

## Every 50 Hours

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

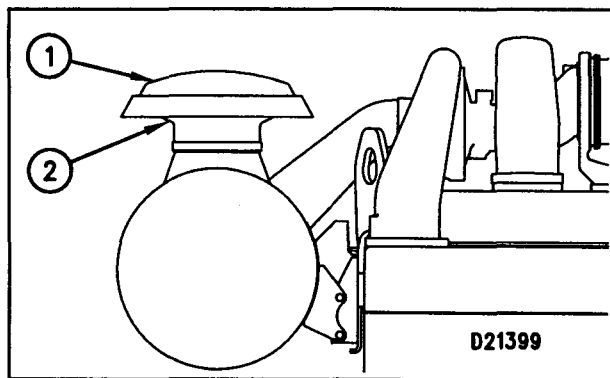
Before proceeding with Every 50 Hour maintenance, perform all Daily maintenance requirements.

### Dust Collector

#### NOTICE

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

#### Clean



Typical two stage air cleaner. Individual applications may be different.

1. Remove the air cleaner cap (1). Remove the dust collector cup (2).
2. Wipe dust collector cup with a clean, dry cloth.
3. Install the cup. Install and secure the cap.

NOTE: If equipped with a heavy duty air cleaner: refer to the Heavy Duty Air Cleaner topic in the Daily section of this manual for information about cleaning the dust collector cup.

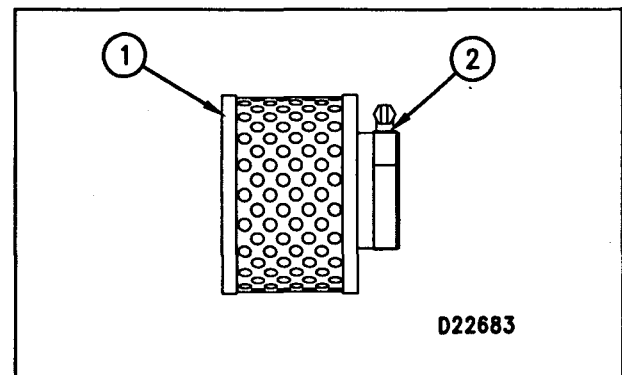
### Light Duty Air Cleaner (If Equipped)

Light duty air cleaners are not serviceable (washable). Light duty air cleaners are intended for a 50 service hours of maximum use, or one year, whichever occurs first. However, engines operating in a severe environment may require more frequent air cleaner replacement.

Dust conditions vary for different operating environments. Service the air cleaner at regular intervals as determined by the operating environment. Check the air cleaner service indicator (if equipped) daily.

Check the air cleaner for cleanliness and damage such as rips and tears. Replace the air cleaner element at the required service interval, or more often as determined by the operating environmental dust conditions.

To Replace the Light Duty Air Cleaner Element:



1. Loosen the clamp (2) fastening the air cleaner element (1) to the air intake, and remove the dirty element and clamp.
2. Install the clamp on a new element.
3. Install the new element to the air intake and tighten the clamp.

## Every 125 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.*

Before proceeding with this maintenance, perform all previous maintenance interval requirements.

### Clutch (If Equipped)

#### Check/Adjust

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

### Lubricate

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

### Generator Space Heaters (If Equipped)

#### Check

The SR4 generator can operate in high humidity conditions without problems. However, problems can occur when the generator is idle and the surrounding air is warmer than the generator. Moisture can form on the windings and result in poor performance and even result in damage to the windings. Whenever the generator is not in use, insure that the space heaters are in operation.

## Every 250 Hours

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

NOTE: Naturally Aspirated engines need the following maintenance performed at Every 500 Hours under normal operating conditions instead of 250 Hours.

- Scheduled Oil Sampling (S•O•S)
- Engine Oil and Filter Change
- Clean Crankcase Breather
- Initial Valve Lash Adjustment

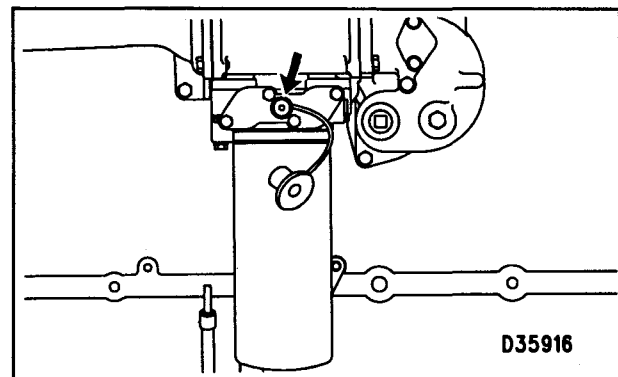
Before proceeding with this maintenance, perform all previous maintenance interval requirements.

### Scheduled Oil Sampling (S•O•S) Analysis

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

#### Obtain Sample

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 two methods recommended to obtain S•O•S samples from the engine crankcase.



