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3508, 3512 and 3516 DIESEL MARINE ENGINES

Maintenance Intervals

Excerpted from Operation & Maintenance Manual (SEBU6100-02-01)

3500 Marine Engine Maintenance Schedule

Use quantity of fuel used, service hours, or time interval, whichever occurs first. Refer to the Terminology topic in the Information Section of this manual for information relating to Top End and Overhaul.

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Every 2000 Service Hours*

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Every 3000 Service Hours or Two Years*

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Every 4000 Service Hours*

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Top End

To minimize downtime and provide you with the lowest cost and highest value, Caterpillar recommends that the engine be overhauled before failure by scheduling an overhaul with your Caterpillar dealer. Refer to the Top End Overhaul section in this manual on page 125

Cylinder Heads – Inspect 126
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Overhaul

To minimize downtime and provide you with the lowest cost and highest value, Caterpillar recommends that the engine be overhauled before failure by scheduling an overhaul with your Caterpillar dealer. Refer to the Overhaul section in this manual on page 128

Cylinder Heads, Connecting Rods, Cylinder Liners, Pistons, Turbochargers, Cam Followers, Fuel Transfer Pump, Prelube Pump, Injectors, Governor, Wrist Pins and Main Oil Pump – Inspect/Rebuild or Exchange if necessary
Piston Rings, Main Bearings, Rod Bearings, Valve Rotators and Crankshaft Seals – Install new
Crankshaft, Camshaft, Cam Bearings, Damper, Fuel System Linkage, Gear Train, Gear Train Bushings, Spacer Plates and Driven Unit Alignment – Inspect
Coolant Analysis – Obtain
Oil Cooler – Clean/Test 129
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*First Perform Previous Service Hour Items

**For larger optional sump capacity of 224 liters (59 gallons), these items occur at 500 Service Hours.
For larger optional sump capacity of 425 liters (112 gallons), these items occur at 1000 Service Hours.

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Maintenance Section
3500 Marine Engine Maintenance Schedule

Maintenance Schedule Intervals

3508 SERVICE HOURS/FUEL CONSUMPTION			
Service Hours	Rated Up to 1300 rpm	Rated 1301 to 1600 rpm	Rated 1601 to 1800 rpm
Every 50 Service Hours or	4,550 liter (1,200 U.S. gallon) of Fuel	5,450 liter (1,440 U.S. gallon) of Fuel	6,400 liter (1,650 U.S. gallon) of Fuel
Every 250 Service Hours or	22,700 liter (6,000 U.S. gallon) of Fuel	27,200 liter (7,200 U.S. gallon) of Fuel	32,000 liter (8,500 U.S. gallon) of Fuel
Every 1000 Service Hours or	89,000 liter (23,500 U.S. gallon) of Fuel	109,000 liter (28,800 U.S. gallon) of Fuel	128,500 liter (34,000 U.S. gallon) of Fuel
Every 2000 Service Hours or	178,000 liter (47,000 U.S. gallon) of Fuel	218,000 liter (57,600 U.S. gallon) of Fuel	257,000 liter (68,000 U.S. gallon) of Fuel
Every 3000 Service Hours or Two Years or	267,000 liter (70,500 U.S. gallon) of Fuel	327,500 liter (86,400 U.S. gallon) of Fuel	386,500 liter (102,000 U.S. gallon) of Fuel
Every 4000 Service Hours or	356,000 liter (94,000 U.S. gallon) of Fuel	436,000 liter (115,200 U.S. gallon) of Fuel	514,000 liter (136,000 U.S. gallon) of Fuel
Every 6000 Service Hours or	535,000 liter (141,000 U.S. gallon) of Fuel	654,000 liter (172,800 U.S. gallon) of Fuel	771,000 liter (204,000 U.S. gallon) of Fuel
Top End @ 976,000 liter (257,500 U.S. gallon) of Fuel or	Every 11,000 Service Hours	Every 9000 Service Hours	Every 7500 Service Hours
Overhaul @ 1,952,000 liter (515,000 U.S. gallon) of Fuel or	Every 22,000 Service Hours	Every 18,000 Service Hours	Every 15,000 Service Hours
3512 SERVICE HOURS/FUEL CONSUMPTION			
Service Hours	Rated Up to 1300 rpm	Rated 1301 to 1600 rpm	Rated 1601 to 1800 rpm
Every 50 Service Hours or	6,670 liter (1,760 U.S. gallon) of Fuel	8,200 liter (2,160 U.S. gallon) of Fuel	9,700 liter (2,560 U.S. gallon) of Fuel
Every 250 Service Hours or	33,400 liter (8,800 U.S. gallon) of Fuel	41,000 liter (10,800 U.S. gallon) of Fuel	48,500 liter (12,800 U.S. gallon) of Fuel
Every 1000 Service Hours or	133,500 liter (35,000 U.S. gallon) of Fuel	164,000 liter (43,200 U.S. gallon) of Fuel	194,000 liter (51,200 U.S. gallon) of Fuel
Every 2000 Service Hours or	267,000 liter (70,000 U.S. gallon) of Fuel	328,000 liter (86,400 U.S. gallon) of Fuel	388,000 liter (102,400 U.S. gallon) of Fuel
Every 3000 Service Hours or Every Two Years or	398,000 liter (105,000 U.S. gallon) of Fuel	491,000 liter (129,600 U.S. gallon) of Fuel	582,000 liter (153,600 U.S. gallon) of Fuel
Every 4000 Service Hours or	534,000 liter (140,000 U.S. gallon) of Fuel	654,000 liter (172,800 U.S. gallon) of Fuel	776,000 liter (204,800 U.S. gallon) of Fuel
Every 6000 Service Hours or	796,000 liter (210,000 U.S. gallon) of Fuel	982,000 liter (259,200 U.S. gallon) of Fuel	1,164,000 liter (307,200 U.S. gallon) of Fuel
Top End @ 1,460,000 liter (385,000 U.S. gallon) of Fuel or	Every 11,000 Service Hours	Every 9000 Service Hours	Every 7500 Service Hours
Overhaul @ 2,920,000 liter (770,000 U.S. gallon) of Fuel or	Every 22,000 Service Hours	Every 18,000 Service Hours	Every 15,000 Service Hours
3516 SERVICE HOURS/FUEL CONSUMPTION			
Service Hours	Rated Up to 1300 rpm	Rated 1301 to 1600 rpm	Rated 1601 to 1800 rpm
Every 50 Service Hours or	8,800 liter (2,300 U.S. gallon) of Fuel	10,600 liter (2,800 U.S. gallon) of Fuel	12,900 liter (3,400 U.S. gallon) of Fuel
Every 250 Service Hours or	44,000 liter (11,600 U.S. gallon) of Fuel	53,000 liter (14,000 U.S. gallon) of Fuel	64,500 liter (17,000 U.S. gallon) of Fuel
Every 1000 Service Hours or	176,000 liter (46,500 U.S. gallon) of Fuel	212,000 liter (56,000 U.S. gallon) of Fuel	258,000 liter (68,000 U.S. gallon) of Fuel
Every 2000 Service Hours or	352,000 liter (93,000 U.S. gallon) of Fuel	424,000 liter (112,000 U.S. gallon) of Fuel	516,000 liter (136,000 U.S. gallon) of Fuel
Every 3000 Service Hours or Every Two Years or	528,700 liter (139,500 U.S. gallon) of Fuel	636,700 liter (68,000 U.S. gallon) of Fuel	773,000 liter (204,000 U.S. gallon) of Fuel
Every 4000 Service Hours or	704,000 liter (186,000 U.S. gallon) of Fuel	848,000 liter (168,000 U.S. gallon) of Fuel	1,032,000 liter (272,000 U.S. gallon) of Fuel
Every 6000 Service Hours or	1,056,000 liter (279,000 U.S. gallon) of Fuel	1,272,000 liter (336,000 U.S. gallon) of Fuel	1,548,000 liter (408,000 U.S. gallon) of Fuel
Top End @ 1,942,000 liter (512,500 U.S. gallon) of Fuel or	Every 11,000 Service Hours	Every 9000 Service Hours	Every 7500 Service Hours
Overhaul @ 3,884,000 liter (1,025,000 U.S. gallon) of Fuel or	Every 22,000 Service Hours	Every 18,000 Service Hours	Every 15,000 Service Hours

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

WARNING

To avoid personal injury due to unexpected start, attach a **DO NOT OPERATE** or similar warning tag to start switch or controls before performing maintenance or repairing the engine. When appropriate, attach tags at the engine and pilot position, and disconnect starting controls.

DO NOT ALLOW UNAUTHORIZED PERSONNEL ON OR AROUND THE ENGINE WHEN IT IS BEING SERVICED.

Inspect Engine for Leaks and Loose Connections

A walk-around inspection is recommended to ensure the installation is clean and leaks are kept to a minimum. This should only take a few minutes and by taking the time to make these checks, costly repairs and accidents can be avoided and the equipment will be ready to run should the need arise.

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

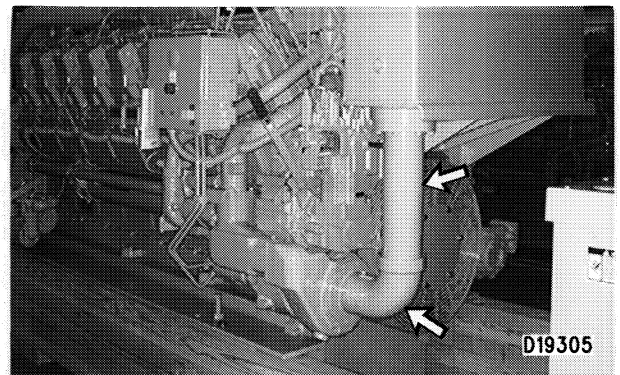
NOTICE

Accumulated grease and oil on an engine and/or platform (walkway) is a fire hazard. Remove this debris with steam cleaning or high pressure water. Every 1000 Service Hour interval or each time any significant quantity of fluid is spilled on an engine and/or platform.

Check the fluid levels more frequently than the recommended maintenance intervals and continue to monitor fluid levels until any leak is found and fixed. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more frequently than the recommended intervals.

- Wipe all fittings, caps and plugs before performing maintenance to reduce the chance of system contamination.
- Check the engine, cooling system, aftercooler and generator (if equipped) for dirt and debris. Inspect the radiator (if equipped) for leaks and trash build-up.
- All guards must be in place. Repair or replace missing or damaged guards.

Cooling System



Inspect:

- Cooling system lines and elbows for cracks and loose clamps. Check the condition of all pipes and fittings.
- Condition of all belts for cracks, breaks or other damage. Replace if necessary.

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.

- 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. If leaks are found, check the coolant level frequently and continue to monitor the level until the water pump is repaired. Excessive coolant leakage may indicate the need to replace the water pump seal.

For removal and installation of water pump(s) and/or seals, see the Service Manual for this engine or consult your Caterpillar dealer.

Lube and Fuel System

Inspect:

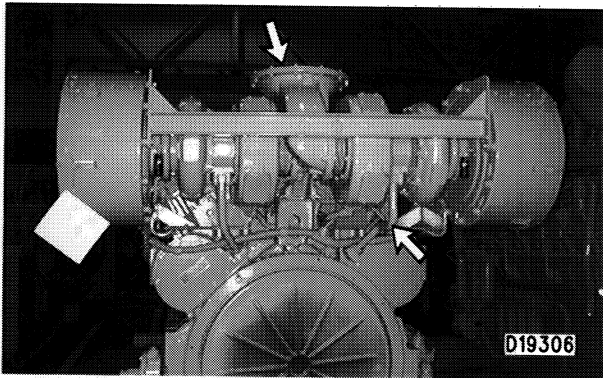
- Lube system for oil leaks, such as front and rear crankshaft seals, oil pan gasket, oil filters, hose & tube connections and valve covers.
- Auxiliary oil filters, if equipped, for leaks and loose connections.
- Fuel system for leaks, loose or worn hoses, and loose fuel line clamps and fittings that are properly clamped and tight.

NOTICE

Fuel line clamps should not be over torqued. Over torqueing causes the clamps to butterfly, which results in low clamping force and fuel line vibration and eventual failure.

NOTE: Tighten fuel line clamps as required using 6V4980 Torque Screwdriver Tool Group. The standard torque for these fasteners (#10 screw) is 20 lb inch (2.26 N•m).

Air Intake System



Inspect:

- Air intake system hoses, piping and elbows for cracks and loose clamps. Check the condition of all connections and fittings.

Electrical

Inspect:

- Wiring and wiring harnesses for loose connections and worn or frayed wires.
- Engine-to-frame ground strap for good connection and condition.
- Check condition of gauges. Replace if cracked or cannot be calibrated.

While operating, frequently observe the engine oil pressure, oil filter differential, fuel pressure, fuel filter differential, water temperature and the air cleaner differential gauges.

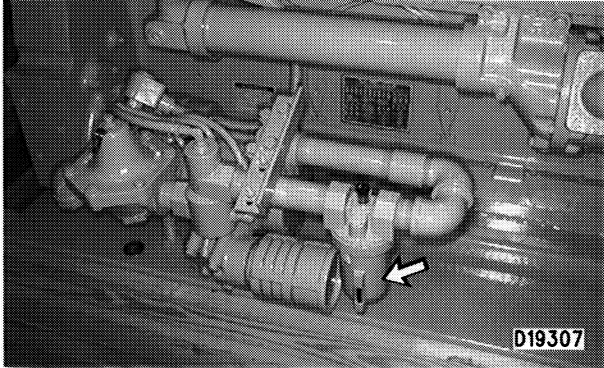
- Disconnect any battery chargers that are not protected against the starting motor current drain. Check condition of batteries and the level of electrolyte, unless equipped with a maintenance free battery.

Air Starting Motor and Air Prelube Pump Lubricators

- Adjust the air starting system pressure, if necessary. Fill all air starting system lubricators.

NOTICE

Never allow the air lubricator jar to become empty. The starting and prelube pump motors will be damaged by lack of proper lubrication.



- The vanes of the air starting motor and air prelube pump motor are lubricated with a fine oil mist from the starting motor oiler while the air starting motor is operating.
- When the air lubricator jar becomes half empty, remove oil filler plug and fill the jar with clean diesel fuel or kerosene. Refer to the Lubricant Viscosity Recommendations for more information.

Engine Crankcase

NOTICE

Make sure you read and understand the information in the Safety and Lubricant Specifications sections of this Manual before you proceed with maintenance of the lube oil system.

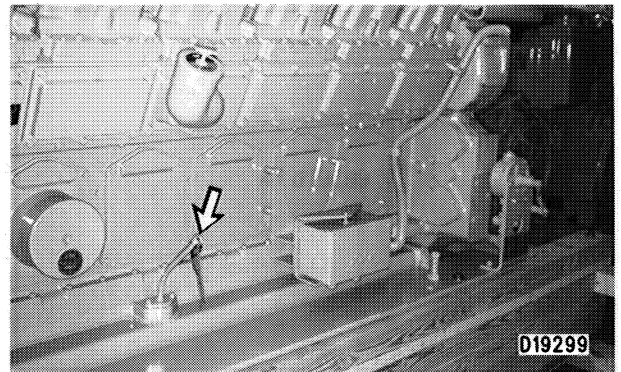
Check Oil Level

Check the engine crankcase lube oil on a daily basis. The dipstick is stamped on both sides.

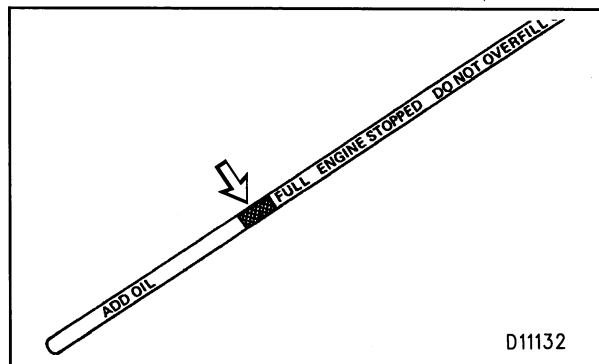
Be sure to read the correct side of the dipstick. The ADD and FULL levels are not the same when checking the oil while the engine is stopped or idling.

- One side is marked to be read when checking the oil level with the ENGINE STOPPED WITH OIL COLD.
- The other side is marked to be read with the ENGINE AT LOW IDLE WITH WARM OIL.

Engine Stopped



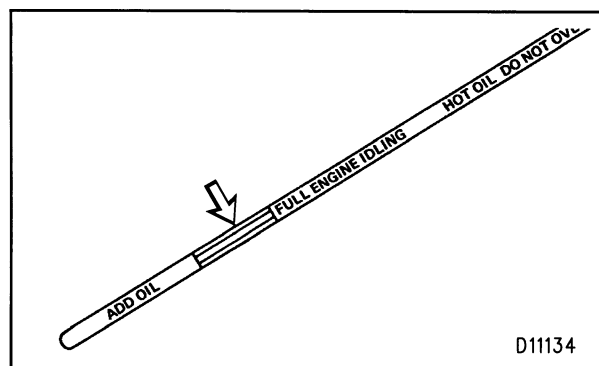
- Check the oil level with the engine STOPPED.



