engine and inspect for cooling system leaks.

Batteries

Clean/Check Electrolyte Level

Battery Electrolyte Chart	
Battery	Interval
Conventional	125 Hour
Low Maintenance	250 Hours
Maintenance Free	None Required

1. Remove the filler caps. Maintain the electrolyte level to the bottom of the fill plug openings.

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

At proper charging rate, batteries should not require more than 30 cc (1 oz) water per cell per week.

2. Keep batteries clean.
3. Loosen and remove cable clamps from all battery terminals.
4. Clean all battery terminals.
5. Clean all cable clamps.
6. Install and tighten cable clamps to battery terminals.
7. Coat cable clamps and terminals with 5N-5561 Silicone Lubricant, petroleum jelly or MPGM grease.

Check Battery Charger (if equipped)

- Check the battery charger for proper operation. If batteries are properly charged, ammeter reading should be very near zero. All batteries should be kept charged to a corrected specific gravity of 1.250 or above.
- The batteries should be kept warm, if possible. The battery temperature affects the cranking power. If the battery is too cold, it will not crank the engine, even if the engine is warm.
- When the engine is not run for long periods of time or is run for short periods, the batteries may not fully recharge. Ensure a full charge to help prevent the battery from freezing.

Battery or Battery Cable Replacement

1. Turn the START switch OFF. Turn the ignition switch (if equipped) OFF and remove the key and all electrical loads.
2. Disconnect the cable from the negative battery terminal. Be sure the cable cannot contact the terminal.
3. Disconnect the negative battery cable terminal at the battery(s) that goes to the start switch. Where four 12 volt batteries are involved, the negative side of two batteries must be disconnected.
4. Proceed with necessary system repairs. Reverse steps to reconnect all cables.

Every 500 Hours

You must read and understand the warnings and instructions contained in the Safety section of this manual, before performing any operation or maintenance procedures.

Scheduled Oil Sampling (S•O•S)

Obtain Sample and Analysis

Refer to the Scheduled Oil Sampling topic in the Every 250 Hours section of this manual.

Engine Crankcase

Replace Oil and Filter(s)

Refer to the Engine Crankcase topic in the Every 250 Hours section of this manual.

Crankcase Breather

Clean

Refer to the Crankcase Breather topic in the Every 250 Hours section of this manual.

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Maintenance Section
Every 1000 Hours

Every 1000 Hours

You must read and understand the warnings and instructions contained in the Safety section of this manual, before performing any operation or maintenance procedures.

Engine Protection Devices

Inspect/Check

The alarm and shutoff controls should be checked for proper operation in order to ensure engine protection. The manual shutoff devices should be tested for proper operation.

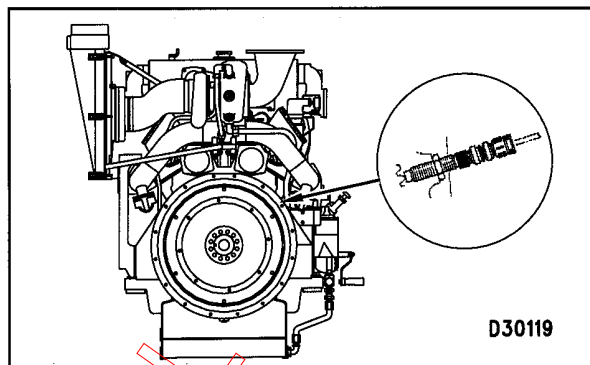
All checks and tests should be made by Caterpillar authorized service personnel or other qualified mechanics. Consult with your Caterpillar dealer for assistance.

Visual Inspection

Visually check the condition of all sensors and wiring. Look for loose, broken, or damaged wiring and components. Repair or replace any damaged wiring or components immediately.

Magnetic Pickup

Inspect/Adjust



Magnetic pickups are mounted in the flywheel housing.

A magnetic pickup mounted in the flywheel housing functions as a speed sensor.

- 1.** Remove the magnetic pickup (1) from the flywheel housing. Check the condition of the end of the pickup. Check for signs of wear and contaminants.
- 2.** Clean the metal shavings and other debris from the face of the magnet.
- 3.** Install and adjust the pickup as described in the Service Manual.

Every 3000 Hours

You must read and understand the warnings and instructions contained in the Safety section of this manual, before performing any operation or maintenance procedures.