Oil Sampling Valve

- Use the sampling valve.
- Use a sampling gun inserted into the sump.

NOTE: Refer to How to Take a Good Oil Sample, PEHP6001 for a step-by-step explanation if using this method of sampling crankcase oil.

Caterpillar recommends using one of the above methods. If either of these methods are not possible, then use a drain stream method when changing oil.

NOTE: When using the drain stream to obtain the oil sample, do not sample from the beginning or end of drain stream. 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.

S•O•S INTERVAL CHART	
Compartment	Interval
Engine Crankcase	Every 250 Hours (T & TA Only)
Engine Crankcase	Every 500 Hours (NA Only)

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

### Oil Drain Intervals

The Maintenance Schedule assumes the use of SUPERIOR QUALITY API CF-4 (minimum) performance oil, which has sufficient TBN for fuels with less than 0.5 percent sulfur.

Many conditions exist that can affect the selection of an optimum oil change period. The fundamental requirement in this decision must be to maintain the lube oil in an acceptable condition that provides continual engine protection. The quality and amount of oil available is balanced against oil ability to absorb combustion by-products. It is essential to include an S•O•S analysis of oil condition before oil change period adjustment is considered.

All oils do not perform equally. A lower quality lube oil would require that the oil change intervals be reduced accordingly. If the sulfur content in the fuel is greater than 1.5 percent by weight, use an oil with a TBN of 30 and reduce oil change interval by one half the interval recommended in the Maintenance Schedule.

If the engine crankcase oil has reached its condemning limits as established by the oil analysis program, refer to the topic, Engine Oil and Filter(s), in this publication for the procedure to change the crankcase oil and oil filters.

Due to manufacturing tolerances, engine application and maintenance variation, all engines do not consume fuel and oil at the same rate. The amount of fuel consumed is in direct relation to the **maximum** oil change interval selected. 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, average fuel consumption and add oil rate may be determined by multiplying the total quantity of fuel consumed by the operating (service) hours of the engines.

For more information on adjusting or extending oil change intervals for specific applications, see your Caterpillar dealer.

## Engine Oil and Filter(s)

NOTE: The engine must be on a level surface to perform this maintenance procedure.

Refer to the Lubricant Specifications section of this manual for the recommended oil to use for this engine.

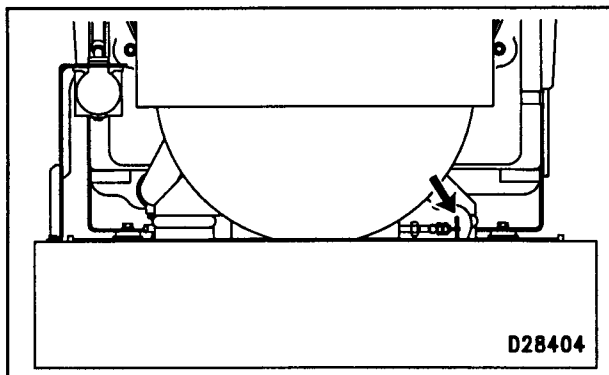
Do not drain oil when the engine is cold. As oil cools, suspended waste particles settle on the bottom of the crankcase or oil pan. The waste particles are not removed with the draining cold oil. Drain the crankcase with the engine stopped and the oil warm. This allows for the draining of the waste particles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

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

### Change Oil

Obtain an oil sample for S•O•S (Scheduled Oil Sampling) analysis at this time.

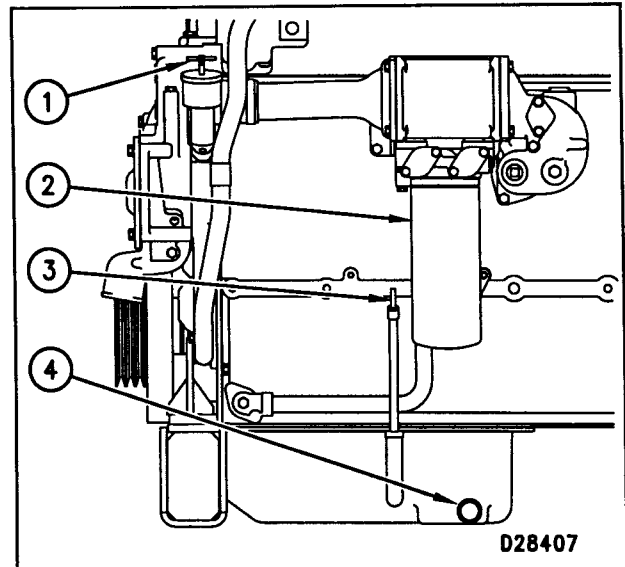
1. After the engine has been run at normal operating water temperature, STOP the engine. Remove the crankcase oil drain plug(s) and allow the oil to drain. If equipped with drain lines, turn knob on valve counterclockwise (CCW) to drain the oil.