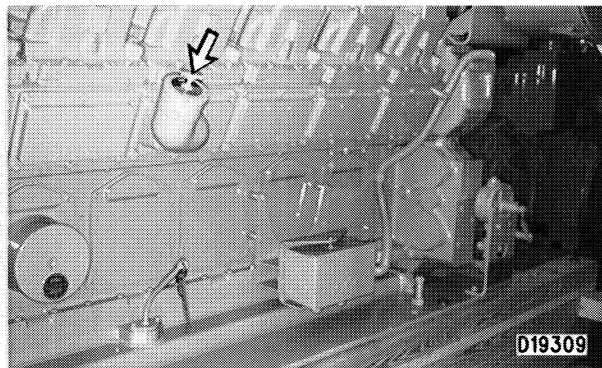
- Maintain the oil level to the FULL mark (between the ADD and FULL marks) on the ENGINE STOPPED WITH OIL COLD side of the dipstick. Add oil if necessary.

Engine Running

- Measure engine oil level with the engine operating at low idle.



- Maintain oil level to FULL mark on the ENGINE AT LOW IDLE WITH WARM OIL side of dipstick.



1. Remove oil fill cap and add oil if necessary. DO NOT fill the crankcase above the FULL mark on the dipstick. Refer to the Refill Capacities Chart in this manual for the correct crankcase capacity of your engine.

NOTICE

DO NOT fill to reach above or to the top of the FULL mark on the dipstick.

Operating your engine when the oil level is above the FULL mark could cause your crankshaft to dip into the oil. If this occurs, air bubbles may be created from the crankshaft dipping into the oil will reduce the lubricating characteristics of your oil.

A crankshaft that dips into the oil during engine operation, would result in a loss of power and a possible alarm from high crankcase pressure.

- If the engine is equipped with an oil level make-up system, fill and maintain to the FULL-COLD mark.

NOTE: Remote mounted or auxiliary filters require additional oil. For all information pertaining to auxiliary filters, refer to the Refill Capacities chart, OEM filter manufacturer's instructions or your Caterpillar dealer.

Lube System

- Check for lubrication leaks, such as the front and rear crankshaft seals, crankcase, oil filter, oil gallery plugs, sensors and valve covers.

NOTE: If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more than the recommended service intervals prescribed in this publication until a leak is found or fixed, or until the suspicion for a leak has been proven to be unwarranted.

Oil Consumption Estimate

Oil consumption, along with fuel consumption and maintenance information, can be used to estimate total operating cost. It can also be used to estimate the capacity of a makeup oil system required to accommodate your maintenance intervals.

Oil consumption, like fuel consumption, is somewhat proportional to the percent load at which the engine is operating. The higher the percent load, the higher the amount of oil consumed per hour.

The oil consumption rate, or BSOC (brake specific oil consumption), unit of measure is grams per brake kilowatt hour (g/bkW-h) [pounds per brake horsepower hour (lb/bhp-h)]. The BSOC varies depending on the load on your engine. The established typical mid-life BSOC values for your engine can be determined by contacting your Caterpillar dealer for assistance in determining typical oil consumption for your engine.

The Engine Technical Manual, EDS 96.2, has established typical mid-life BSOC values for 3500 engines operating at 100 percent load factor. These values are listed below.

3500 BSOC		
Engine Model	g/bkW-h	lb/bhp-h
Low Speed	0.365	0.0006
High Speed	0.548	0.0009

Oil Consumption as an Overhaul Indicator

When an engine's oil consumption has risen to three times the initial (new) consumption rate due to normal wear, then the engine should be scheduled for overhaul. There may be a corresponding increase in blowby and also a slight increase in fuel consumption. Contact your Caterpillar dealer for assistance in determining typical oil consumption for your engine.

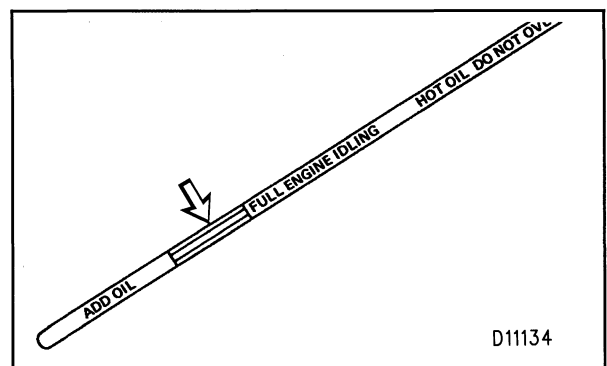
Marine Gear

Check Oil Level



WARNING

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



1. Check the oil level at LOW IDLE with the marine gear engaged. Maintain the oil level at the FULL mark on the dipstick.
2. Add oil as required. Do not overfill the marine gear. For marine gear other than Caterpillar 7200 Series, refer to the manufacturer's recommendations.

Cooling System

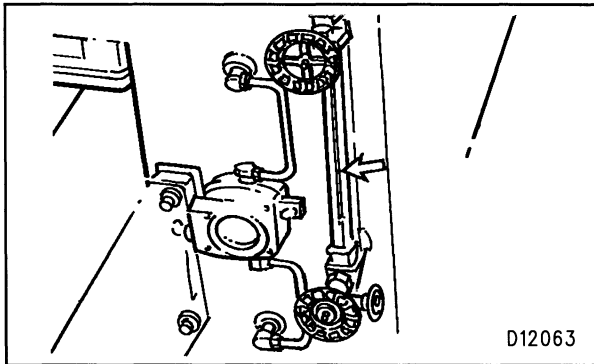
NOTICE

Make sure you read and understand the information in the Safety and Cooling System Specifications sections of this Manual before you proceed with maintenance of the cooling system.

Check Coolant Level

WARNING

Climbing equipment may be required to access this service point. Refer to the Safety Section, Mounting and Dismounting topic for safety information.



- Check the position of the float in the sight gauge (if equipped). At normal operating temperature, the coolant level float should be in the upper half of the sight gauge.

If Coolant is Low

Refer to the Cooling System Specifications section in this publication for all information pertaining to water, antifreeze and supplemental coolant additive requirements before performing this maintenance procedure.

- Stop the engine and allow the engine to cool before performing this maintenance procedure.
- Release vent valve (if equipped) slowly to relieve pressure. Remove the filler cap slowly to relieve pressure and inspect condition of cap gasket. Replace cap if gaskets are damaged.

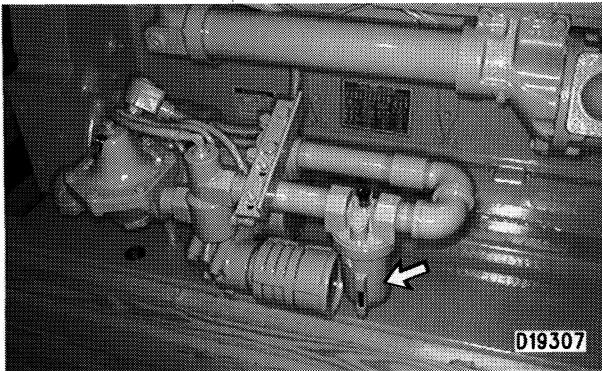
NOTICE

To prevent engine damage, never add coolant to an overheated engine. Allow the engine to cool first.

- Maintain the coolant level within 13 mm (½ inch) below the bottom of the fill pipe or to the proper level (upper half) on the sight glass (if equipped) by adding make-up coolant water. Install the filler cap.
- Inspect for leaks or damaged piping. Make repairs if necessary.
- Check for proper block heater operation by feeling the side of the engine block and or checking the engine coolant temperature gauge. A properly operating block heater will maintain the coolant temperature in the block at 32°C (90°F) minimum.

Air Starter Motor Lubricator

Check Lubricator



NOTICE

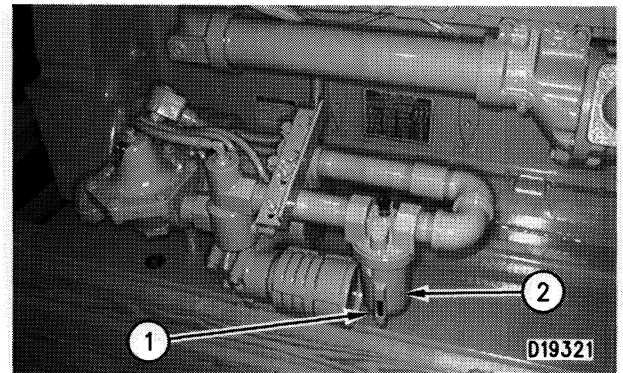
Never allow the air lubricator jar to become empty. The starting motor will be damaged by lack of proper lubrication.

The vanes of the starting motor are lubricated with a fine oil mist from the motor oiler while the motor is operating.

When the oiler bowl becomes half empty, remove the oil filter plug and fill the bowl with clean oil or diesel fuel or kerosene. Refer to the Recommended Lubricant Viscosities chart for proper oil.

Cleaning Lubricator Jar

- The collector jar must be emptied when it becomes half full. The jar collects both the lubricant, after it has lubricated the starting motor vanes, and moisture condensation from the compressed air.

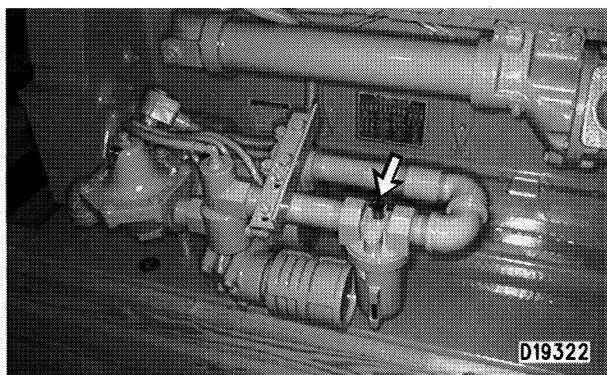


1. Shut off the air supply to the starting motor control valve.
2. Open the drain valve (1) at the bottom of the bowl. The drain valve releases pressure from the bowl and allows the lubricant to drain.
3. Remove and clean the oiler bowl (2), using warm water only.
4. Dry the oiler bowl. Inspect for cracks. Replace if necessary.
5. Fill the oiler bowl with lubricant. Refer to the Lubricant Viscosity Recommendations in this manual for more information.
6. Install the oiler bowl (2) and close the drain valve (1).
7. Turn on the air supply to the starting motor control valve.

Oiler Feed Adjustment

If necessary, adjust the oiler feed to release four drops of lubricant per minute into the starting motor air stream and prelube pump.

1. Be sure there is NO fuel supply to the engine.
2. Operate the air start control lever or button to engage the starting motor to crank the engine.
3. Count the drops of lubricant released per minute into the air stream.



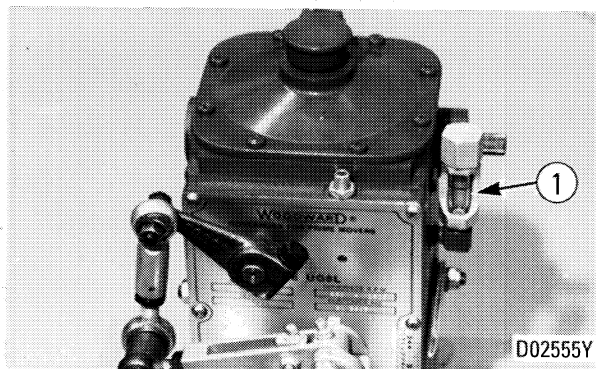
- Turn the valve needle (the uppermost knob on the oiler) counterclockwise (CCW) to increase the number of drops per minute or turn the valve needle clockwise (CW) to decrease the number of drops per minute.

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.

Governor

Woodward UG8L Governor

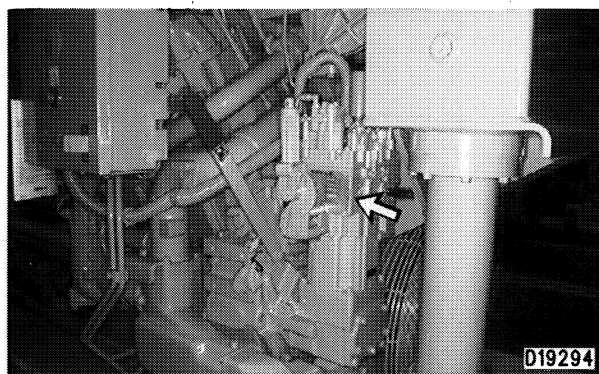
Measure Oil Level



With the engine stopped, measure the governor oil level. Maintain oil level at the FULL mark on the gauge or dipstick, if equipped.

Woodward 3161 Governor

Inspect for Proper Operation



The Woodward 3161 governor is connected to the engine oil lubrication system. The oil supply (under pressure) is sent to the governor through an orifice and internal passages. The governor keeps the correct oil level and drains excess oil back into the engine. The Woodward 3161 Governor will require oil only when it has been removed for service and at initial start up of a new engine. If engine rpm becomes erratic, the oil level in the Woodward 3161 Governor should be checked.

The oil level should be 60 to 76 mm (2.4 to 3.0 inches) below the surface of the hole where the sump plug is located. Add oil as needed to maintain the correct oil level.

If the oil level is low, clean the spiral orifice.

Oil is supplied to the governor from the engine and through the spiral orifice. Remove the spiral orifice, clean and install. Refer to the Service Manual for the complete procedure.

The Woodward 3161 governor, by design, maintains the proper oil level and drains the excess oil back to the engine, providing a continuous flow. Other than the spiral orifice, no other maintenance is required.

If the governor has been disassembled for repairs, fill the governor housing with engine oil. Do not start the engine without oil in the governor housing. Damage to the engine will result.

Air Tank

Drain Water and Sediment

This maintenance should be performed daily (or as necessary) to remove water and sediment. Water in the air system could freeze, corrode internal parts or cause the air system to malfunction. Drain moisture and sediment from the air reservoir as required.

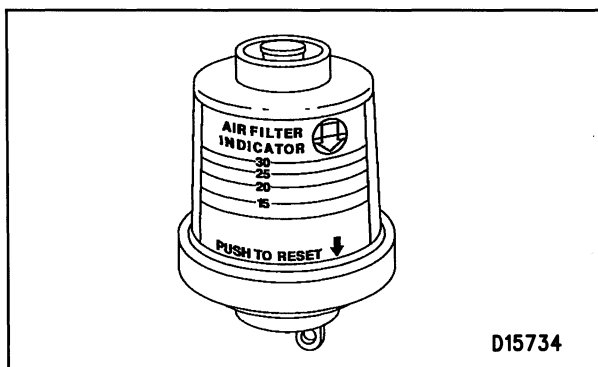
WARNING

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

- Check the air level in the tank. The tank should be kept as full as possible. Refill the tank when below three-fourths full to minimize the possibility of moisture accumulation in the tank.
- To drain the water and sediment, open the drain valve. Allow water and sediment to drain into a container. Close drain valve. Wipe up spills.
- Check all lines for leaks, loose clamps and fittings and loose or worn hoses. If a leak is found, repair as necessary.

Air Cleaner Service Indicator

Check



Check the air cleaner indicator. Service the air cleaner elements when the yellow diaphragm enters the red zone or the piston locks in the visible position. Maximum air cleaner differential pressure is 7.5 kPa (30 inches of H₂O).

Air Cleaner Elements

NOTICE

Never service the air cleaners with the engine running, since this will allow dirt to enter the engine. Do not clean elements by bumping or tapping them. Do not use filter elements with damaged pleats, gaskets or seals.

Refer to the air cleaner manufacturer's instructions if using air filters other than Caterpillar's.

Check the air ducts for leaks. Make all repairs to leaky air ducts immediately, as dirt and debris could enter the engine causing damage to the turbocharger and engine components.

If your air cleaner is not equipped with an air cleaner service indicator, you can obtain one at your Caterpillar dealer. Make sure the air inlet piping is secured and air filters are in place. Inspect the air intake system piping, elbows and gaskets for cracks or damage. Replace items as needed. Check for loose clamps and tighten if necessary.

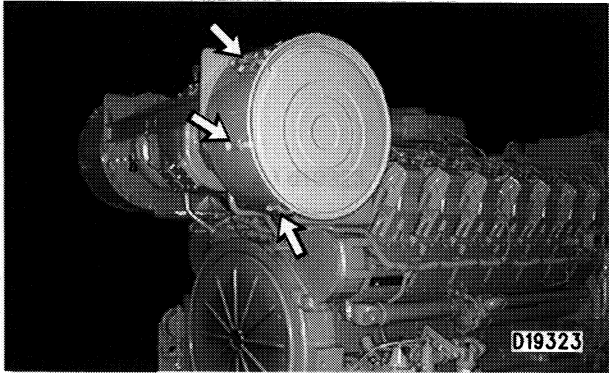
- Clean or replace the air filter elements using the air filter differential pressure gauge or air cleaner indicator as the basis for determining the condition of the elements to establish this maintenance interval.
- The air filters should be inspected frequently when restriction reaches 3.75 kPa (15 inches of H₂O) and fuel consumption begins to increase slightly. The Air Filter Differential Pressure must NOT exceed 7.5 kPa (30 inches of H₂O) before replacing air filters. Severe fuel consumption loss will result if air filter restriction exceeds 7.5 kPa (30 inches of H₂O).