Water Temperature Regulators (Thermostats)

Replace

Replacing your thermostats prior to failure is a recommended preventive maintenance practice because it reduces the chances for unscheduled downtime.

Depending on load, a thermostat that fails in a partially opened position will cause either an overheating or an over cooling condition.

If the thermostat fails in the closed position, it will cause excessive overheating. Excessive overheating could result in cylinder head cracking or piston seizure problems.

If the thermostat fails in the open position, it 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 build-up inside the cylinder. This excessive carbon build-up could result in accelerated ring and liner wear.

NOTICE

Failure to replace your thermostat on a regularly scheduled basis could cause severe engine damage.

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

If the thermostat is installed wrong, the engine may overheat, causing cylinder head damage. Ensure that the new thermostat is installed in the original position. Ensure that the thermostat vent hole is open.

DO NOT use liquid gasket material on the gasket or cylinder head surface.

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

NOTE: If replacing thermostats ONLY, drain the coolant from the cooling system to a level below the thermostat housing.

Refer to the Cooling System Specifications in this publication for all information regarding Acceptable Water, coolant/antifreeze and SCA requirements, or contact your Caterpillar dealer for assistance.

Cooling System (Extended Life Coolant Only)

Add Extender

Caterpillar Extended Life Coolant (ELC) does not require the frequent Supplemental Coolant Additive (SCA) additions associated with the present conventional coolants. Only a "one time" coolant Extender is required.

Extender should be added to ELC after 3000 service hours or two years, whichever comes first.

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

1. Loosen the cooling system filler cap slowly to relieve pressure. Remove the cap.
2. It may be necessary to drain enough coolant from the cooling system to allow for the addition of the Extender.
3. Add Extender according to the requirements for your engine's cooling system capacity. Refer to the Refill Capacities chart in this manual for the cooling system capacity for your engine. Refer to the Coolant Specifications in this manual for the Caterpillar ELC Extender Additions chart.
4. Clean the filler cap. Inspect the filler cap gaskets. Replace the cap if the gaskets are damaged. Clean the filler cap receptacle. Install the cap.

Cooling System (Conventional HD Coolant Only)

Drain/Clean/Replace Coolant

Clean/Flush the cooling system before the recommended maintenance interval if:

- the coolant is heavily contaminated
- the engine overheats frequently
- foaming is observed
- the oil cooler has failed, allowing oil to contaminate the coolant
- fuel has entered the cooling system and contaminated the coolant

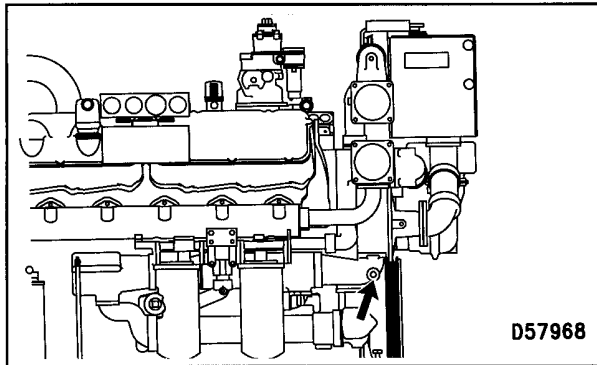
NOTICE

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

NOTE: A good time to inspect the water pump, replace the thermostat, and replace hoses is when your engine's cooling system has been drained.

Drain

1. Stop the engine and allow the engine to cool. Loosen the cooling system cap slowly to relieve any pressure, and remove the cap.



Engine block cooling system drain plug location.

2. Open the cooling system drain valve (if equipped). If not equipped with a drain valve, remove the engine block drain plug. Remove the oil cooler drain plug. Remove the drain plug from the bottom of the water pump housing. Allow the coolant to drain.

NOTICE

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

For information regarding disposal and recycling of used coolant:

Contact Caterpillar Service Technology Group:
Outside Illinois: 1-800-542-TOOL
Inside Illinois: 1-800-541-TOOL
Canada: 1-800-523-TOOL

Clean

- Flush the cooling system with clean water to remove any debris.
- Close the drain valve (if equipped). Clean the drain plug(s). Clean the drain plug fitting(s). Install the drain plugs. Refer to the Torque Specifications section in this manual.