Oil Drain Valve

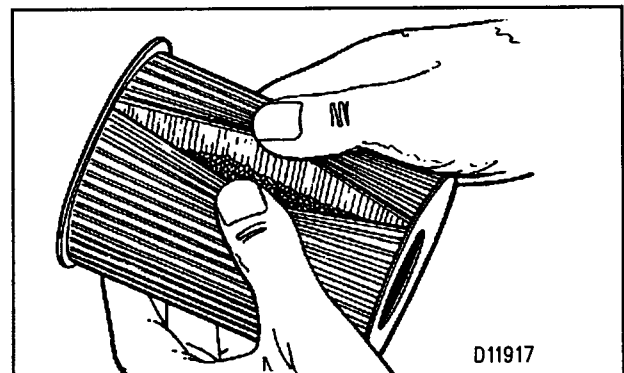
2. Install the oil drain plug(s). Tighten the plug(s) to  $70 \pm 14 \text{ N}\cdot\text{m}$  ( $50 \pm 10 \text{ lb ft}$ ). If equipped with a drain line valve, turn the valve knob clockwise (CW) to shut the drain.

### Change Filter(s)



Oil Filler Cap (1), Oil Filter (2), Oil Level Gauge (dipstick) (3), and Oil Drain Plug (4).

1. Use a 2P8250 Filter Wrench to remove the oil filter (2) and optional bypass oil filter, if equipped.



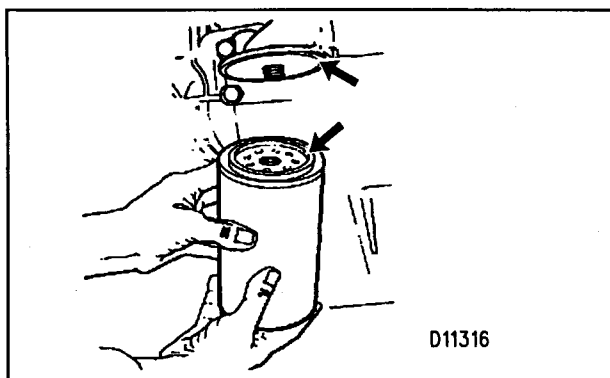
Element with debris.

2. Use a 4C5084 Oil Filter Cutter (which replaced the former 6V7905 Service Tool) to cut the oil filter open. Spread the pleats apart and inspect the element for metal debris. An excessive amount of debris in the oil filter element may be indicative of early wear or a pending failure.

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

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

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



- 3.** Wipe the sealing surface of the filter mounting base. Make sure all of the old gasket is removed.

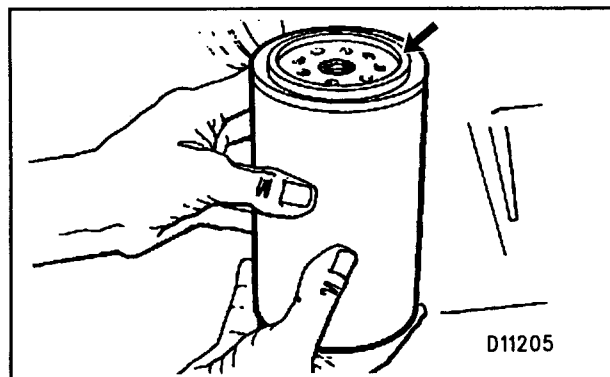
**NOTE:** Change oil filter(s) at every oil change. Make sure to use the correct Caterpillar oil filter(s) for your engine arrangement.

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**NOTICE**

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

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- 4.** Apply a small amount of clean engine oil to the new filter gasket.

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**NOTICE**

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

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- 5.** Install the new filter(s) until the gasket contacts the base. Tighten the filter  $\frac{3}{4}$  of a turn more by hand. Do not over tighten.

- Replace the bypass filter (if equipped) as instructed in Steps 3, 4 and 5. The Caterpillar bypass filter will require an additional 2.5 L (2.6 U.S. qts) of oil.

## Fill Crankcase

**6.** Remove the oil filler cap (1). Refer to Lubricant Specifications, Lubricant Viscosities and Refill Capacities chart for the proper oil and quantity to use for this engine. Fill the crankcase with the proper amount of oil. Under Filling or overfilling of engine crankcase oil can cause engine damage. Before starting the engine, ensure your oil level is within the correct operating range on the ENGINE STOPPED side of the dipstick (3).