If the air cleaner element becomes plugged, the air can split the element filter material. This allows unfiltered air into the engine which would drastically accelerate engine wear. If the air cleaner elements become plugged, but does not split, engine performance will deteriorate and output power will be reduced.

- The primary element (Caterpillar air filters) can be cleaned up to six times before replacement. The element, when cleaned, should be thoroughly checked for rips or tears in the filter material. Replace the primary element every year even if it has not been cleaned six times.

NOTE: Air cleaner filter elements can be cleaned with either air, water or detergent. Have spare elements on hand to use while cleaning used elements.

Change Air Cleaner Elements



1. Release the cover fasteners from around the filter housing.
2. Remove the cover.
3. Remove the element and soot filter. Remove the soot filter from around the air cleaner element and discard it.
4. Clean the inside of the housing.
5. Install a new soot filter around the element.
6. Install the new or cleaned element and soot filter.
7. Install the cover and fasten it.
8. Reset the air cleaner indicator by pressing the reset button.
9. Repeat steps 1 thru 8 for the air cleaner on the opposite side.

Cleaning Air Cleaner Elements



Pressure air can cause personal injury. When using pressure air, wear protective face shield and clothing.

The primary element (Caterpillar air filters) can be cleaned up to six times before replacement. The element, when cleaned, should be thoroughly checked for rips or tears in the filter material. Replace the primary element every year even though it has not been cleaned six times.

NOTICE

Do not clean filter elements by bumping or tapping. Do not use filter elements with damaged pleats, gaskets or seals.

NOTE: Air cleaner filter elements can be cleaned with either air, water or detergent. Have spare elements on hand to use while cleaning used elements. For more information, refer to Guideline for Reusable Parts, Form SEBF8062.

Refer to the air cleaner manufacturer's instructions if using air filters other than Caterpillar. Check the air duct for leaks. Make all repairs to leaky air ducts immediately, as dirt and debris could be induced into the engine causing damage to the turbocharger and engine components.

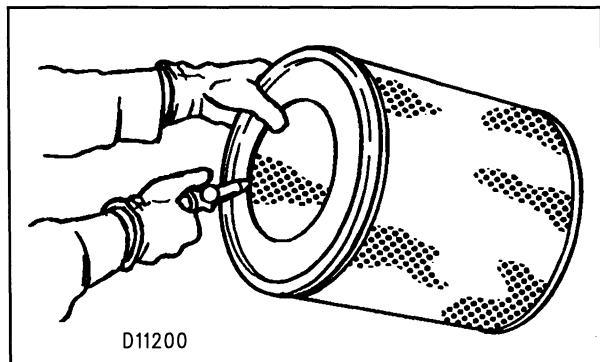
1. Remove the air cleaner cover and element and cover the turbocharger compressor inlet.
2. Clean the inside of the air cleaner cover and body with a clean, dry cloth.
3. Inspect the replacement element for damage, dirt or debris.
4. Remove the covering from the turbocharger compressor inlet and install a clean, undamaged element.
5. Install the air cleaner housing cover and fasten it. Reset the service indicator.

Cleaning with Water, Air, or Detergent

NOTICE

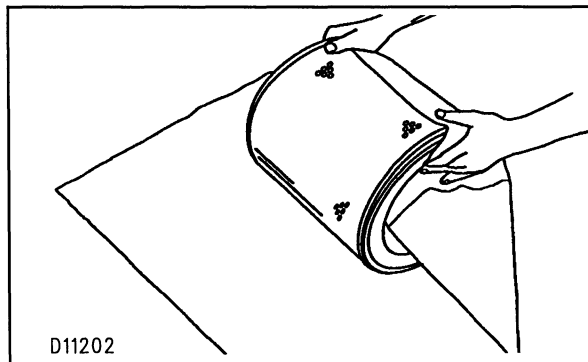
Do not clean the filter elements by bumping or tapping them. Engine damage could result.

Filter elements can be cleaned with 205 kPa (30 psi) maximum air pressure, 280 kPa (40 psi) maximum water pressure, or detergent washing.



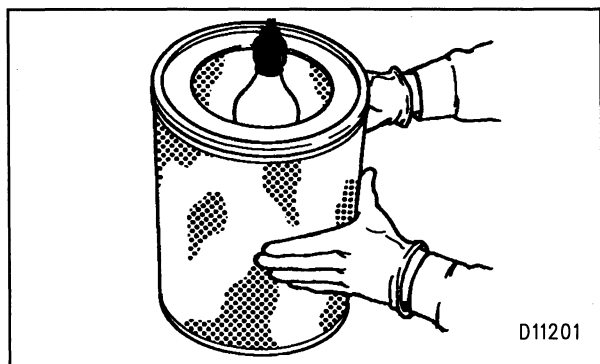
- 1.** Direct air or water along the pleats inside and outside of filter element.

The element can be washed in warm water and nonsudsing household detergent. Rinse inside and outside the pleats and air dry fully.



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

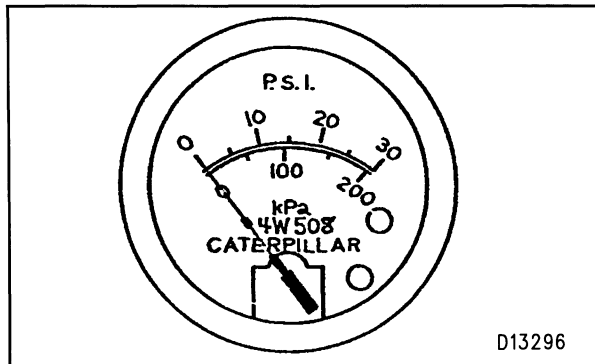
For more information on air cleaner element cleaning, refer to Guideline for Reusable Parts—Cleaning and Inspection of Air Filters, SEBF8062.



- 2.** Inspect the filter elements after cleaning. Do not use a filter element with damaged pleats, gaskets or seals.

Engine Oil Filter Differential Pressure

Check



The engine oil filter elements should be changed when the oil filter pressure differential gauge registers 105 kPa (15 psi) when engine is at rated speed and is at operating temperature.

If the engine is equipped with a duplex oil filter system, the filter elements can be changed with the engine running.

For the procedure to change oil filter elements or to service duplex oil filters, refer the topic Engine Oil and Filters under the Every 250 Service Hour interval.

Engine Fuel Filter Differential Pressure

Check

The final fuel filter elements should be replaced when the fuel filter differential gauge registers 105 kPa (15 psi), when engine is at rated speed and operating temperature. The primary fuel filter should be cleaned each time the elements are changed.

If the engine is equipped with a duplex fuel filter system the elements can be changed with the engine running. For the procedure to change fuel filter elements or to service duplex fuel filters refer to the topic Fuel Filters under the Every 1000 Service Hour interval.

Every 50 Service 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.

This maintenance is to be performed at the interval specified in the Maintenance Schedule. Before proceeding with this maintenance, perform Daily maintenance interval requirements.

Zinc Rods

Inspecting Zinc Rods

Zinc rods are inserted in the engine's 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.

Therefore, the zinc rods must be inspected Every 50 Service Hours, and replaced when they have deteriorated.

Depending on the engine and attachments, their location may be in the oil cooler heat exchanger bonnet, sea water heat exchanger bonnet, aftercooler lines, sea water pump and/or in the sea water lines.

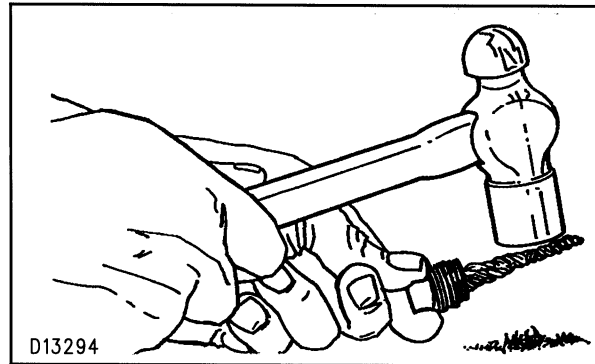
3500 Family Marine Engine Zinc Plug Locations:

- Seawater oil cooler/heat exchanger - There are three (3) zinc rods and plugs located in the end bonnets of the heat exchanger.
- Seawater Pump - There is one (1) zinc rod and plug located on the seawater pump elbow.
- Marine Gear Heat Exchanger (7200 Series) - There is one (1) zinc rod and plug located in the end bonnet.

Note: For all other marine gears refer to the manufacturers recommendations.

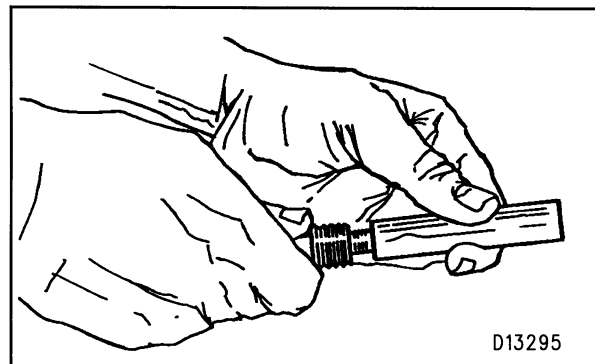
To service the zinc rods and plugs, use the following procedure:

1. Remove and observe condition of all zinc rods.



2. Tap the zinc rods lightly with a hammer. If a rod has deteriorated, or flakes apart when tapped, install a new zinc rod. Inspect the plug for damage. Replace if necessary.

Installing New Zinc Rods



1. Unscrew or drill the existing rod from the plug base.
2. Install a new rod in the plug base.
3. Install the plug.

Caterpillar Marine Gear

New or Reconditioned Only

Change oil and filter on a new or reconditioned unit after the first 50 Service Hours. See Caterpillar Marine Gear in the Every 1000 Service Hours section of this manual. For marine gear other than Caterpillar 7200 Series, refer to the manufacturer's recommendations.

Every 250 Service 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.

This maintenance is to be performed at the interval specified in the Maintenance Schedule. Before proceeding with this maintenance, perform all previous maintenance interval requirements.

Scheduled Oil Sampling (S•O•S)

Obtain Sample

S•O•S INTERVAL CHART	
Compartment	Interval
Engine Oil	250 Service Hours

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

Normal test results from the oil samples will be used to develop a "baseline" which will be used as a basis for determining the oil change interval for your engine, giving you the ultimate time between oil changes without the risk of engine damage.

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. There are several methods used to obtain S•O•S samples from Caterpillar diesel engines.

- Use a sampling gun inserted into the sump.
- Use a sampling valve installed for samples.
- Use the drain stream method when changing oil.

The sample valve should be flushed with oil coming out of the crankcase to rinse the dirt and debris from the valve.

Caterpillar recommends the first two methods. However, if these methods are not possible, then use a drain stream method when changing the oil.

If the drain stream method is used to obtain the oil sample, take the sample after some oil has drained and before the final drain oil stream. The oil at the beginning or end of the drain stream is not mixed well enough to be representative of circulating oil in the compartment and may carry debris that can give false S•O•S analysis results.

Refer to How to Take a Good Oil Sample, PEHP6001 for a step-by-step explanation if using this method of sampling oil. Contact your Caterpillar dealer for information and assistance in establishing the S•O•S program for your engine and application.

If the engine crankcase oil has reached its condemning limits as established by the oil analysis program before the established oil drain interval, refer to the topic, Engine Oil and Filters in this publication to replace the crankcase and/or auxiliary system oil.

Oil Drain Intervals

It is essential that an S•O•S analysis be performed on a regular basis to analyze oil condition before modifying oil change intervals can be considered. Due to manufacturing tolerances, engine application and maintenance variations, all engines do not consume fuel and oil at the same rate. Some history of fuel and oil consumed for each engine (or group of engines) in a similar application must be established. For a group of engines, determine the average fuel consumption and add oil rate.

For more information on establishing oil change intervals for specific engines and applications, see your Caterpillar dealer.

Engine Oil and Filters

Oil and Filter Change Interval

Use the chart below to establish the oil and filter change interval based on the engine oil sump capacity, minimum API oil classification and diesel fuel sulfur content of 0.5 percent or less.

Oil and Filter Change Interval			
Engine	250 HRS	500 HRS	1000 HRS
3508	104 Liter 27 US Gal. 22 Imp. Gal.	227 Liter 59 US Gal. 42 Imp. Gal.	424 Liter 112 US Gal. 90 Imp. Gal.
3512	152 Liter 40 US Gal. 33 Imp. Gal.	312 Liter 81 US Gal. 67 Imp. Gal.	613 Liter 162 US Gal. 134 Imp. Gal.
3516	204 Liter 53 US Gal. 44 Imp. Gal.	401 Liter 106 US Gal. 88 Imp. Gal.	842 Liter 219 US Gal. 182 Imp. Gal.

NOTE: This chart establishes the basis for the oil change interval only which affects S•O•S sampling, engine oil change, oil filters and initial valve lash adjustment. All other items are to be performed at Every 250 Service Hours.

Change Oil

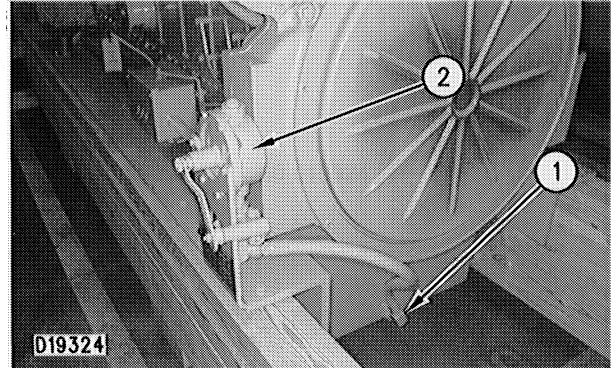


WARNING

Use caution when draining oil or changing filters. Hot oil or components can cause burns if they contact skin.

Drain the crankcase with the oil warm and the engine stopped to allow for the draining of waste particles that are suspended in the oil. As the oil cools, suspended waste particles will settle on the bottom of the crankcase and will not be removed with the draining oil.

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



1. Remove the crankcase drain plug (1) or use the hand operated sump pump (2) and drain the oil. Obtain an oil sample for S•O•S (Scheduled Oil Sampling) analysis.

When using the drain stream to obtain the oil sample, do not sample from the first or final draining since 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.

NOTE: S•O•S compliments a good preventive maintenance program. Caterpillar recommends using S•O•S at regular intervals, to monitor the condition and the 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 compartment.

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

2. Install the crankcase drain plug and tighten it to 70 ± 14 N•m (50 ± 10 lb ft).

Drain Filter Housing (If Equipped)

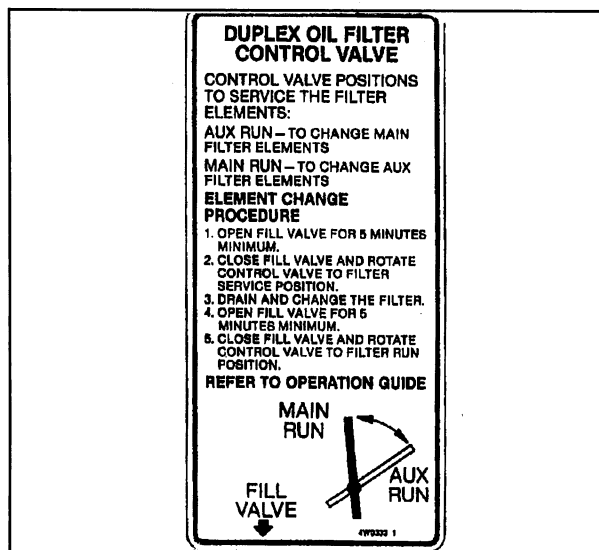
NOTICE

This procedure must be performed with the engine STOPPED unless equipped with Duplex Oil Filters.

If your engine is NOT equipped with duplex oil filters, go to step #1.

If equipped with duplex oil filters, the engine oil filters can be changed while the engine is running. This is useful if the oil filters need replacement before the Engine Crankcase Oil drain interval. Follow the procedure below.

Duplex Oil Filters (If Equipped)



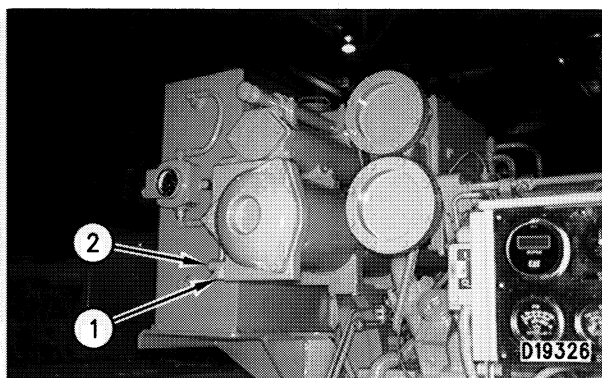
WARNING

Filter contains hot pressurized fluid when engine is running. Follow instructions on control valve to avoid injury. If rapid air movement exists to blow fluid, stop engine to avoid fire.