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 pt) of cleaner per 15 L (4 US gal) of cooling system capacity. Install the cooling system filler cap.

4. Start and run the engine for a minimum of 30 minutes with a coolant temperature of at least 82°C (180°F). Stop the engine and allow the engine to cool.

5. Loosen the filler cap slowly to relieve any pressure, and remove the cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the cleaning solution to drain. Flush the cooling system with clean water until the draining water is clear. Close the drain valve (if equipped). Clean the drain plugs. Clean the drain plug fittings. Install the drain plugs. Refer to the Torque Specifications section in this manual.

Cooling Systems with Heavy Deposits or Plugging

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

Follow the same steps as outlined above, with the following modifications to steps 3 and 4:

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

4. Start and run the engine for a minimum of 90 minutes with a coolant temperature of at least 82°C (180°F). Stop the engine and allow the engine to cool.

Fill

Refer to the Cooling System Specifications for all information regarding acceptable water, coolant/antifreeze, and supplemental coolant additive requirements. Refer to the Refill Capacities chart in this publication for the capacity of your engine's system.

1. Fill the system with the recommended coolant/antifreeze mixture.
2. Start and run the engine with the filler cap removed. Allow the coolant to warm, the thermostat to open and the coolant level to stabilize. Check the coolant level. Add coolant mixture if necessary to bring the coolant to within 13 mm (½ in) below the bottom of the fill tube or the correct level on the sight glass (if equipped).
3. Clean the filler cap. Clean the filler cap receptacle. Inspect the filler cap gasket. If the gasket is damaged, discard the old filler cap and install a new filler cap. If the gasket is not damaged, use a 9S-8140 Pressurized Pump Group to pressure test the filler cap. The correct filler cap pressure is stamped on the face of the filler cap. If the filler cap does not hold the correct pressure, install a new filler cap.
4. Install the filler cap. Start the engine. Inspect for coolant leaks and proper operating temperature.

Engine Mounts

Inspect

Inspect the engine mounts for deterioration and proper bolt torque. Engine vibration may be caused by improper engine mounting and/or engine mount deterioration. Any engine mount showing deterioration should be replaced. Refer to the Torque Specifications section of this publication for recommended bolt torque values. See the Marine Engine Application and Installation Guide for more information.

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Crankshaft Vibration Damper

Inspect

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

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

Removal and Installation

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

Visconic Damper

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

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

Valve Lash

Check/Adjust

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

Subsequent adjustments should be made at Every 3000 Hour interval.

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

NOTICE

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

WARNING

Be sure the engine cannot be started while this maintenance is being performed. To prevent possible injury, do not use the starting motor to turn the flywheel.

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

NOTICE

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

Valve Rotators

WARNING

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

NOTICE

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

After setting the valve lash and before installing the valve covers:

1. Start the engine. Follow the engine starting procedure in this manual. Operate the engine at low idle.
2. Observe the top surface of each valve rotator. Each valve rotator should turn slightly each time the valve closes.

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

Fuel Ratio Control, Set Point, and Low Idle

Check/Adjust

The fuel ratio control limits the amount of fuel to the cylinders during acceleration. This affects the amount of exhaust smoke. The set point check is a method for diagnosing engine performance. Slow engine response and low power indicate that a fuel control adjustment or repair is necessary.

NOTICE

Adjustments and repairs should be made by an authorized Caterpillar dealer.

The fuel ratio control, set point, and idle speed checking and adjusting should only be performed by Caterpillar authorized service personnel or other properly trained mechanics. Consult with your Caterpillar dealer for assistance. Authorized Caterpillar dealers are equipped to properly perform these services.

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Marine Engine Performance Analysis Report (PAR)

Obtain Report

A Marine Engine Performance Analysis Report (PAR) compliments a good preventative maintenance program.

PAR reflects the results of various tests normally conducted by your Caterpillar dealer for the purpose of:

- identifying potential problems
- determining components or systems that should be adjusted, replaced, etc.
- confirming your engine is operating efficiently and within specifications

Approximately 80 to 85 percent of a commercial engine's operation and maintenance cost is the cost of fuel. Therefore, substantial cost reductions can be achieved by keeping your engine operating at peak efficiency.