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### NOTICE

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

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

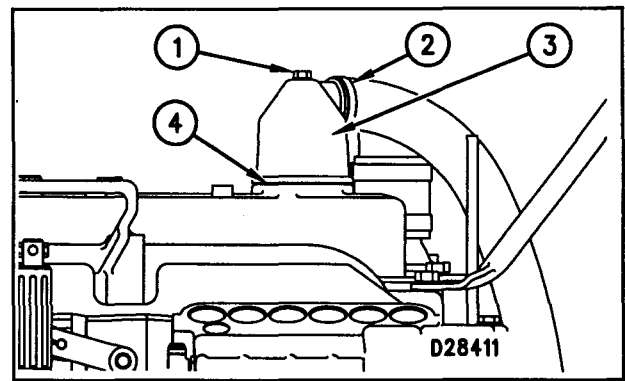
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- 7.** Start and run the engine at LOW IDLE for two minutes to ensure the lube system (including auxiliary filters, etc.) has oil and the oil filter(s) are filled. Inspect for oil leaks.
- 8.** Stop the engine and allow the oil to drain back to the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

## Crankcase Breather

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

### Clean



- 1.** Loosen breather retaining bolt (1).
- 2.** Loosen hose clamp(s) (2) and remove breather assembly (3) and seal (4).
- 3.** Wash the breather in clean, nonflammable solvent. Allow the breather assembly to dry.
- 4.** Install a new seal.
- 5.** Assemble the breather. Install the breather in reverse order of removal.
- 6.** Tighten the hose clamp(s) (2).

Refer to the Torque Specifications section of this manual for Torque for Standard Hose Clamps–Worm Drive Band Type hose clamps.

## Engine Valve Lash

### Check/Adjust

#### **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 adjusting valve lash.**

Initial valve lash adjustment on new, rebuilt or remanufactured engines is recommended at the first scheduled oil change interval (250 hours for Turbocharged engines and 500 hours for Naturally Aspirated engines) due to initial wear and seating of valve train components. Subsequent adjustments should be made at Every 2000 Hour interval.

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

See the valve lash topics in the Service Manual or contact your Caterpillar dealer for the complete valve adjustment procedure.

## Cooling System

### NOTICE

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

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

### Test for Supplemental Coolant Additive (SCA) Concentration (Conventional Coolant/Antifreeze Only)

Use the 8T5296 Coolant Additive (Conditioner) Test Kit to check for a three to six percent SCA concentration.

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

- Coolant is heavily contaminated.
- The engine overheats frequently.
- Foaming is observed in the radiator.
- 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.

Caterpillar Antifreeze contains the necessary SCA. Add SCA after flushing the system only if Caterpillar Antifreeze is NOT being used.

### Add Supplemental Coolant Additive (SCA)

#### NOTICE

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



1. Loosen the radiator filler cap slowly to relieve pressure. Remove the cap.
2. It may be necessary to drain enough coolant from the radiator to allow for the addition of the SCA.
3. Add 0.25 liter (½ pt) of Caterpillar SCA for every 20 liter (5 US gal) of cooling system capacity.

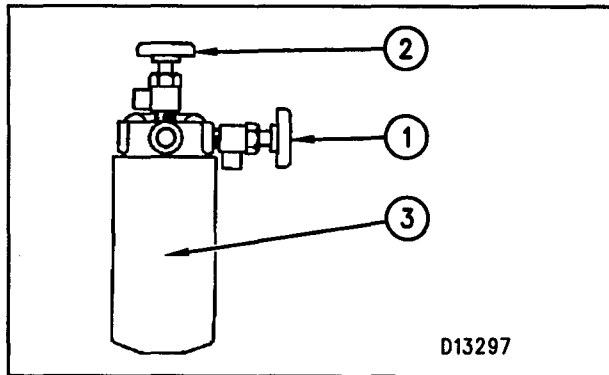
Refer to the Refill Capacities chart in this publication for the cooling system capacity for your engine.

4. Inspect the radiator filler cap gaskets. Replace the cap if the gaskets are damaged.
5. Install the filler cap.

#### Replace Coolant Additive Element (If Equipped)

##### NOTICE

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



1. Close the coolant additive element inlet valve (1) and outlet valve (2). Remove and discard the coolant additive element (3).
2. Clean the element mounting base. Make sure all of the old gasket is removed.
3. Install a new Caterpillar coolant additive element.
4. Coat the gasket of the new element with a thin film of engine oil.

5. Install the element. Spin the element until the seal contacts the base, then tighten ¾ turn more by hand. Do not over tighten.

6. Open the inlet valve (1) and the outlet valve (2).

7. Remove the radiator filler cap.

8. Start the engine and check for leaks. Allow the coolant level to stabilize.

9. Add premixed coolant water, if necessary, to bring the coolant to within 13 mm (½ inch) below the bottom of the fill pipe or to the proper level on the sight glass, if equipped.

10. Replace the radiator filler cap.

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

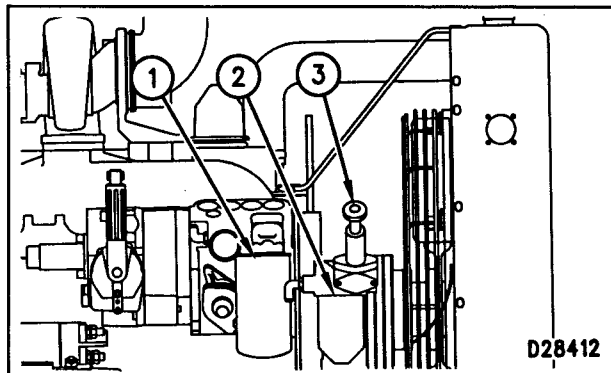
## Fuel System

### Fuel Tank Maintenance

Fuel tanks should have some provision for draining water and sediment from the bottom. Some fuel tanks use piping that allow water and sediment to settle. This water and sediment should be drained at each oil change.