- Move selector valve to the AUXiliary RUN position to change main filter elements or MAIN RUN position to change auxiliary filter elements.
- Allow the oil pressure gauge (or differential pressure) to reach zero.
- Open FILL VALVE for five minutes minimum.
- Close FILL VALVE and rotate control valve to AUXiliary RUN (or MAIN RUN) position to drain and change appropriate filter elements.
- Open FILL VALVE again for five minutes minimum.
- Close FILL VALVE and rotate control valve to MAIN RUN (or AUXiliary RUN) position.

NOTICE

This procedure must be performed with the engine STOPPED unless equipped with Duplex Oil Filters.



Engine Oil Filter Housing

1. To drain oil from the engine oil filter housing, install a 1/2-14 pipe nipple in the engine oil filter housing drain valve (1). Attach one end of a suitable hose to the nipple. Put the other end of hose in a container to catch the oil.
2. Open the engine oil filter housing drain valve (1) by turning the square stem counterclockwise (CCW). Remove vent plug (2) from the side of the engine oil filter housing. Allow oil to drain, then replace all plugs and close the drain valve.

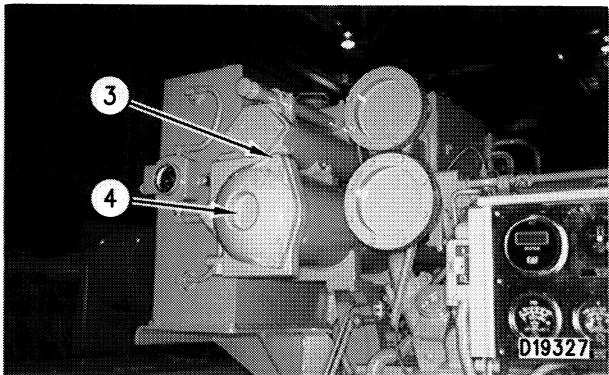
Replace Filters

Oil Filter Housing with Elements

WARNING

Possible injury can result when removing cover.

Spring force will be released when cover is removed. Be prepared to hold the cover as the bolts are loosened.



1. Loosen the three bolts (3) that hold the oil filter cover in place. Remove the oil filter cover (4). Remove the engine oil filter elements.

2. Wipe out the engine oil filter housing with a clean cloth.

3. Install new engine oil filter elements.

NOTE: Make sure to use the correct Caterpillar oil filter element(s) for your engine arrangement. Use of an oil filter element not recommended by Caterpillar could result in severe damage to your engines' bearings, crankshaft, etc., as a result of the larger debris particles or unfiltered oil entering your engine.

4. Inspect the engine oil filter cover O-ring seal. Install a new seal if necessary.

5. Install the engine oil filter cover (4). Make sure that the springs are seated properly between the elements and the cover.

6. Close the filter housing drain valve (1). Remove the drain hose. Clean and install vent plug (2) into the filter housing.

Batteries

Check Electrolyte Level

BATTERY ELECTROLYTE CHART	
Battery	Interval
Conventional	125 Service Hours
Low Maintenance	250 Service Hours
Maintenance Free	None Required

Tighten the battery retainers and check the following at least Every 250 Service Hours, and more often if conditions require.

1. Inspect the electrolyte level in each battery cell, except maintenance free. Remove fill caps. Maintain electrolyte to bottom on fill plug openings.

- If 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. The salts used in the treatment of artificially softened water will damage or reduce the efficiency of your batteries.

- At the proper charging rate in a moderate climate, batteries should not require more than 30 cc (1 ounce) of water per cell per week. Check the cells weekly in extreme temperatures, cell water usage could be higher.

2. Keep batteries clean. Clean the top of the batteries with a clean cloth.

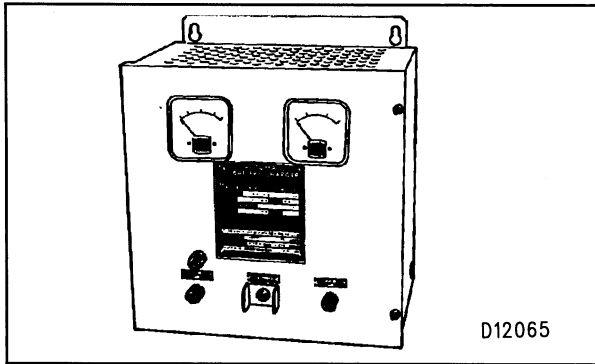
3. Loosen and remove cable clamps from all battery terminals.

4. Clean all cable clamps and battery terminals.

5. Coat cable clamps and terminals with petroleum jelly, 5N5561 Silicone Lubricant or MPGM grease.

6. Install and tighten cable clamps to battery terminals. Install the post cover.

Check/Record Battery Charger (If Equipped)



Check the battery charger for proper operation. Record the charging amperage reading. 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

NOTE: When replacing batteries, battery cables, or disconnect switch, use the procedure that follows.

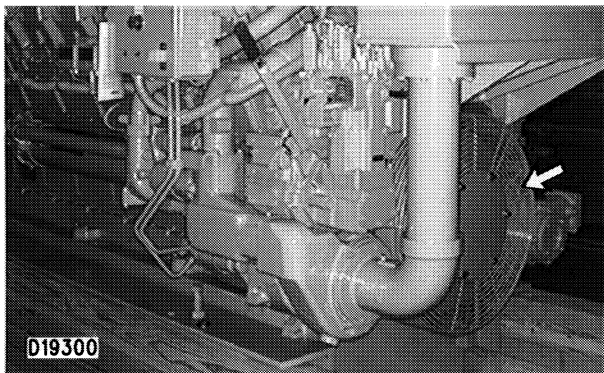
1. Turn OFF start switch and all electrical loads.
2. The cable that is connected to the frame must be disconnected at the disconnect switch (one cable connects to frame and one to battery negative). Be sure the disconnect cable cannot contact the switch stud where it was just removed.
3. Disconnect the negative battery cable terminal at the battery(s) that goes to the disconnect switch. Where four 12 volt batteries are involved, the negative side of two batteries must be disconnected.
4. Proceed with necessary system repairs.
5. Connect the cable from the frame to the disconnect switch (one cable connects to frame and one to battery negative).
6. Connect the negative battery cable terminal from the disconnect switch to the battery(s). Where four 12 volt batteries are involved, the negative side of two batteries must be connected.

Belts, Hoses and Radiator Fins (If Equipped)

Inspect/Check

Inspect the condition and adjustment of alternator and accessory drive belts (if equipped) and replace if they show any signs of wear. A broken or worn alternator, fan or drive belt will cause performance problems. 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. A slipping or improperly adjusted belt can cause engine cooling or battery problems when your generator is needed. Inspect for worn, broken or loose belts (alternator, fan, drive, etc.).



1. Remove belt guard.
2. Inspect the belts for wear. Replace belts if worn, cracked or frayed.

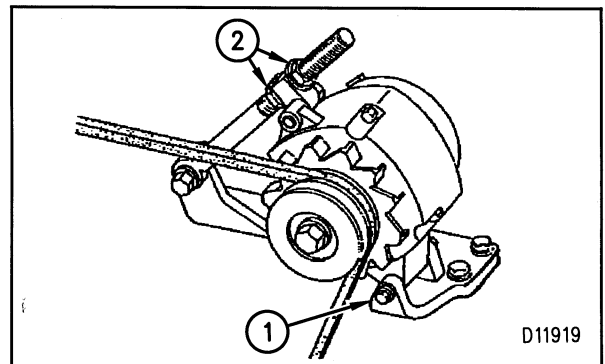
When belt replacement is necessary, belts must be replaced in complete matched sets. Never replace only one belt. The new belt will carry all of the load and consequently, fail rapidly.

3. If belts do not require replacement or adjustment, install the belt guard. If belts require adjustment or replacement, do not install the belt guard. Refer to the Belt Adjustment procedure when belt adjustment and/or replacement is necessary.

Belt Adjustment

1. Apply a 110 N (25 lb) force, perpendicular to the belt, midway between the driving and driven pulley. Measure the belt deflection.

Proper belt deflection is 15 to 20 mm (0.6 to 0.8 inch). Adjust the belt tension as required.



1. To adjust the belt, loosen mounting bolts (1) and adjust with adjusting bolt (2).
2. Move the fan drive up or down as required to obtain the correct adjustment. Tighten mounting bolts.

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

3. If engine is equipped with any other belt driven equipment, check and adjust them as required.
4. Replace the belt guard.

Fan Belts

Inspect

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

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, and all the belts will fail in rapid succession.

Adjustment

Check new belts for adjustment after the first 30 minutes and Every 250 Service Hours thereafter. To check belts apply 110 N (25 lb) force midway between pulleys. Correctly adjusted belts will deflect 12 to 19 mm ($\frac{1}{2}$ to $\frac{3}{4}$ inch) for the first check. Maintain later adjustments at 23 mm ($\frac{7}{8}$ inch).

Loosen the lockbolts on the fan pulley adjusting bracket and adjust fan pulley by applying grease to fitting shown. After belt tension is correct, tighten lockbolts.

Hoses

Hose replacement prior to failure is cost effective and a good preventive maintenance practice. Replacing a hose before it fails saves you money and reduces the chances for unscheduled downtime. By replacing a hose that is cracked, soft or leaking, you will avoid major repairs that could result from a severe engine overheating problem.

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

Radiator Fins (If Equipped)

Inspect/Check



Wear eye protection at all times when cleaning the cooling system. Pressurized water could cause debris to be blown and result in personal injury.

Always clean the radiator fins with the engine stopped. Failure to do so, could result in personal injury caused by the moving fan blades.

Check the radiator fins for debris.

High pressure water is an excellent way to clean the debris out of the radiator fins.

If necessary, use a light bulb behind the radiator fins to see if they are completely clean.

Refer to Know Your Cooling System, SEBD0518, for more detailed information on cleaning your radiator fins.

Fuel Tank

Drain Water and Sediment

This maintenance should be performed as necessary to remove water and sediment. Water in the system could freeze, corrode internal parts or cause the system to malfunction. Drain moisture and sediment as required.

- Check fuel level in the fuel tank. The tank should be kept as full as possible (without overflowing) to ensure the engine can be started and run as required. Refill the tank when below three-fourths full to minimize the possibility of moisture accumulation in the tank. Fuel expands when warm, so do not overfill the tank.
- Drain the water and sediment from the fuel tank. Open drain valve. Allow water and sediment to drain into a container. Close drain valve. Wipe up spills.
- Check all lines for leaks, loose clamps and fittings and loose or worn hoses. If a leak is found, repair as necessary.

Refer to the Fuel Specification Section of this Manual for additional information on fuel tanks and fuel lines.

Engine Valve Lash, Injector Timing and Rotators

Check/Adjust

With the engine stopped and cold, inspect and adjust the bridge and valve adjustment. Before adjusting valve lash, a bridge adjustment must be made. After checking the bridge adjustment for each cylinder, proceed with the valve lash adjustment, if necessary. Refer to the Service Manual for the complete procedure.

Initial Valve Lash

NOTE: Initial valve lash adjustment on new, or rebuilt 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 2000 service hour intervals.



WARNING

To prevent possible injury, DO NOT use the starting motor to bar over the engine. Be sure the starting motors are disabled and engine cannot be started while this maintenance is being performed.

Always have the Engine Control Switch (ECS) in the STOP or OFF/RESET position to immediately discharge the starting system.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring valve lash. Measure the valve lash with the ENGINE STOPPED. To obtain an accurate measurement, allow at least 20 minutes for the valves to cool to engine cylinder head and block temperature.

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.

Always turn the flywheel in the direction of normal rotation. Before checking or adjusting the valve lash, move the valve rocker arm up and down several times to push the oil out of the push rod socket. This is necessary to get accurate valve lash measurements.

Stop the engine according to the procedure in the Engine Stopping section and inspect the valve cover gasket to ensure it is not damaged. Thoroughly clean the area around the valve mechanism covers to prevent the entry of foreign matter into the top of the cylinder head and valve mechanism.

When the valve lash (clearance) is checked, an adjustment is **NOT** necessary if the measurement is within ± 0.08 mm (± 0.003 inch) of the value given in the Valve Lash Setting chart.

If the measurement is outside of the range given for valve lash, an adjustment is necessary. Set the lash to the nominal clearance given in the Valve Lash Setting chart. Refer to the Service Manual or your Caterpillar dealer for the complete valve adjustment procedure.

Valve Bridge

NOTICE

Be sure to adjust the valve bridges before adjusting any valves.
Perform procedure for both bridges for each cylinder. Put clean engine oil on the contact points of both bridges and in the bridge bores.

The valve bridge should be checked and/or adjusted each time valve lash is checked and/or adjusted. Valve and valve mechanism components do not always wear evenly which can allow the bridge to go out of adjustment.

There are two rocker arms per cylinder. One rocker arm for the two exhaust valves and one rocker arm for the two inlet valves. Each pair of valves is connected by a bridge which is actuated by the rocker arm. The valves in each pair are adjusted simultaneously by adjusting screw in the rocker arm. Each bridge is adjusted by adjusting screw.

It is not necessary to remove the rocker arm shaft to adjust the valve bridges, but there must be lash. Push on the top of the rocker arm directly above the center of the bridge to check bridge adjustment. Refer to the Service Manual for the complete adjustment procedure.

NOTE: Caterpillar recommends replacement of improperly operating valve rotators. An improperly operating valve rotator will shorten valve life through accelerated valve face and valve seat wear.

Rotators

With the engine idling, observe the rotation of the valves only after setting the valve lash.

WARNING

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

NOTICE

If a damaged rotator is not replaced, valve face guttering could result in pieces of the valve to fall into the cylinder. This can cause piston and cylinder head damage.

Refer to the Service Manual or your Caterpillar dealer for more information on complete valve adjustment procedure.

1. After setting all valve lash and before installing the valve cover, start the engine. Move the governor control to LOW IDLE position.
2. Watch the top surface on each valve rotator. Each valve rotator should turn slightly each time the valve closes. If a valve fails to rotate, contact your Caterpillar dealer.

Injector Timing

The first time the valve lash is checked and/or adjusted, the injector timing should be checked and/or adjusted. Use the procedure as established in the Service Manual, or contact your Caterpillar dealer for assistance.

Cooling System—Engines Using Standard Type Antifreeze Only

NOTICE

This maintenance is for engines using standard type antifreeze only. DO NOT mix standard type antifreeze and Long Life Coolant (LLC). Make sure you read and understand the information in the Safety and Cooling System Specifications sections of this Manual before you proceed with this maintenance.

Test for Coolant Additive Concentration

Use the 8T5296 Coolant Additive (Conditioner) Test Kit to check for coolant additive concentration of Caterpillar conditioner. The sample can be tested by your Caterpillar dealer to determine the concentration of supplemental coolant additive or use the 8T5296 Coolant Additive (Conditioner) Test Kit to check for concentration. Add coolant additive if the percentage is below three percent, but do not allow concentration to exceed eight percent.

If the concentration level is above eight percent, sludge and mud-like deposits may be formed in the cooling system. This has an adverse affect on engine performance and can also lead to costly repairs of the engine and cooling system. For more information, order a copy of Coolant and Your Engine, SEBD0970, available through your Caterpillar dealer or refer to the Cooling System Specifications in this manual or your Caterpillar dealer.

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

- Coolant is heavily contaminated.
- The engine overheats frequently.
- Foaming is observed in the cooling system.
- The oil cooler has failed allowing oil in the cooling system and contaminated the coolant.
- Fuel has entered the cooling system and contaminated the coolant.
- Supplemental coolant additive and antifreeze other than Caterpillar products are used.

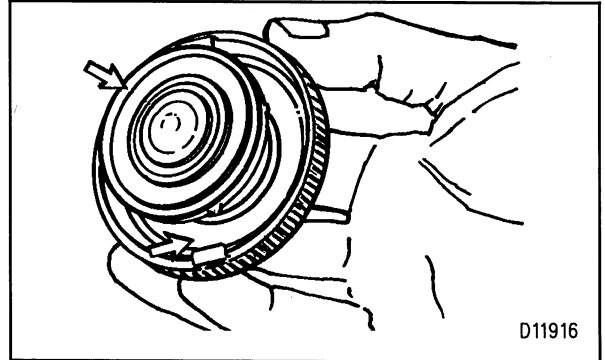
NOTICE

Caterpillar does not recommend the use of cooling system solutions that are intended to stop leaks. Use of these products may result in excessive internal deposits that could reduce the engine's heat transfer characteristics.

Excessive and continuous over concentration of coolant additive of six percent (greater than the maximum eight percent initial fill when using water only without antifreeze) together with antifreeze concentrations greater than 60 percent will result in deposits on the higher temperature surfaces of the cooling system, accelerate water pump seal wear and may result in heat exchanger tube blockage which creates a barrier that reduces the engine's heat transfer characteristics and could cause cracking of the cylinder head and other high temperature components.