Marine PAR also:

- Verifies the quality of initial propulsion system installation
- Identifies mismatched propulsion components and systems
- Establishes fuel efficient operating habits
- Determines propulsion system deterioration rates
- Fine tunes maintenance, repair, and overhaul schedules

Caterpillar recommends Marine Engine Performance Analyses at the initial Sea Trial and on a regularly scheduled basis. Ensure that your propulsion system is operating at optimum performance and efficiency with a PAR. Consult with your Caterpillar dealer for complete details in order to establish a Marine Engine PAR program for your vessel.

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Maintenance Section
Every 5000 Hours

Every 5000 Hours

You must read and understand the warnings and instructions contained in the Safety section of this manual, before performing any operation or maintenance procedures.

Fuel Injection Nozzles

Test/Exchange

Fuel injection nozzles are subject of tip wear. Tip wear, a result of fuel contamination, can cause:

- increased fuel consumption
- black smoke
- misfire
- rough running

Nozzles should be cleaned, inspected, tested, and replaced if necessary. Refer to Special Instruction SEHS7292, for using the 8S-2245 Nozzle Cleaning Kit. Consult with your Caterpillar dealer about nozzle cleaning and testing.

NOTICE

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

Abnormal engine running, smoke emission, and engine knock can be symptoms of nozzle malfunction. Each nozzle must be isolated one at a time in order to determine the malfunctioning nozzle.

1. Start the engine.

NOTICE

A nozzle will be damaged if the top of the nozzle turns in the body. The engine will be damaged if a defective nozzle is used because the fuel spray pattern that comes out of the nozzle will be incorrect. Nozzles can be permanently damaged by twisting if only one wrench is used to loosen or tighten the fuel line nuts. Do NOT let the tops of the nozzles turn when the fuel lines are loosened. Use one wrench to hold the nozzle and another to loosen the fuel line nut.

2. Loosen each fuel line nut at the fuel injection pump, one at a time. A cloth or similar material must be used to prevent fuel from spraying on the hot exhaust components. Tighten each nut before loosening the next nut.

3. A defective nozzle may be identified when a fuel line nut is loosened and:

- the exhaust smoking is partially or completely eliminated
- engine performance is not affected

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

Removing and Installing Fuel Injection Nozzles

Special tooling is required to remove and install nozzles. Refer to the Service Manual for information. Consult with your Caterpillar dealer for assistance.

Inspect, Rebuild, or Exchange

If the engine is operated until the components fail, additional engine damage can result. Caterpillar recommends that the following components be inspected in order to ensure reliable engine performance:

- Jacket Water Pump
- Raw/Sea Water Pump
- Alternator
- Starting Motor
- Air Compressor

Caterpillar Recommendation

To minimize downtime, Caterpillar recommends the use of Remanufactured components (subject to availability) as the most cost effective option.

Removal and Installation

Refer to the Service Manual or contact your Caterpillar dealer for assistance with removal and installation of engine components.

Water Pumps

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 is observed, replace all seals. Refer to the service manual for the disassembly and assembly procedure.

Inspect the component for wear, cracks, pin holes and proper operation. Refer to the service manual or consult with your Caterpillar dealer if repair or replacement is needed.

Raw/Sea Water Pump

If the pump flow is reduced or if the pump can not self-prime, check for excessive wear of the impellers and the port plates. Refer to the Service Manual for the disassembly and assembly procedure. Rebuild or exchange the pump if necessary.

Alternator

Caterpillar recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and proper battery charging. Inspect the ammeter gauge during engine operation to ensure the batteries and/or electrical system is performing correctly. Make repairs as necessary. Refer to the Service Manual.

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

Starting Motor

If the starting motor fails, the engine may not start in an emergency situation. Caterpillar recommends a scheduled inspection/check of your starting motor. The starting motor should be checked for correct operation.

Clean and check all the electrical connections on electric starting motors. Check for air leaks at all the pipe connections on air starting motors. If repairs are needed, refer to the Service Manual, or contact your Caterpillar dealer for assistance.

Air Compressor

Refer to the Service Manual or refer to the OEM literature for information concerning the air compressor. Contact your Caterpillar dealer for assistance.

Turbocharger

Periodic inspection and cleaning is recommended for the turbocharger compressor housing (inlet side). Since the crankcase fumes are ingested through the inlet air system, oil and combustion by-products may collect in these two areas.