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

### Clean/Replace Filters

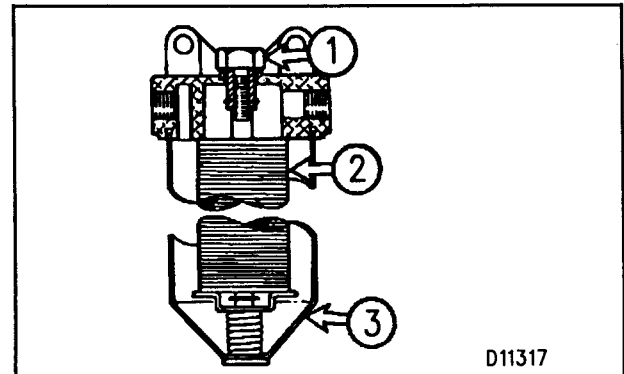


Final Fuel Filter (1), Primary Fuel Filter (2), and Fuel Priming Pump (3).

- Stop the engine.
- Turn the ECS switch OFF or disconnect the battery (or starting motor) when performing maintenance on fuel filters.
- Shut off the fuel tank supply valve to the engine. Drain water and sediment from the primary fuel filter.

### Clean Primary Filter (If Equipped)

Use the following procedure to clean the primary fuel filter (if equipped).



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

1. Loosen the bolt (1) on the primary filter housing and remove the filter case (3).
2. Remove the element (2) and wash it in clean, nonflammable solvent.
3. Install the element (2) and case (3). Tighten bolt (1) to a torque of  $24 \pm 4 \text{ N}\cdot\text{m}$  ( $18 \pm 3 \text{ lb ft}$ ).

### Replace Final Fuel Filter

1. Remove and discard the final fuel filter.
2. Clean the gasket sealing surface of the filter base. Make sure all of the old gasket is removed.
3. Apply clean diesel fuel to the new fuel filter gasket.

#### NOTICE

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

4. Install new filter. Spin filter until gasket contacts the filter base. Tighten the filter  $\frac{3}{4}$  turn more by hand. Do not over tighten.
5. Prime the fuel system.

## Priming the Fuel System

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

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

### All engines:

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

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

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### NOTICE

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

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

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

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### NOTICE

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

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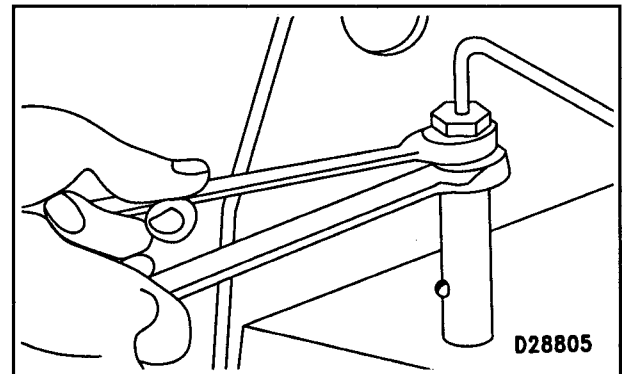
5. Operate the priming pump until the flow of fuel from the vent valve is continuous and free of air bubbles. If the engine does not have a fuel priming pump, crank the engine until the fuel flows free of air bubbles. Do not crank the engine for more than 30 seconds. Allow the starter to cool for two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

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

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

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

8. Loosen the fuel line nuts, one at a time, at the fuel injection nozzle.



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### NOTICE

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

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

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

## Radiator Fins, Aftercooler, Belts, and Hoses

### Inspect/Check Radiator Fins

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.

### Inspect/Check Aftercooler System

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#### NOTICE

A hose failure or significant system leak will cause a large drop in boost pressure and power. The engine can be operated at this power level long enough to reach a safe stop or repair area. Sustained operation under this condition should be avoided.

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Inspect the front of the air-to-air aftercooler. Examine core fins for external damage, insects, dirt, debris, salt, corrosion, etc. Use a firm stainless steel brush and soapy water to remove dirt, debris, salt, etc. Depending on your findings and operating environment, the maintenance interval for cleaning the air-to-air aftercooler may be more frequent.

A slight reduction in power or response, or a small increase in exhaust temperature, may indicate a small air leak in the charge air cooler core or piping. Inspect all air ducting and gasket connections at each oil change. Constant torque hose clamps should be secure. Tighten these clamps until the spring is at least partially compressed.

Inspect all welds for cracks. Check the mounting brackets to ensure they are secure and in good condition.