Add Coolant Additive (Conditioner)

NOTE: For separate circuit systems, refer to the specific system volumes to determine the quantity to be added to each system. Be sure to test both systems as the jacket water may deteriorate faster because of system temperatures.



- 1.** Release the cooling system relief valve or filler cap slowly to relieve pressure and remove filler cap. Inspect condition of cap gasket. Replace cap if necessary.
- 2.** It may be necessary to drain enough coolant from the system to allow for the addition of cooling system additive (conditioner).
- 3.** Add Caterpillar Cooling System Conditioner. Add 0.25 liter (½ U.S. pint) of Caterpillar Cooling System Additive (Conditioner) for each 38 liter (10 U.S. gallon) of cooling system capacity. This will maintain the required concentration of conditioner.

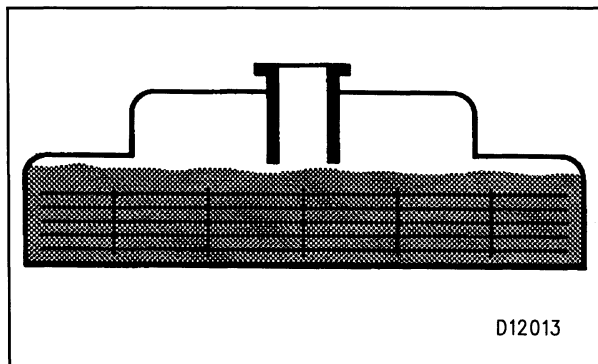
NOTE: On new, rebuilt or remanufactured engines only, or when draining and changing the coolant, add liquid additive concentration of coolant additive of 1 liter (1 U.S. quart) for every 15 liter (4 U.S. gallon) of cooling system capacity for systems using water only.

Caterpillar Antifreeze contains the necessary coolant additive precharge. Only add the coolant additive precharge if you have decided not to use Caterpillar Antifreeze.

Refer to the Refill Capacities chart in this Manual for the cooling system capacity for your engine.

NOTICE

Do not use any Methoxypropanol-based antifreeze or coolants in the cooling system. Methoxypropanol will cause some seals and gaskets to deteriorate and fail.



4. Maintain coolant level to within 13 mm (½ in) below the bottom of the filler tube or to the proper level (upper half) on the sight glass, if equipped. Add premixed coolant if necessary to bring the coolant to the proper level.

Refer to the topic **Cooling System Specifications** in the **Specifications** section in this manual for additional information about coolant mixture and supplemental coolant additive.

5. Start the engine and check cooling system pipes and lines for leaks, damaged piping or connections. Allow the coolant level to stabilize. Inspect the cooling system pipes and lines for leaks and/or damaged connections. Make repairs if necessary. Install the filler cap.

Coolant Analysis

Obtain Coolant Sample

There are two types of coolant analysis that can be performed (1) concentration of coolant conditioners (inhibitor or additive) and (2) coolant water mineral content. These samples should be obtained regularly.

The concentration of Supplemental Coolant Additive (Conditioner) should be checked regularly with the 8T5296 Test Kit. The recommended maintenance intervals should be adequate for many users, however the concentration should be checked periodically.

The water used in the coolant mixture can leave deposits on engine components, yet coolant additive concentrations were properly maintained. A water analysis should be performed annually (every year), as well as when the cooling system is drained, cleaned and flushed, or at overhaul when new water (at fill time) is put into the system.

Full water analysis may be available from your local water utility company or an agricultural agent. Private laboratories are also available. Most laboratories need approximately 250 ml (½ U.S. pint) of water. Many Caterpillar dealers and customers send water samples to the following:

L.O.C.C. Corporation
905 Bayshore Drive
Coos Bay, OR 97420 U.S.A.
Telephone: (503) 267-4904

NALCO Chemical Co.
Naperville Technical Center
One Nalco Center
Naperville, IL 60566 U.S.A.
Telephone: (312) 961-9500

Check the lab you use for details about labeling and shipping. Contact your Caterpillar dealer for assistance if needed.

Cooling System Cleaning

There are two types of cooling system cleaners available. One is the 6V4511 Standard-Type in the 2 liter (½ U.S. gallon) container and the other is the 4C4611 Fast Acting-Type in the 4 liter (1 U.S. gallon) container.

The 6V4511 requires approximately 120 service hours of engine operation to remove scale, lime and other debris. The 4C4611 requires only 90 minutes of engine operation. Both types must remain in the system for a minimum of specified time to work properly, however, neither type will harm the engine if left in for a longer period of time.

The 6V4511 must be added before the Every 3000 Service Hour maintenance interval. Add 1 liter (1 U.S. quart) of Caterpillar Cooling System Cleaner, 6V4511, for every 15 liter (4 U.S. gallon) of cooling system capacity. Continue to operate the engine for the specified time before draining.

The 4C4611 may be added just prior to draining (such as the same day of a day trip) and the system cleaned and flushed after operating for the specified time period.

Refer to the **Cooling System—Clean/Flush** topic in this manual or your Caterpillar dealer for more detailed information.

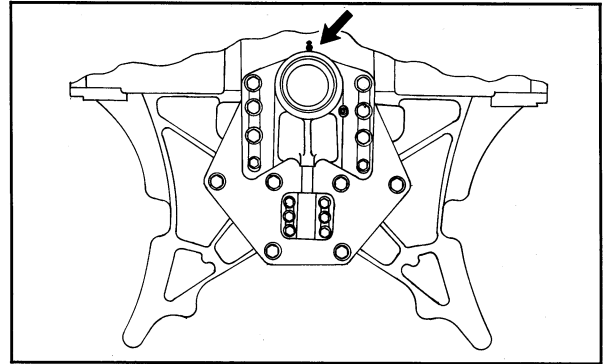
Inspect Radiator

Clean the cooling system (radiator) fins of dirt and debris.

Refer to Know Your Cooling System, SEBD0518, and Coolant and Your Engine, SEBD0970, or your Caterpillar dealer for more detailed information.

Fan Drive Bearing (If Equipped)

Lubricate Fitting



Lubricate fan drive bearing.

Every 1000 Service 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.

This maintenance is to be performed at the interval specified in the Maintenance Schedule. Before proceeding with this maintenance, perform all previous maintenance interval requirements.

Engine Protective Devices

Inspect/Check

The engine protective shutoff controls must be inspected and checked for proper operation. This will ensure that if a malfunction should occur, the engine will shutdown without being damaged.

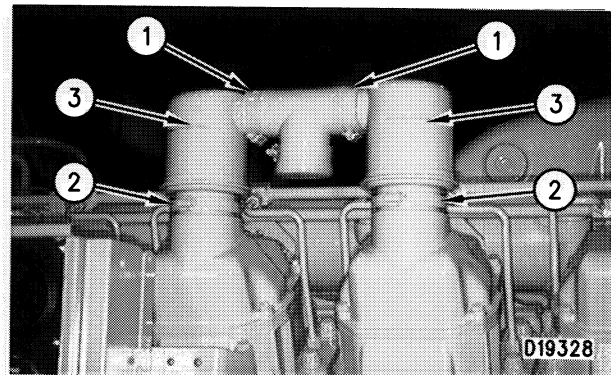
Have the inspection and checks made by a qualified mechanic. Consult your authorized Caterpillar engine dealer, or refer to the Service Manual for your engine.

The Hydramechanical Shutoff should be inspected and tested to ensure proper operation and protection to the engine. Refer to Engine Controls Section under the Operation Section in this manual.

Check air inlet valve to make sure it closes during testing.

Crankcase Breather

Clean



1. Loosen hose clamps (1) on breathers and slide the fumes disposal tube from the breather assemblies.

2. Loosen breather retaining clamp (2) on each of the two breathers (3). Remove breather (3) and the seal.

3. Wash breather (3) in clean, nonflammable solvent and allow to dry before installation.

NOTE: Put clean engine oil or petroleum jelly on the rubber parts to make installation easier.

4. Install new seals and breather (3) in the same position and in reverse order of removal. Tighten bolt clamp.

5. Slide the hose on to breather (3).

6. Tighten all clamps (1) to $4.5 \pm 0.6 \text{ N}\cdot\text{m}$ ($40 \pm 5 \text{ lb in}$).

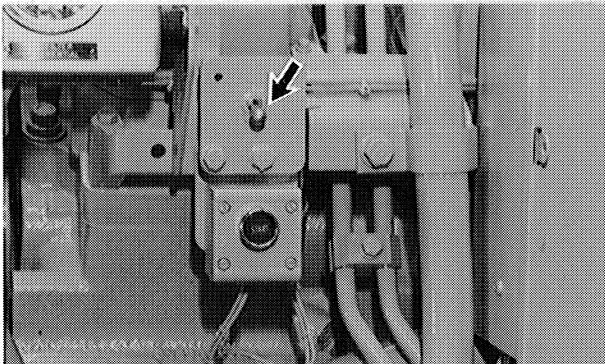
NOTE: If crankcase breathers are not serviced on a regular basis, they will become plugged. A plugged crankcase breather would result in excessive crankcase pressure that may cause crankshaft seal leakage.

Woodward UG8L Governor (If Equipped)

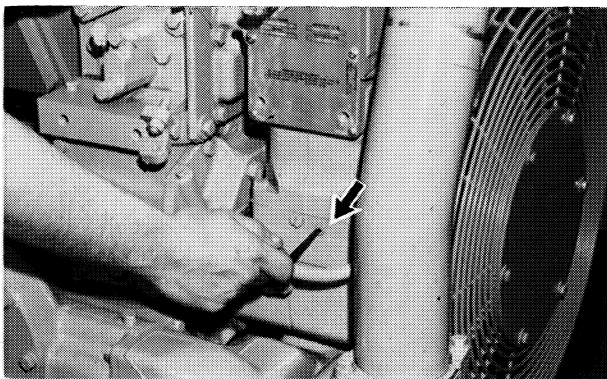
Change Oil

WARNING

To prevent personal injury, be sure the engine cannot be started. Disconnect the ground cable from the battery terminal.



1. Move the ON/OFF switch to the OFF position or disconnect the ground cable from the battery terminal. Close the fuel tank fuel supply valve.

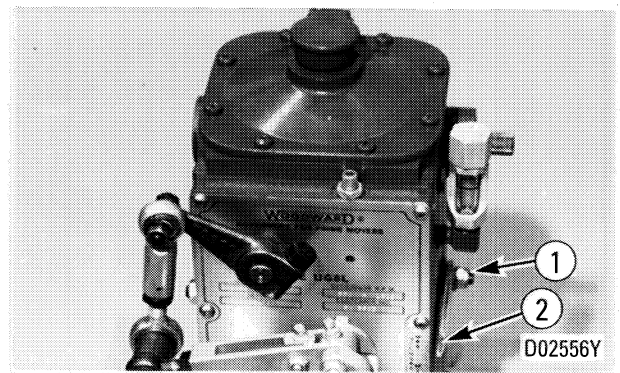


2. Remove governor drain plug. Allow oil to drain. Clean and install the drain plug.
3. Fill the governor with clean oil to the FULL mark on the dipstick or proper level on the sight gauge. Refer to Refill Capacities for proper oil.
4. Connect the ground cable to the battery and open the fuel tank supply valve.

5. Use the procedure that follows to bleed the governor.

Bleed Air From the Governor

1. Start the engine according to the instructions in the Engine Starting topic in this Manual and allow the engine to reach normal operating temperature.



2. Loosen nut (1) on the side of the governor which holds compensation adjusting pointer (2).
3. Manually move pointer (2) to the extreme upper position. Tighten nut (1). This will allow the governor to be purged of air.
4. Remove the plug from the base of the governor. Use a wide blade screwdriver to turn the needle valve three or more turns counterclockwise. Allow the engine to surge for approximately 30 seconds.
5. Loosen the nut and move the compensation adjusting pointer to the extreme downward position. Tighten the nut. Slowly turn the needle valve clockwise until the surging stops.
6. It should now take less than one turn from this point to close the valve completely. Open the valve to the same position where the surging had stopped.
7. Manually move the governor linkage to disturb the engine speed. If the engine speed stabilizes, and the needle valve is only $\frac{1}{2}$ to $\frac{3}{4}$ turn open, the governor is properly adjusted. Install the base plug.

If more than a $\frac{3}{4}$ turn is required to stop engine surging, proceed with the following steps.

8. Raise the pointer two divisions on the pointer scale. Turn the needle valve counterclockwise three or more turns. Allow the engine to surge approximately 30 seconds.

9. Gradually turn the needle valve clockwise until surging just stops. Note the portion of a turn required to close the needle valve.

10. Open the valve exactly to the same position surging stopped.

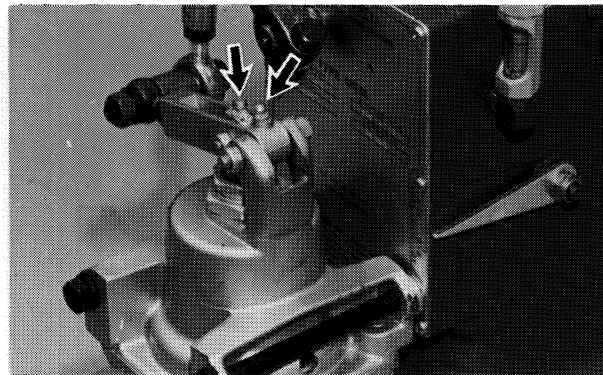
11. Manually move the governor linkage to disturb the engine speed. The engine speed should stabilize with the needle valve opened $\frac{1}{2}$ to $\frac{3}{4}$ turn. A valve opened less than $\frac{1}{2}$ of a turn produces a slow response to load changes. A valve opened more than $\frac{3}{4}$ of a turn produces excessive speed response to load change. If the engine does not stabilize between $\frac{1}{2}$ to $\frac{3}{4}$ turn open, raise the pointer two divisions and repeat steps 8 through 11.

12. When the engine speed stabilizes, install the base plug.

For more information on adjusting the governor, refer to the Service Manual or your Caterpillar dealer.

Governor Air Actuator (If Equipped)

Lubricate Fittings



Lubricate governor air actuator (2 fittings).

Fuel Filters

WARNING

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

Disconnect the battery when changing fuel filters.

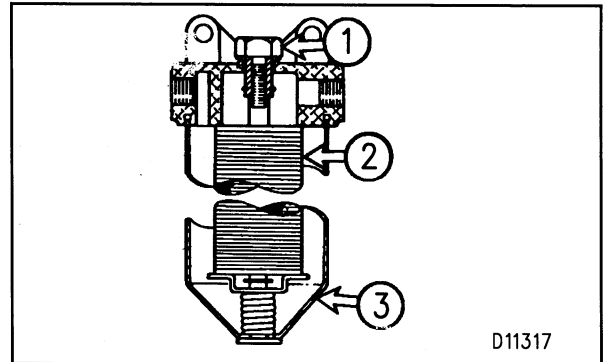
NOTICE

Do not fill fuel filter housings with fuel before installing elements. Contaminated fuel will cause accelerated wear to fuel system components.

The final fuel filter elements should be replaced when the fuel filter differential gauge registers 105 kPa (15 psi), when engine is at rated speed and operating temperature. The primary fuel filter should be cleaned each time the elements are changed.

Cleaning the Primary Fuel Filter

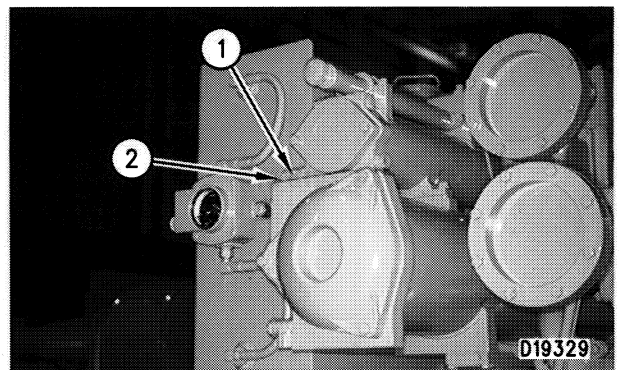
1. Stop the engine.
2. Close the fuel supply line valve.



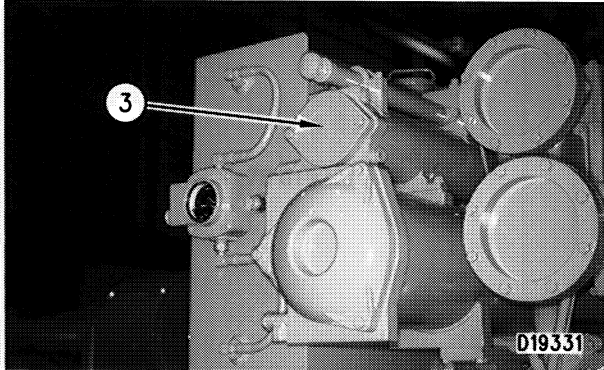
3. Loosen nut (1) on the cover and remove case (3).
4. Remove filter element (2). Clean the element and case in clean, nonflammable solvent.
5. Inspect and install the two cover gaskets. Install new gaskets if necessary.
6. Install the cleaned filter element and case.
7. Open fuel supply line valve.
8. Prime the fuel system. Refer to Priming the Fuel System.