This buildup, over time, can contribute to loss of engine power, increased black smoke, and overall loss of engine efficiency. This buildup is only a possible contributor to these conditions.

Operating the engine until the turbocharger fails can severely damage the turbocharger's compressor wheel and/or the engine. Damage to the turbocharger compressor wheel could allow parts from the compressor wheel to enter the engine cylinder, causing additional damage to the piston, valve, and cylinder head.

NOTICE

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

Minor leakage of a turbocharger housing under extended low idle operation will 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 speed up at no load), DO NOT continue engine operation until the turbocharger is repaired or replaced.

An inspection/check of your turbocharger will minimize unscheduled downtime and reduce the chance for potential damage to other engine parts.

NOTE: Turbocharger components require precision clearances and balancing due to operation at high rotational (torsional) speeds. Severe Service Applications can accelerate component wear and may suggest the need to Inspect/Repair/Replace the cartridge at reduced intervals to ensure maximum reliability and retention of the full core.

Removal and Installation

For removal and installation, or repair/replacement options of turbochargers, see your Caterpillar dealer. Refer to the Service Manual for this engine or consult your Caterpillar dealer for the procedure and specifications.

Clean/Inspect/Check

1. Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually check for oil leaks.
2. Turn the compressor wheel and turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and turbine wheel for contact with the turbocharger housing. There should NOT be any visible signs of contact between the turbine or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating wheel(s) and the housing, the turbocharger should be reconditioned or replaced.
3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the wheel, it indicates a possible turbocharger oil seal leak.

The leak may be the result of extended engine operation at low idle or an intake air line restriction (plugged air filters), which causes the turbocharger to "slobber".

4. Use a dial indicator to check end clearance on the shaft. Attach the dial indicator point on the end of turbocharger shaft. Push and pull the other end of the shaft. Note the total dial indicator reading. If the measured end play is greater than the Service Manual specifications, repair or replace the turbocharger. Measured end play less than the minimum Service Manual specifications could indicate carbon build up on the turbine wheel. The turbocharger should be disassembled for cleaning and inspection if the measured end play is less than the minimum Service Manual specifications.
5. Inspect the turbine housing bore for corrosion.
6. Clean the turbocharger housing with standard shop solvents and a soft bristle brush.
7. Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

Every 6000 Hours

You must read and understand the warnings and instructions contained in the Safety section of this manual, before performing any operation or maintenance procedures.

Cooling System (Extended Life Coolant Only)

Drain/Flush/Replace Coolant

Only clean water is needed to clean and flush the cooling system when ELC is drained and replaced.

Drain

1. Stop the engine and allow the engine to cool. Loosen the coolant filler cap slowly to relieve any pressure, and remove the cap.
2. Open the cooling system drain valve (if equipped). If not equipped with a drain valve, remove the engine block drain plug. Remove the oil cooler drain plug. Remove the drain plug from the bottom of the water pump housing. Allow the coolant to drain.

NOTICE

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

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

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

Flush

3. Flush the cooling system with clean water to remove any debris.
4. Close the drain valve (if equipped). Clean the drain plugs. Clean the drain plug receptacles. Install the drain plugs. Refer to the Torque Specifications section in this manual.
5. Fill the cooling system with clean water. Install the filler cap. Operate the engine until the temperature reaches 49 to 66°C (150 to 120°F).
6. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly to relieve any pressure, and remove the cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water.
7. Repeat steps 5 and 6.

Fill

8. Fill the cooling system with ELC. Refer to the refill capacities chart in this manual for the amount of ELC needed to refill your system.
9. Start and run the engine with the filler cap removed. Allow the ELC to warm, the thermostat to open, and the coolant level to stabilize. Add ELC if necessary to bring the coolant to the proper level.
10. Clean the filler cap. Clean the filler cap receptacle. Inspect the filler cap gasket. If the gasket is damaged, discard the old filler cap and install a new filler cap. If the gasket is not damaged, use a 9S-8140 Pressurized Pump Group to pressure test the filler cap. The correct filler cap pressure is stamped on the face of the filler cap. If the filler cap does not hold the correct pressure, install a new filler cap.
11. Install the filler cap. Start the engine. Inspect for coolant leaks and proper operating temperature.