NOTE: Whenever air-to-air aftercooler parts are repaired and/or replaced, a leak test is highly recommended. Refer to the service manual or consult your Caterpillar dealer for the correct procedure to use when performing a leak test.

### Inspect/Adjust Belts

Inspect the condition and adjustment of alternator belts and fan drive belts.

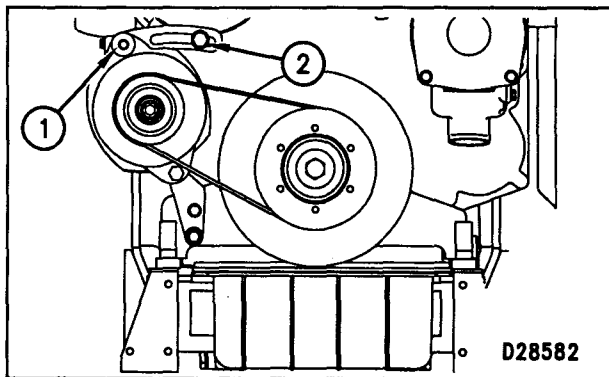
Inspect all drive belts for wear and replace if they show any signs of wear.

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

If belts are too loose, they vibrate enough to cause unnecessary wear on the belts and pulleys. If belts are too tight, unnecessary stresses are placed upon the pulley bearings and belts which might shorten the life of both.

1. Inspect the condition and adjustment of alternator belts and fan drive belts.
2. To check the belt tension, apply 110 N (25 lbs) of force midway between the pulleys. Correctly adjusted belts will deflect 13 to 19 mm ( $\frac{1}{2}$  to  $\frac{3}{4}$  inch).

### Adjust Alternator Belts



3. To adjust the alternator drive belts, loosen mounting nut (1) and adjusting bracket nut(s) (2).
4. Adjust the alternator in or out by either tightening or loosening adjusting nut(s) (2), as required, to obtain the correct adjustment.
5. Tighten nuts (1) and (2).
6. If new belts are installed, check belt adjustment again after 30 minutes of engine operation. Replace belts in matched sets only.

### Adjust Fan Drive Belts

1. To adjust the fan drive belts, loosen mounting bolts and adjust with adjusting bolt.
2. Move the fan drive up or down as required to obtain the correct adjustment. Tighten mounting bolts.
3. If new belts are installed, check belt adjustment again after 30 minutes of engine operation.

### Inspect Hoses

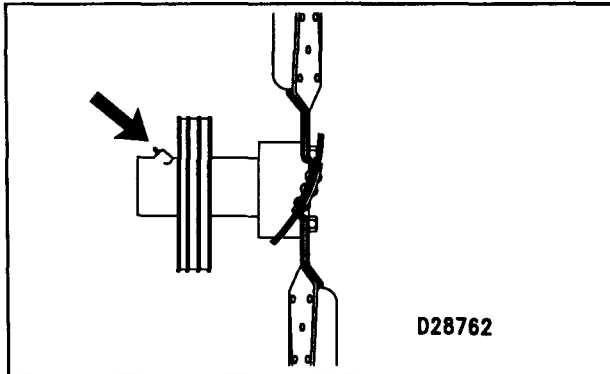
Hose replacement prior to failure is a cost effective preventive maintenance practice. Replacing a hose before it fails saves you money and reduces the chances for unscheduled downtime. By replacing a hose that is cracked, soft, or leaking, you will avoid major repairs that could result in a severe engine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

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

- Inspect all hoses for leaks due to cracking and softness. Inspect for loose clamps.
- Replace hoses that are cracked or soft and tighten loose clamps. Refer to the Replace Hoses topic in this publication.

## Fan Drive Bearing

### Lubricate Fitting



Lubricate one fitting.

Use Caterpillar Bearing Lubricant Special Purpose Grease, part number 2S3230, to service ball and roller bearings which operate at high speeds and temperatures. NLGI No. 2 Grade is acceptable for temperatures from  $-34$  to  $163^{\circ}\text{C}$  ( $-20$  to  $325^{\circ}\text{F}$ ).

Inspect the fan drive pulley assembly. It should be difficult to detect movement of the shaft in the bearing. The bearing end play should be  $0.03$  to  $0.23$  mm ( $.001$  to  $.009$  inch). The radial play should be no greater than  $0.13$  mm ( $.005$  inch).

If the shaft is loose, an inspection of the internal components should be made. If the assembly should require disassembly, refer to the Special Instruction, SMHS7001 or the Service Manual for the procedure.