Changing Final Fuel Filters

1. Close the fuel supply line valve.



2. Attach one end of the drain hose to drain valve (1). Put the other end of the hose in a container to catch the fuel.
3. Open drain valve (1). Remove vent plug (2) and drain the fuel filter housing.

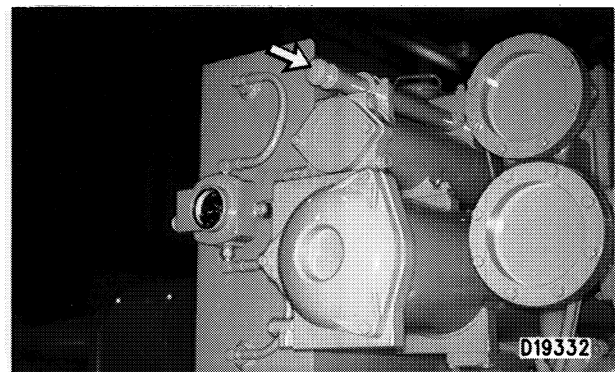


4. Remove cover (3) from service end of the filter housing.
5. Remove the five used filter elements from inside the filter housing. Wipe all sediment from inside the filter housing.
6. Install new filter elements.
7. Inspect the cover O-ring seals. Install new seals if necessary. Install the cover.
8. Install vent plug (2), close drain valve (1) and remove drain hose.
9. Open the fuel supply line valve.
10. Prime the fuel system.

Priming the Fuel System

If Equipped With A Priming Pump

1. Open the fuel supply line valve.
2. Move the ON/OFF switch at the engine, to the OFF position.



3. Turn the pump handle knob counterclockwise. Release the lock plate from the retainer on the fuel priming pump.
4. Operate the fuel priming pump until the air in the fuel system has been pumped through the fuel return line to the fuel tank.
5. Start the engine. If engine misfires or there is excessive smoke, further purging of air from the fuel system is required.

For Engines Not Equipped With A Fuel Priming Pump:

To prime the fuel system, pour clean, water-free fuel into the dirty side (outer ring) of the fuel filter. Pour fuel slowly, allowing time for the fuel to seep through the filter, filling the canister. Install the filter and crank the engine until started.

Duplex Fuel Filters

The duplex fuel filter system will allow continuous operation while the fuel filters are being changed.

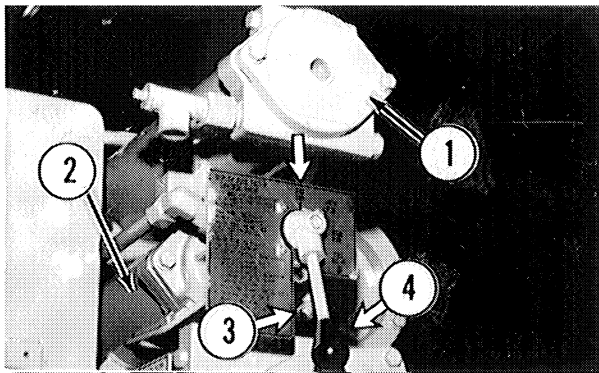
NOTE: Under normal operation, the main fuel filters are to be used until they need to be replaced. Auxiliary filters are to be used for continuous engine operation while the main filters are being changed.

When the fuel filter differential gauge registers 105 kPa (15 psi), the main fuel filter elements should be replaced.

Changing the Main Final Fuel Filters

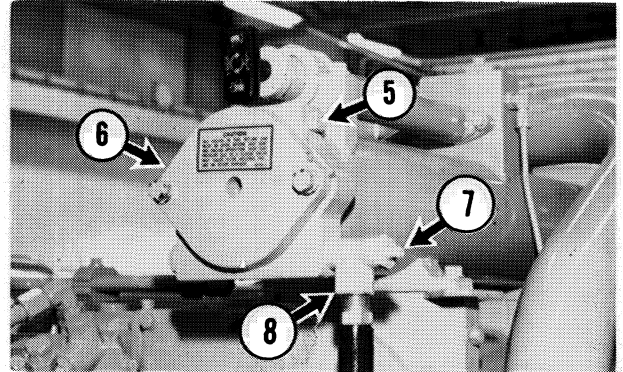


Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.



Main Final Fuel Filters (1) and Auxiliary Final Fuel Filters (2).

1. Open fill valve (3) for five minutes minimum.
2. Close fill valve (3) and rotate control valve (4) to the AUXILIARY RUN position.



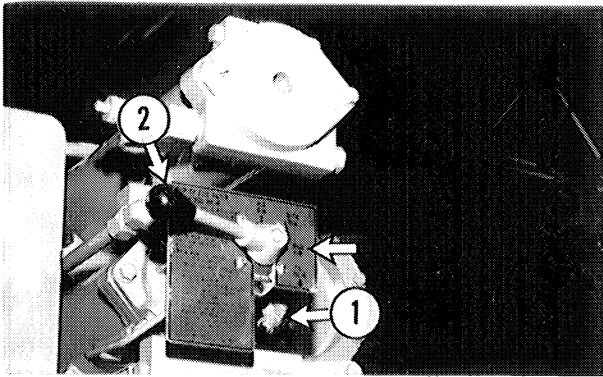
3. Attach one end of the drain hose to drain valve (8). Put the other end of hose in a container to catch the fuel. Open drain valve stem (7). Remove vent plug (5) and drain the fuel filter housing.
4. Remove end cover (6) from the end of the main final fuel filter housing.
5. Remove the five used fuel filter elements from inside the fuel filter housing. Wipe all sediment from inside the fuel filter housing.
6. Install five new fuel filter elements.
7. Inspect the cover O-ring seal. Install new seal if necessary.
8. Install fuel filter housing end cover (6) and the vent plug (5). Make sure the drain valve stem (7) is closed.
9. Open fill valve (3) for minimum of five minutes.
10. Close fill valve (3) and rotate control valve (4) to MAIN RUN position.
11. Check for leaks. Remove the drain hose and dispose of the drained fuel properly.

Changing Auxiliary Final Fuel Filters

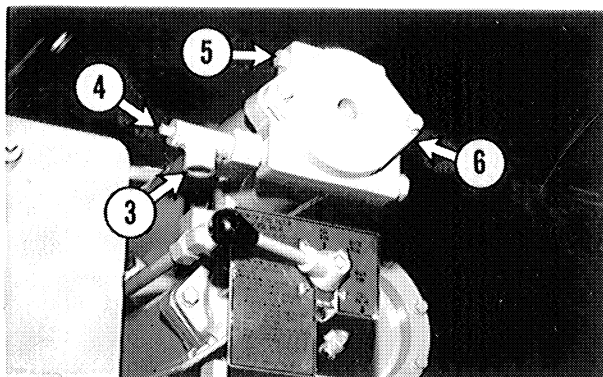
MAIN FINAL FUEL FILTERS NOT IN USE

If the main final fuel filters have been used and there are no replacement filters, the auxiliary final fuel filters may be used for a maximum of 1000 service hours engine operation or until the fuel filter differential gauge registers 105 kPa (15 psi).

NOTE: The engine must be shut down to change the auxiliary final fuel filters when the main final fuel filters have been used and there are no main final fuel replacement filters. Use the following procedure.



1. Leave the control valve (2) in the AUXiliary RUN position. Open the fill valve (1) for a minimum of five minutes. Close the fill valve (1) and rotate the control valve (2) to the MAIN RUN position.



2. Attach one end of drain hose to drain valve (3). Put the other end of the hose in a container to catch the fuel. Open drain valve stem (4). Remove vent plug (5) and drain the fuel filter housing.

3. Remove cover (6) from the end of the filter housing. Remove the two used fuel filter elements from inside the fuel filter housing.

4. Wipe all sediment from inside the fuel filter housing. Install two new fuel filter elements.

5. Inspect the cover O-ring seal. Install new seal if necessary. Install cover (6).

6. Make sure that vent plug (5) is installed, and drain valve stem (4) is closed.

7. Open fill valve (1) for minimum of five minutes.

8. Close fill valve (1) and leave control valve (2) in the AUXiliary RUN position, for normal operation.

9. Check for leaks. Remove drain hose and dispose of the drained fuel properly.

MAIN FINAL FUEL FILTERS IN USE

To change the auxiliary final fuel filters while the engine is running and the control valve is in the MAIN RUN position, proceed to step 1.

1. Attach one end of the drain hose to drain valve (3). Put the other end of the hose in container to catch the fuel. Open drain valve stem (4). Remove vent plug (5) and drain the fuel filter housing.

2. Remove cover (6) from the end of the fuel filter housing. Remove the used fuel filter elements from inside the fuel filter housing.

3. Wipe all sediment from inside the fuel filter housing. Install new fuel filter elements.

4. Inspect the cover O-ring seal. Install new seal if necessary. Install cover (6).

5. Make sure that vent plug (5) is installed, and drain valve stem (4) is closed.

6. Open fill valve (1) for minimum of five minutes. Close fill valve (1) and leave control valve (2) in the MAIN RUN position, for normal operation.

Caterpillar Marine Gear

NOTE: For marine gear other than Caterpillar 7200 Series, refer to the manufacturer's recommendations.

WARNING

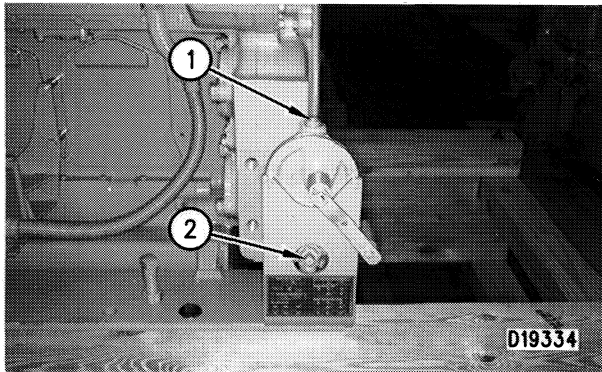
Use caution when draining oil or changing filters. Hot oil or components can cause burns if they contact skin.

Change Oil

With the oil warm and the engine stopped, drain the marine gear.

1. Remove the marine gear drain plug and allow the oil to drain.
2. Clean and install the drain plug.

If a Sump Pump is Used to Drain Oil



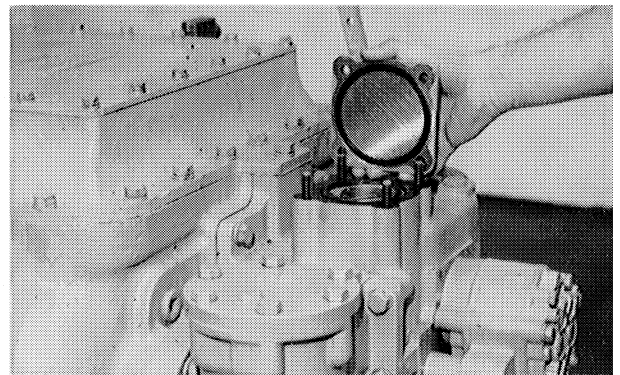
1. Connect a drain line and container to the pump outlet (1).
2. Be sure valve on the engine oil pan line is closed. Marks on the valve must be turned at right angles to the direction of the engine oil line.
3. Open valve (2) on the marine gear oil line. The marks on this valve must be turned so that one mark points to the pump and the second mark points to the marine gear.
4. Operate the sump pump handle until the marine gear is empty.

5. Close the sump pump valve on the oil line to the marine gear.

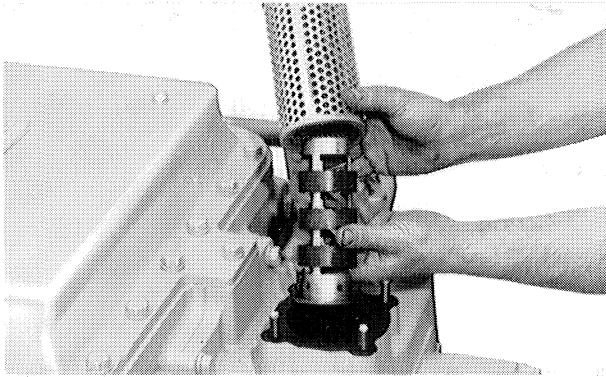
Change Filter

1. Remove the marine gear oil filter housing drain plug and allow the oil to drain.
2. Remove the cover assembly with the oil filter attached.
3. Remove the nut, retainer and filter element from the cover.
4. Clean the filter housing and the cover assembly with clean nonflammable solvent.
5. Inspect the retainer plate and cover seals. Install new seals if necessary.
6. Install a new filter element. Install the retainer and nut to the cover assembly. Tighten the nut to 14 ± 3 N•m (10 ± 2 lb ft).
7. Install the cover assembly. Tighten all bolts.
8. Clean and install the filter housing drain plug.

Clean the Oil Strainer



1. Remove the oil strainer cover.



2. Remove the spring washer, strainer and magnetic screen tube.
3. Wash the oil strainer and magnetic screen tube with clean nonflammable solvent.

If a magnet is broken, install the new magnet properly. The North (N) poles and South (S) poles of the magnets are adjacent to each other so that they repel instead of attract: S - N, N - S, S - N.

4. Inspect the oil strainer and the cover seal for damage. Use new parts if used ones are damaged.
5. Install the magnetic screen tube, strainer, spring washer, seal and cover.

Cleaning the Marine Gear Breather

1. Remove the breather.
2. Clean the breather with clean, nonflammable solvent.
3. Install the breather.

Fill the Marine Gear

NOTICE

Be sure both valves (one to the marine gear and one to the engine oil pan) are closed. Otherwise, a transfer of oil may occur during operation and damage could result.

Fill the marine gear to the FULL mark on the oil level gauge. Refer to the Refill Capacities chart for the correct amount of oil.

Marine Gear Output Shaft Seal

Lubricate Fitting

Lubricate the marine gear output shaft seal through one fitting at top rear of the marine gear. Slowly rotate the output shaft while lubricating the seal. Refer to the OEM Owner's Manual for more information on the marine gear output shaft seal.

Every 2000 Service 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.

This maintenance is to be performed at the fuel interval specified in the Maintenance Schedule. Before proceeding with this maintenance, perform all previous maintenance interval requirements.

Engine Valve Lash, Valve Bridge and Rotators

Check and Adjust

NOTE: Initial valve lash adjustment on new or rebuilt engines should have been performed at the first scheduled oil change interval. The adjustments should now be made at this interval.

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.

When the valve lash (clearance) is checked, an adjustment is NOT necessary if the measurement is within the range given in the Valve Lash Setting chart. If the measurement is outside of the range given for valve lash, an adjustment is necessary. Set the lash to the nominal clearance given in the Valve Lash Setting chart. Refer to the Service Manual or your Caterpillar dealer for the complete valve adjustment procedures.

WARNING

To prevent possible injury, do not use the starter motor to turn the flywheel.

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

Set the nominal clearance given in the Valve Lash Setting chart shown.

VALVE LASH SETTING	
Intake	0.38 mm (0.015 inch)
Exhaust	0.76 mm (0.030 inch)

Valve Bridge

The valve bridge should be checked and/or adjusted each time valve lash is checked and/or adjusted. Refer to the Service Manual for the complete adjustment procedure.

Rotators

Observe Rotation of Valves With Engine Idling After Setting the Valve Lash

WARNING

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

Caterpillar recommends replacement of improperly operating valve rotators. Use the procedure as established in the Service Manual, or contact your Caterpillar dealer for assistance.

Turbochargers

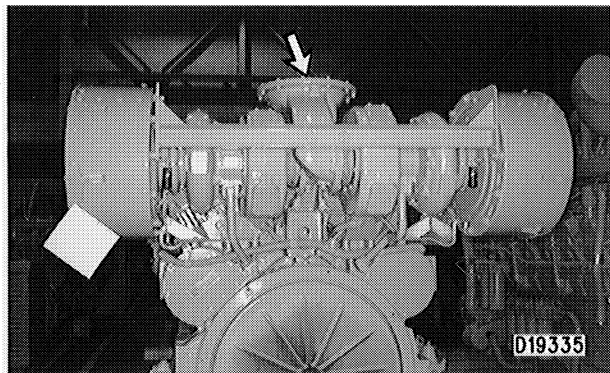
NOTICE

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 no turbocharger bearing failure 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.

Inspect/Check for Proper Operation



1. Remove the inlet piping and exhaust outlet piping, air cleaner cover and air cleaner element to provide access to the turbocharger. Visually check for oil leaks. Check the complete exhaust system for leaks and cracks. Make all necessary repairs with the engine shut down.

2. Turn the turbine and compressor wheel by hand. The assembly should turn freely. Inspect the turbine wheel and compressor 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 the assembly does not turn freely, refer to the Service Manual or consult your Caterpillar dealer.

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 turbo oil seal leak. The leak may be the result of extended engine operation at low idle or an intake air line restriction (plugged filters).

Maintain the compressor wheel/turbo housing by cleaning with standard shop solvents and a soft bristle brush.

3. Check the end play and bearing clearance on the turbine wheel and shaft. It should be difficult to detect movement of the shaft in the bearing. If the shaft is loose in the bearings, an inspection of the internal components should be made.