## Batteries

### Clean/Check Electrolyte Level (if required)

BATTERY ELECTROLYTE CHART	
Battery	Interval
Conventional	100 Hour
Low Maintenance	250 Hours
Maintenance Free	None Required

1. Remove fill caps. Maintain electrolyte level to bottom on fill plug openings.

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

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

2. Keep batteries clean.

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

4. Clean all battery terminals.

5. Clean all cable clamps.

6. Install and tighten cable clamps to battery terminals.

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

### Check Battery Charger (if equipped)

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

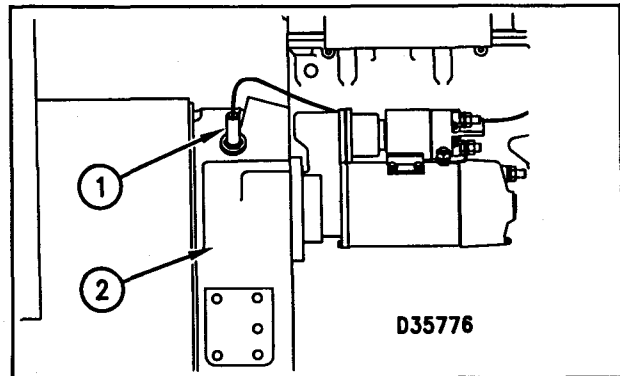
## Battery or Battery Cable Replacement

NOTE: When replacing batteries or battery cables, use the following procedure.

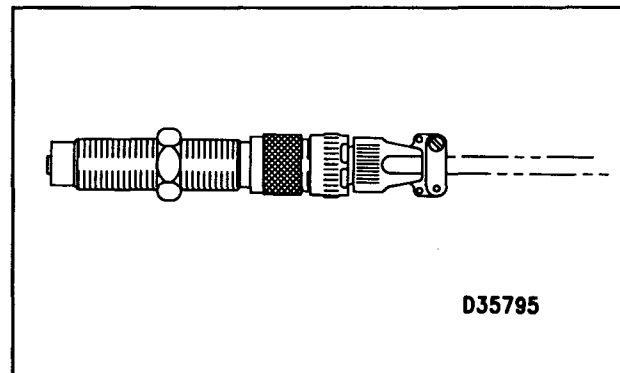
1. Turn off the START switch or the ECS switch to the OFF/RESET position. Turn off (open) the ignition switch (if equipped) and remove the key and all electrical loads.
2. Disconnect the cable from ground (one cable connects to frame and one to battery negative). Be sure the cable cannot contact where it was just removed.
3. Disconnect the negative battery cable terminal at the battery(s) that goes to the control panel switch. Where four 12 volt batteries are involved, the negative side of two batteries must be disconnected.
4. Proceed with necessary system repairs. Reverse steps to reconnect all cables.

## Magnetic Pickup

### Inspect/Clean



1. Remove the magnetic pickup (1) from the flywheel housing (2) and check the magnet condition.



### Magnetic Pickup

2. Clean the metal shavings and other debris from the face of the magnet.
3. Install the magnetic pickup into the flywheel housing by turning pickup clockwise (CW) until the magnet comes in contact with the flywheel ring gear tooth.
4. Back out the pickup thread counterclockwise (CCW)  $\frac{1}{2}$  of a turn ( $180 \pm 15$  degrees) to maintain a clearance between the magnetic pickup and the flywheel ring gear tooth. Tighten the locknut  $45 \pm 7$  N•m ( $33 \pm 5$  lb ft).

For additional information on the magnetic pickup(s) for your engine, refer to the Service Manual.

## Every 500 Hours (NA Only)\*

*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 interval applies to Naturally Aspirated (NA) Engines only. For information regarding all topics in this section, refer to the Every 250 Hour maintenance interval.

\*Before proceeding with this maintenance, perform all previous maintenance interval requirements.

### Scheduled Oil Sampling (S•O•S) Analysis

#### Obtain Sample

Refer to the Scheduled Oil Sampling topic in the Every 250 Hour maintenance interval in this publication.

### Engine Oil and Filter(s)

#### Replace

Refer to the Engine Oil and Filters topic in the Every 250 Hour maintenance interval in this publication.

### Crankcase Breather

#### Clean

Refer to the Crankcase Breather topic in the Every 250 Hour maintenance interval in this publication.

### Engine Valve Lash (First Oil Change Only)

#### Check/Adjust

Refer to the Engine Valve Lash topic in the Every 250 Hour maintenance interval in this publication.



## Every 1000 Hours

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

Before proceeding with Every 1000 Hour maintenance, perform all previous maintenance interval requirements.

### Engine Protection Devices

#### Inspect for Proper Operation

Refer to the Service Manual for the procedure. All engine protective devices must be checked and maintained to provide the engine with proper protection if a component malfunction or failure should occur. Check all engine protective devices.

NOTE: Never use the Emergency Shutdown controls for a normal stopping procedure.

### SR4 Generator and Control Panel (If Equipped)

#### SR4 Generator

#### WARNING

Before working inside the generator, make sure that the starting motor can not be activated by any automatic or manual signal.

When the engine-generator is operating, voltages up to 600V are present in these areas near or on the regulator:

1. the regulator terminal strip
2. the excitation transformer terminal strip (self-excited generator only)

Do not short these terminals to ground with any part of the body or any conductive material. Loss of life or injury could result from electrical shock or injury from molten metal.