If the measurements are not within specifications, the turbocharger must be repaired or replaced. Refer to the Service Manual for the procedure and specifications. See your Caterpillar dealer for repair or replacement options.

4. When installing or replacing V-band clamps, position the gap (tightening screw) down if possible so any accumulation of moisture will drain away.

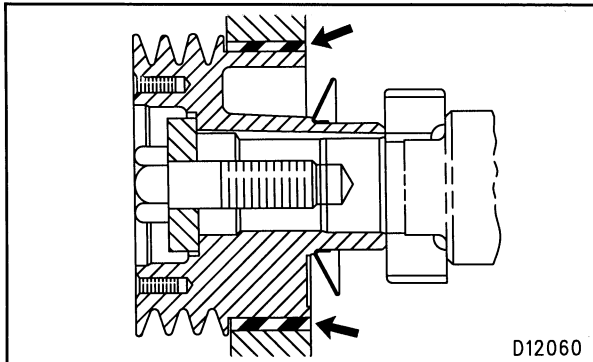
5. Repeat the procedure for the other turbocharger.

Removal and Installation

For removal and installation, or repair/replacement options of turbochargers, refer to the Service Manual. If maintenance is required, see your Caterpillar dealer.

Crankshaft Vibration Damper

Inspect



Damage to or failure of the damper will increase vibrations and result in damage to the crankshaft and other engine components. A failing vibration damper will cause more gear train noise at variable points in the speed range. 3500 Marine Engines can be equipped with a rubber damper and/or a viscous damper.

If there is damage to the damper, refer to the Service Manual for your engine before installing a new damper.

It is our recommendation to replace the damper for any of the reasons that follow.

- The engine has had a failure because of a broken crankshaft.
- S•O•S analysis has detected that the crankshaft front bearing is badly worn or there is a large amount of gear train wear that is not caused by a lack of oil.

If none of the above conditions is found, dampers can be used again, providing the damper is not damaged.

Viscous Damper (If Equipped)

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

Rubber Damper (If Equipped)

A vibration damper can have a visual wobble (movement to the front and rear when in rotation) on the outer ring. This does not mean a replacement is necessary since some wobble of the outer ring is normal. To see if the amount of wobble is acceptable, or replacement is necessary, check the damper with the procedure in the Service Manual.

The vibration damper has marks on the hub and ring. These marks will indicate the condition of the vibration damper. If the marks are not in alignment, the rubber seal between the ring and the hub has separated from the ring and/or hub. If the marks are not in alignment, install a new vibration damper.

NOTE: Refer to the Service Manual for the necessary replacement procedure.

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Maintenance Section
Every 2000 Service Hours

Engine Mounts

Inspect/Check

Caterpillar recommends checking the engine mounts for deterioration and proper bolt torque. This will prevent excessive engine vibration caused from improper mounting. See the Marine Engine Application and Installation Guide LEKM9213 for more information.

Every 3000 Service Hours or Two Years

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

This maintenance is to be performed at the fuel interval specified in the Maintenance Schedule. Before proceeding with this maintenance, perform all previous maintenance interval requirements.

Cooling System—Engines Using Standard Type Antifreeze Only

Clean/Flush Coolant

NOTICE

This cooling system maintenance is for standard type antifreeze only. **DO NOT** mix Standard Type Antifreeze and Long Life Coolant (LLC). Do not perform this maintenance until you read and understand the material in the Safety and Cooling System Specifications sections of this manual.

Caterpillar does not recommend the use of cooling system solutions that are intended to stop leaks. Use of these products may result in excessive internal deposits that could reduce the engine's heat transfer characteristics as well as damage to the water pump seals.

This procedure is to be used for normal maintenance of cooling systems to return to "like new" condition. For heavy build-up of scale and deposits, a severe acid-type, commercial cleaner or mechanical cleaning will be required.

NOTE: If cooling system conditioner has been added at Every 250 Service Hours as recommended, the coolant change period can be extended to 4000 Service Hours.

Performing maintenance on the cooling system is important because the cooling system has a direct effect on the operation and service life of the engine. Improper maintenance can result in a variety of problems that could shorten the engine's service life, reduce the efficiency of the cooling system, result in poor engine performance, and in some cases, result in an increase in fuel consumption.

Add Cooling System Cleaner

There are two types of cooling system cleaners available. One is the 6V4511 Standard-Type in the two liter (½ U.S. gallon) container and the other is the 4C4611 Fast Acting-Type in the four liter (one U.S. gallon) container.

The 6V4511 requires approximately 120 to 250 service hours of engine operation to remove scale, lime and other debris. The 4C4611 requires only 90 minutes of engine operation. Both types must remain in the system for a minimum of specified time to work properly, however, neither type will harm the engine if left in for a longer period of time.

The 6V4511 must be added before the Every 3000 Service Hour maintenance interval. Add 4 liter (1 U.S. gallon) of Caterpillar Cooling System Cleaner, 6V4511, for every 60 liter (16 U.S. gallon) of cooling system capacity. Continue to operate the engine for the specified time before draining.

The 4C4611 may be added just prior to draining and the system cleaned and flushed after operating for the specified time period. Follow the directions on the container.

Inspect Cooling System Piping, Hoses and Clamps

- Inspecting the items (and associated clamps and hardware) reduces the chances for unscheduled downtime. Inspect all system components for leaks due to cracking, softness next to clamps and loose clamps. Replace any component that is cracked or soft and tighten loose clamps.

Before replacing piping and/or hoses drain the coolant from the cooling system (or drain coolant to a level below the piping and/or hose that is replaced if replacing piping and/or hoses ONLY). Refer to Drain topic in this Manual.

Remove clamps, disconnect the old components and replace with new. Install clamps. See the Torque Specifications section of this Manual for the appropriate torque values.

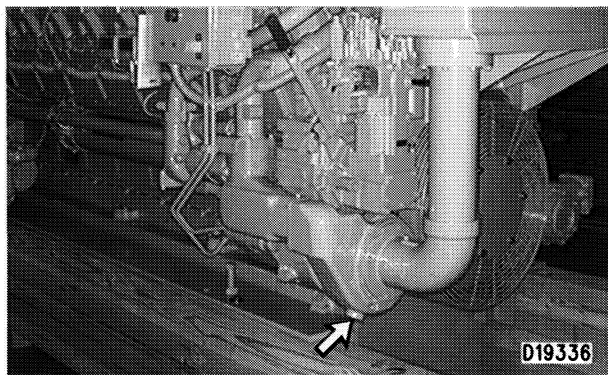
- If replacing cooling system piping and/or hoses prior to this interval, refer to Fill System with Coolant topic in this Manual. If performing the Every 3000 Service Hour maintenance interval, continue with Cooling System Clean/Flush procedure.

Drain

When you drain, clean, flush and replace the coolant, small particles, undesirable chemicals, scale and other deposit formations are removed. These deposits reduce the necessary heat transfer characteristics of the cooling system.

Coolant water drain groups, installed in the jacket water pumps, may be available for draining engine coolant. Contact your Caterpillar dealer for assistance.

1. Stop the engine and allow to cool. Disable the starting system and place a DO NOT OPERATE tag on the START valve or START switch.
2. Shut off separate circuit inlet water flow (if equipped). Slowly turn the cooling system pressure cap to the first stop to release the system pressure. Then push down and turn the cap until it is released.
3. Drain the system according to the requirements of your system.



Drain plug on bottom of water pump housing.

Remove the drain plug or open the drain valve from cooling water system and/or bottom of jacket water pump housing. Remove the drain plugs to drain the coolant tank, the water pump(s), the aftercooler, thermostatic valve, engine cylinder block drain plug(s) and all coolant lines. Allow coolant to drain.

Drain the water line between the heat exchanger and the separate circuit water pump (if equipped) to empty the aftercooler housing.

Water Pump Seal

Over concentration of coolant additive (Conditioner), mineral deposits from hard water or cooling system contamination can accelerate the wear on the water pump coolant seal. The cooling system maintenance interval provides an opportunity to inspect and replace the water pump seal if necessary to reduce coolant leakage. If coolant is leaking, make repairs to the pump(s). Check the water pump breather filter for blockage or debris and replace if necessary.

Dispose of used engine coolant in an environmentally correct way 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. Refer to your Caterpillar dealer for information regarding disposal and recycling of used coolant.

4. Clean and install all drain plugs and/or close the cooling system drain valve(s).

Flush

5. Fill the cooling system with clean water mixed with the proper concentration (6 to 10 percent) of Caterpillar Cooling System Cleaner. Install cooling system filler cap. Caterpillar Cooling System Cleaner is available through your Caterpillar dealer.

NOTE: For proper cooling system maintenance cleaning, the system requires 4 liter (1 U.S. gallon) of Caterpillar Cooling System Cleaner to accommodate for every 60 liter (16 U.S. gallon) of cooling system capacity to accommodate the 6 to 10 percent concentration. Add solution slowly at 20 liters (5 U.S. gal.) or less per minute to avoid air locks. See Refill Capacities for amount of solution needed.

6. Start and run (operate) the engine to circulate fluid in the cooling system for 90 minutes. Operate the engine until the thermostat opens and coolant level stabilizes. Fill the cooling system to the bottom of fill tube. Install the filler cap.

7. Stop the engine and allow to cool. Remove cooling system filler cap and system drain plugs to drain the cleaning solution.

8. Flush the cooling system with clean water until the draining water is clear. Clean and install all drain plugs and/or close the drain valve.

NOTE: Repeat Steps 5 thru 8 if necessary until the draining water is clear.

9. Fill the system with a neutralizer. Use a commercially available neutralizer or 0.230 kg (½ lb) sodium carbonate per 38 liters (10 U. S. gallons) water. Operate the engine for 10 minutes. Stop the engine, remove all the drain plugs and drain the neutralizing solution.

Fill System with Coolant

NOTICE

All water is corrosive at engine operating temperature. The cooling system should be protected with cooling system conditioner at all times. Use Caterpillar liquid cooling system conditioner to treat the coolant mixture.

Refer to the Cooling System Specifications in this Manual for all information regarding appropriate maintenance, acceptable water, antifreeze and supplemental coolant additive (Conditioner) requirements.

10. Be certain all drain plugs are clean and installed. Add coolant solution to the cooling system to bring it to the proper level by mixing a solution of acceptable water and Caterpillar Antifreeze. Add solution slowly at 20 liters (5 U.S. gallons) or less per minute to avoid air locks. Refer to Cooling System Specifications and Refill Capacities for amount of coolant needed.

NOTE: When NOT using Caterpillar Antifreeze, add 1 liter (1 U.S. quart) of Caterpillar Coolant Additive (Conditioner) for every 30 liter (8 U.S. gallon) of cooling system capacity. Caterpillar Coolant Additive (Conditioner) should only be used when NOT using Caterpillar Antifreeze.

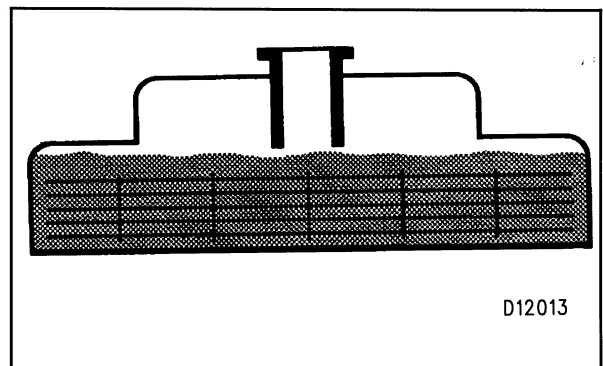
NOTICE

If the aftercooler circuit has been drained, the vent plug on the aftercooler outlet elbow must be opened to allow the aftercooler to fill. Failure to do this, will cause an air lock resulting in engine damage.

NOTE: When refilling the aftercooling system, open the separate circuit valve on the engine jacket water heat exchanger (if equipped).

Prime the separate circuit water pump if necessary. Open the separate circuit vent plug on the aftercooler to allow the aftercooler to fill. Failure to do this will cause an air lock and engine damage. After the aftercooler is filled, close the vent plug before operating the engine.

11. Start and operate the engine with the cooling system vent cap loosened or filler cap removed. Operate the engine and allow the coolant to warm, the thermostats to open and the coolant level to stabilize. Inspect for leaks and proper operating temperature.



12. Stop the engine and check the coolant to ensure it is at the proper level. Add coolant mixture if necessary to bring the coolant to within 13 mm (½ inch) below the bottom of the fill tube or the correct level on the sight glass, if equipped.

NOTICE

In cold weather, frequently check the specific gravity of the coolant solution to ensure adequate protection.

If the engine is to be stored in, or shipped to an area with freezing temperatures, the cooling system must be either protected to the lowest expected outside temperature or drained completely to prevent damage.

Caterpillar recommends the use of a permanent-type antifreeze that when mixed with water, will raise the boiling point of the water. This feature helps reduce cylinder liner pitting and maintain water pump cavitation temperature.

13. Check the condition of the filler cap gasket (if equipped). If the gasket is damaged, discard the old filler cap and install a new filler cap. If the gasket is not damaged, use a 9S8140 Service Tool to pressure test the filler cap. This tool is available from your Caterpillar dealer.

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.

Cleaning Procedure—Oil Cooler and Aftercooler Core

Caterpillar recommends that the oil cooler and aftercooler cores be removed, cleaned and pressure tested at overhaul time, or if a turbocharger failure has occurred, or if at any time the turbocharger develops an oil leak.

1. Remove the core. Turn the core upside down to remove debris from the inlet.

NOTICE

Do not use caustic cleaners to clean the core. Caustic cleaners will attack the internal metals of the core and cause leakage.

2. Back flush internally with a solvent to loosen foreign substances and to remove oil. Caterpillar recommends the use of Caterpillar Hydrosolv 4165 or Hydrosolv 100 Liquid Cleaners.

Part No.	Description	Size
8T7570	Hydrosolv 4165	208L (55 U.S. gal) Drum
8T7571	Hydrosolv 100	208L (55 U.S. gal) Drum

3. Shake the core vigorously to eliminate any trapped debris.

4. Wash the core with hot, soapy water. Rinse thoroughly with clean water.

5. Dry the core with compressed air. Blow air in reverse direction of normal flow. Use all necessary safety equipment while using compressed air.

6. Inspect the system to ensure cleanliness and install the core.

Cooling System—Engines Using Long Life Coolant (LLC) Only

Add Extender

NOTICE

This cooling system maintenance is for LLC only. DO NOT mix standard type antifreeze and Long Life Coolant (LLC). Do not perform this maintenance until you read and understand the material in the Safety and Cooling System Specifications sections of this Manual.

For engines using Caterpillar Long Life Coolant, Extender (part number 119-5152) must be added at the Every 3000 Service Hour interval. With the exception of adding Extender and maintaining the coolant level, no other maintenance is required until the Every 6000 Service Hour interval. Over treatment or under treatment of the Extender will not create any problems within the cooling system if it is kept within 15 percent above or below the normal dosage. Use the table that follows to determine the recommended amount of Extender to add to LLC.

RECOMMENDED AMOUNT OF EXTENDER BY COOLING SYSTEM CAPACITY	
Cooling System Capacity	Recommended Amount of Extender
22-30 L (6-8 U.S. gal)	0.57 L (0.60 qt)
30-38 L (8-10 U.S. gal)	0.71 L (0.75 qt)
38-49 L (10-13 U.S. gal)	0.95 L (1 qt)
49-64 L (13-17 U.S. gal)	1.18 L (1.25 qt)

Every 4000 Service 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.

This maintenance is to be performed at the fuel interval specified in the Maintenance Schedule. Before proceeding with this maintenance, perform all previous maintenance interval requirements.

Air Compressor (If Equipped)

Inspect/Rebuild or Exchange

Caterpillar recommends that the most cost effective method of operation and maintenance for the air compressor is to inspect the unit before it fails and make the decision to rebuild or exchange.

By maintaining the air compressor before failure, unscheduled downtime and potential damage to other engine parts are reduced. The prevention of unscheduled downtime saves money and lowers operating costs.

WARNING

Do not disconnect the air line from the air compressor governor without purging the air and/or auxiliary air systems.

Failure to purge the air systems before you remove the air compressor could cause personal injury.

Inspect the air compressor as instructed by the manufacturers' instructions or for more information on how to check your air compressor, refer to the Service Manual for this engine.

If you decide to inspect your air compressor, be sure to observe the following actions. Visually check for fluid leaks and listen for air leaks. Release the air pressure in the air tank until the air pressure is zero.

If the engine is operated until the air compressor fails, it could cause additional damage to the engine. A failed air compressor could contaminate the engine oil with particles of materials since engine oil also lubricates the air compressor. The circulation of these contaminants through the engine lubricating system could damage the engine's main and connecting rod bearings.

Visually check for fluid leaks. Remove discharge fittings and inspect compressor discharge port and discharge line for excessive carbon deposits. The discharge line must be cleaned or replaced and the compressor checked more thoroughly if there is excessive carbon build-up in either the discharge line or compressor discharge port.

WARNING

DO NOT store alcohol (for cold weather operation) in the operator area. Alcohol is highly flammable and toxic.

In arctic conditions, use alcohol injection to prevent moisture from freezing in the air system.

For more information on how to check your air compressor, refer to the manufacturer's instructions or engine Service Manual. For more information on Maintenance Options, refer to Terminology topic in this Manual.

Caterpillar Recommendation

The most cost effective repair option is to rebuild the air compressor with a repair kit that can be obtained from your Caterpillar dealer. To minimize downtime, Caterpillar recommends that the use of Remanufactured components (subject to availability) as a cost effective option.

Removal and Installation

Refer to the established procedure in the Service Manual for this engine to Remove and Install these components or contact your Caterpillar dealer for assistance.

Electric Starting Motor (If Equipped)

Inspect/Rebuild or Exchange

One unscheduled failure caused by your electric starting motor will cost more in downtime than servicing your starting motor before failure.

If you service your electric starting motor before failure, you will minimize unscheduled downtime. The prevention of unscheduled downtime saves you money and lowers your operating cost.

Our recommended service intervals for performing preventive maintenance on your electric starting motor are based on experience and accumulated data relative to the expectant life of the electric starting motor and its components. These maintenance service intervals are provided for your use to economically schedule your repairs before failure.

Failure to follow our recommendation could be costly to you, due to unexpected downtime.

Caterpillar recommends that the most cost effective method of operation for your electric starting motor is to service the unit before it fails.

Caterpillar Recommendations

Caterpillar recommends that the use of a remanufactured electric starting motor is the most cost effective option.

Marine Engine Performance Analysis Report (PAR)

Obtain

Marine PAR compliments a good preventative maintenance program. PAR reflects the results of various tests normally conducted by your Caterpillar dealer for the purpose of:

- Confirming your engine is operating efficiently and within specifications.
- Identifying potential problems.
- Determining components or systems that should be adjusted, replaced, etc.

Approximately 80 to 85 percent of the total 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.

With Marine Engine Performance Analysis Report (PAR) you also can:

- Identify mismatched propulsion components and systems.
- Establish fuel efficient operating habits.
- Determine propulsion system deterioration rates.
- Fine tune maintenance, repair and overhaul schedules.

Caterpillar recommends a Marine Engine PAR Analysis at the initial Sea Trial and on a regularly scheduled basis to ensure your propulsion system is operating at optimum performance and efficiency. Consult your Caterpillar dealer for complete details in establishing a Marine Engine PAR program for your vessel.

Every 6000 Service 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.

This maintenance is to be performed at the fuel interval specified in the Maintenance Schedule. Before proceeding with this maintenance, perform all previous maintenance interval requirements.

Thermostats

Replace Thermostat, Gaskets and Seal

NOTE: Refer to the Service Manual for detailed instructions regarding Disassembly and Assembly of the Cooling System.

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

This maintenance is to be performed with the cooling system cleaned and drained or the coolant drained to a level below the thermostat housing.

NOTICE

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

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

1. Loosen hose clamps and remove hose from elbow. Disconnect hose assembly from thermostat housing assembly.
2. Remove bolts from elbow and remove elbow and thermostat housing assembly.
3. Remove the gasket, thermostat and seal from the housing.

Flush—If Using Standard Type Antifreeze ONLY

1. Refill the cooling system with clean water mixed with the proper concentration (six to ten percent) of Fast Acting-Type Caterpillar Cooling System Cleaner (if you did NOT use Standard-Type Cleaner). Tighten cooling system filler cap.

NOTE: For proper cooling system maintenance cleaning, refer to label directions for the type of Caterpillar Cooling System Cleaner used in your cooling system.

2. Start and run (operate) the engine to circulate fluid in the cooling system.
3. Stop the engine and allow to cool. Loosen cooling system filler cap and drain plugs.
4. Drain the cleaning solution. Flush the cooling system with clean water and a neutralizing solution until draining water is clear. Clean and install all drain plugs and/or close the drain valve.

NOTE: Sodium Carbonate crystals at a rate of 250 grams per 40 liters of water (½ pound per 10 U.S. gallon of water) may be used as a neutralizer.

Repeat Steps 1 thru 4 if necessary until the draining water is clear.

Install Thermostat

NOTICE

Original thermostats may be used if they meet test specifications shown in the Service Manual and are not damaged or have excessive buildup of deposits.

Caterpillar engines incorporate a shunt design cooling system and require operating the engine with a thermostat installed. If the thermostat is installed wrong, it will cause the engine to overheat.

NOTE: Inspect gaskets before assembly and replace if worn or damaged. The thermostats can be reused if they are tested and meet the test specifications in the Service Manual.

1. Install a new seal in the thermostat housing and install a new thermostat. Install a new gasket in the thermostat housing on the engine cylinder head.
2. Install the cooling system connections and tighten the hose or piping clamps.

Fill

NOTICE

All water is corrosive at engine operating temperature. If using standard type antifreeze, the cooling system should be protected with cooling system conditioner at all times. Use Caterpillar liquid cooling system conditioner to treat the coolant mixture.

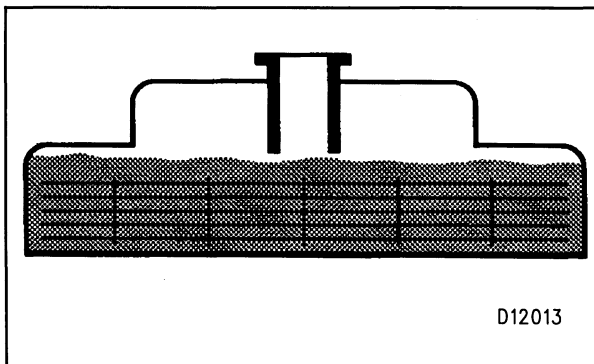
NOTICE

DO NOT mix Long Life Coolant (LLC) with standard type antifreeze. Refer to the Cooling System Specifications section of this publication for all information regarding appropriate maintenance of the cooling system or contact your Caterpillar dealer for assistance. Refer to the Refill Capacities chart in this publication for the cooling system capacity.

1. Be certain all drain plugs are clean and installed.
2. Start and run the engine with the cooling system filler cap loosened. Operate the engine and allow the coolant to warm, the thermostats to open and the coolant level to stabilize. Inspect for leaks and proper operating temperature.

NOTICE

To prevent engine damage, never add coolant to an overheated engine. Allow the engine to cool first.



3. Add coolant mixture if necessary to bring the coolant to within 13 mm (1/2 inch) below the bottom of the fill tube or the correct level on the sight glass, if equipped.

If using standard type antifreeze in your engine, mix a solution of acceptable water and Caterpillar antifreeze. If not adding Caterpillar antifreeze, you must add liquid cooling system conditioner. Refer to the Cooling System Specifications in this manual for more information or contact your Caterpillar dealer for assistance.

If using Long Life Coolant (LLC), replace with the coolant with the acceptable LLC and water mix. Refer to the Cooling System Specifications in this manual for more information on LLC or contact your Caterpillar dealer.

NOTICE

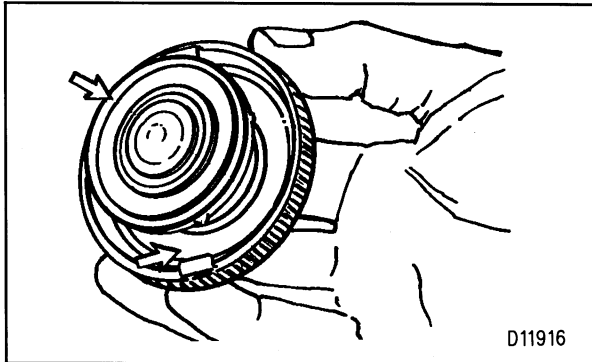
Mixing LLC with other products will reduce the effectiveness of the coolant. This could result in damage to cooling system components. DO NOT mix standard type antifreeze and LLC. Refer to the Cooling System Specifications in this manual or your Caterpillar dealer for more information.

NOTE: Upon initial fill the sight gauge can indicate an incorrect coolant level. Be sure the coolant is to the bottom of the fill tube. Recheck the coolant level and fill the cooling system to the bottom of the fill tube if the system was low.

NOTICE

In cold weather, frequently check the specific gravity of the coolant solution to ensure adequate protection.

If the engine is to be stored in, or shipped to an area with freezing temperatures, the cooling system must be either protected to the lowest expected outside temperature or drained completely to prevent damage. Always check your cooling system before operating your engine. Depending on load, failure to operate with thermostats could result in either an overheating or an excessive cooling condition.



4. Check the condition of the filler cap gasket (if equipped). If the gasket is damaged, discard the old filler cap and install a new filler cap.
5. Stop the engine and check the coolant to ensure it is at the proper level.

Cooling System—For Engines Using LLC Only

Clean/Flush

NOTICE

Do not perform this maintenance until you read and understand the material in the Safety and Cooling System Specifications sections of this publication.

Caterpillar does not recommend the use of cooling system solutions that are intended to stop leaks. Use of these products may result in excessive internal deposits that could reduce the engine's heat transfer characteristics as well as damage to the water pump seals.

Performing maintenance on the cooling system is important because the cooling system has a direct effect on the operation and service life of the engine.

Improper maintenance can result in a variety of problems that could shorten the engine's service life, reduce the efficiency of the cooling system, result in poor engine performance, and in some cases, result in an increase in fuel consumption.

Every 6000 Service Hours, Long Life Coolant (LLC) must be drained from the cooling system. The cooling system must then be flushed out completely and then replaced with LLC. When LLC is drained from the cooling system, **CLEAN WATER** is the only system cleaning/flushing agent required.

When the cooling system coolant is changed from standard antifreeze to LLC, Caterpillar cleaner must be used. Refer to the chart in the Cooling System Specifications Section for the quantities available. After the cleaning solution has been drained, it is **VERY IMPORTANT** that a thorough water flush be used to remove **ALL** of the cleaning agent.

 WARNING

To avoid personal injury from hot water spray, check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

With the engine shut down and cool, use the procedure that follows.

1. Stop the engine and allow to cool. Disable the starting system and place DO NOT OPERATE tags on the START switch in the pilot house and on the engine instrument panel.
2. Loosen the cooling system filler cap slowly to relieve pressure.
3. Drain the system according to the requirements of your system.

Dispose of used engine coolant in an environmentally correct way or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. For information regarding disposal and recycling of used coolant, contact your Caterpillar dealer.

4. Clean and install all drain plugs and/or close the cooling system drain valve(s).

Flush

1. Refill the cooling system with clean water. Tighten cooling system filler cap.
2. Start and run (operate) the engine to circulate fluid in the cooling system.
3. Stop the engine and allow to cool. Loosen cooling system filler cap and drain plugs.
4. Drain the water. Flush the cooling system with clean water until the draining water is clear. Clean and install all drain plugs and/or close the drain valve.

Fill

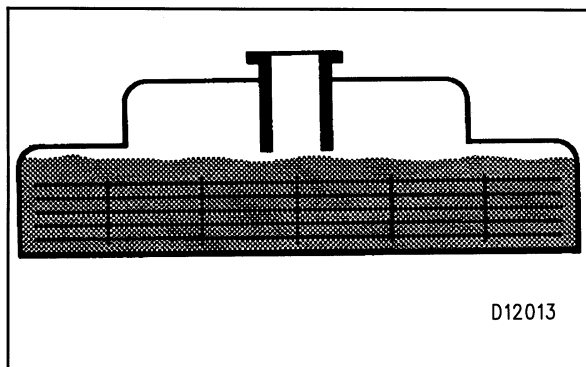
NOTICE

Refer to the Cooling System Specifications section of this publication for all information regarding about the appropriate maintenance of the cooling system or contact your Caterpillar dealer for assistance. See Refill Capacities chart in this publication for the capacity of your engine's system.

1. Be certain all drain plugs are clean and installed. Fill the cooling system with a LLC and water mixture.
2. Start and run the engine with the cooling system filler cap loosened. Operate the engine and allow the coolant to warm, the thermostats to open and the coolant level to stabilize. Inspect for leaks and proper operating temperature.

NOTICE

To prevent engine damage, never add coolant to an overheated engine. Allow the engine to cool first.



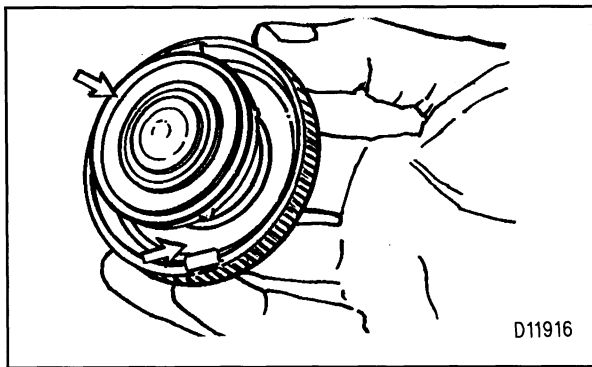
3. Add LLC if necessary to bring the coolant level to within 13 mm (1/2 inch) below the bottom of the fill tube or the correct level on the sight glass, if equipped.

NOTE: Upon initial fill the sight gauge can indicate an incorrect coolant level. Be sure the coolant is to the bottom of the fill tube. Recheck the coolant level and fill the cooling system to the bottom of the fill tube if the system was low.

NOTICE

In cold weather, frequently check the specific gravity of the coolant solution to ensure adequate protection.

If the engine is to be stored in, or shipped to an area with freezing temperatures, the cooling system must be either protected to the lowest expected outside temperature or drained completely to prevent damage. Always check your cooling system before operating your engine. Depending on load, failure to operate with thermostats could result in either an overheating or an excessive cooling condition.



4. Check the condition of the filler cap gasket (if equipped). If the gasket is damaged, discard the old filler cap and install a new filler cap.
5. Stop the engine and check the coolant to ensure it is at the proper level.

Alternator (If Equipped)

Inspect/Rebuild or Exchange

Inspect the alternator for loose connections and correct battery charging. Inspect the ammeter gauge during engine operation to ensure batteries and/or electrical system is performing correctly. Make repairs as necessary. Refer to the Service Manual or contact your Caterpillar dealer.

Caterpillar Recommendation

The most cost effective repair option is to rebuild with a repair kit that can be obtained from your Caterpillar dealer. To minimize downtime, Caterpillar recommends that the use of Remanufactured components (subject to availability) as a cost effective option.

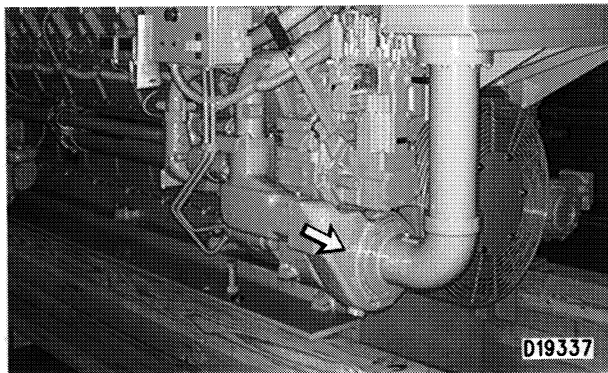
If there is a component you need, contact your Caterpillar dealer to see if it is offered under his Dealer Exchange Component Program.

Removal and Installation

Refer to the established procedure in the Service Manual to remove and install the alternator or contact your Caterpillar dealer for assistance.

Jacket Water Pump and Auxiliary Water Pump

Inspect/Rebuild or Exchange



Jacket water pump shown.

Visually inspect the water pumps for leaks. If leaking is observed, replace all seals. Refer to the Service Manual for the procedure to replace the seals.

Inspect the component for wear, cracks, pin holes and proper operation. If repairs or replacement is needed, see the Service Manual or contact your Caterpillar dealer.

Air Starting Motor (If Equipped)

Inspect/Rebuild or Exchange

One unscheduled failure caused by your air starting motor will cost more in downtime than servicing your starting motor before failure.

If you service your starting motor before failure, you will minimize unscheduled downtime. The prevention of unscheduled downtime saves you money and lowers your operating cost.

Our recommended service intervals for performing preventive maintenance on your air starting motor are based on experience and accumulated data relative to the expectant life of the air starting motor and its components. These maintenance service intervals are provided for your use to economically schedule your repairs before failure.

Failure to follow our recommendation could be costly to you, due to unexpected downtime.

Caterpillar recommends that the most cost effective method of operation for your air starting motor is to service the unit before it fails.

Service Options

New Parts – Genuine Caterpillar parts are constantly tested and modified to incorporate the latest design advances. Your Caterpillar dealer can provide the parts needed for rebuilding your air starting motor. Your benefit: Long-lasting replacement parts at competitive prices.

Repair Kits – These useful kits can be obtained from your Caterpillar dealer. These kits include all the necessary parts and instructions to repair your air starter, in either your own location or at your servicing dealer's facility. Repair kits simplify parts ordering, help speed repairs and reduce parts costs.

Dealer Exchange – In some areas, exchange, rebuilt air starting motors are available over-the-counter.

New – Replace with a new air starting motor.