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#### NOTICE

Electronic components in the regulator can be damaged during generator operation if contact is made between the part and ground.

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#### Clean/Inspect Voltage Regulator

If moisture is allowed to remain in contact with an electrical winding, some of the moisture will eventually be absorbed. This will lower the resistance of the winding insulation. The insulation used on the windings of Caterpillar generators is moisture resistant, but constant exposure to moisture will gradually lower the insulation's resistance.

Dirt can make the problem worse because it can hold the moisture in contact with the insulation. Salt (from coastal location sea air) can also make the problem much worse. This is because salt tends to absorb moisture from the air. When the salt and moisture combine, they make a good electrical conductor.

- Clean the voltage regulator and generator of dirt and debris. Use a brush to loosen accumulations of dirt and a vacuum system for removal. Use of compressed air is not recommended, because of moisture present in the form of condensate.

Carbon tracking on insulators can be caused by dirt or loose connections. These carbon paths must be cleaned or the insulators replaced. Failure to correct a carbon tracking problem will eventually result in a short in the electrical circuit.

- Visually check for loose or broken wires and connections. Check the wires and connections on the regulator assembly. Check all wires and connections in the generator. Make any necessary repairs to the wiring as required.

Visually inspect the generator and control panel. Check for loose, broken, or damaged wiring or components. The inspection only takes a few minutes and could avert a potential problem that could cause your generator set to fail.

### Operational Checks

Start the engine. Use the starting procedure found in the SR4 Generators and Control Panels Operation and Maintenance Manual, SEBU6150.

The following operational checks include:

- generator operation and engine starting
- lubricating and fuel systems
- overall operation

The checks should take no longer than five minutes to complete. A more thorough Performance Analysis should be performed every 3000 hours with the engine operating under load.

While operating, frequently observe all readings, especially the engine oil pressure and the water temperature.

### Check and Record Readings from Frequency (rpm) and Generated Voltage

NOTE: The operating voltage of a cold (just started) generator will be slightly higher than the operating voltage of a generator that has been under load and warm. The full load voltage of an SR4 Generator will decrease a maximum of one percent when this generator temperature stabilizes at 100°C (212°F).

Most of the voltage decrease occurs in about 30 minutes. Generally, voltages stabilize within two hours.

### Recommended Periodic Insulation Resistance Checks

Use a megohmmeter to check generator winding insulation resistance periodically. The frequency of the megohmmeter test is determined by the generator's environment and by previous megohmmeter test indications.

The megohmmeter test is described in Service Manual for SR4 Generators, SENR3985 or Special Instruction, SEHS9124, Cleaning and Drying of Caterpillar Electric Set Generators, or contact your Caterpillar dealer.

Your Caterpillar dealer has the trained personnel and equipment to provide this service for you.

The shutoff controls must be checked so that they function properly when they are required. To prevent damage to the engine while performing the test, only authorized personnel or your Caterpillar dealer should perform the checks.

### Control Panel

#### Check Gauges

Check the condition of all readings on the Control Panel. Check the condition of all gauges. Repair or replace any broken gauge before it becomes a problem.

- **Water Temperature** - Check for proper operating coolant temperature. It should normally indicate between 79°C (175°F) and 98°C (208°F). Maximum allowable temperature is 99°C (210°F) with the cooling system pressurized. Somewhat higher temperatures may occur under certain conditions.
- **Oil Pressure** - Check for proper operating oil pressure. The pressure will be greatest after starting a cold engine. Oil pressure will decrease as the engine warms while idling. As the engine speed is increased to full load speed, oil pressure will increase and stabilize. Minimum oil pressure is 240 kPa (35 psi) at rated speed.

NOTE: If oil pressure fails to rise within 15 seconds after the engine starts, stop the engine and make necessary repairs.

- Fuel Pressure - Check for proper operating fuel pressure. Minimum fuel pressure is 140 kPa (20 psi) at rated speed.

While operating, frequently observe all readings, especially the engine oil pressure and the water temperature.

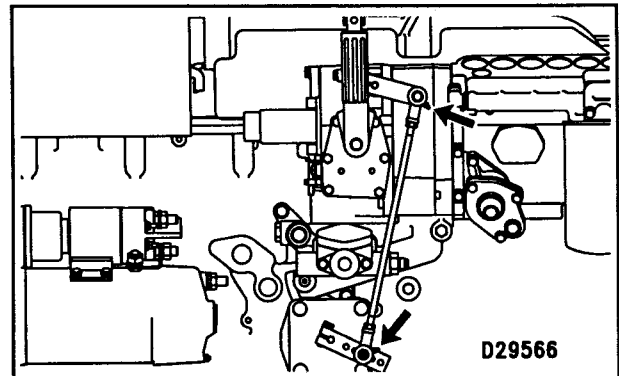
### Automatic Operation

Check that all switches are in proper position for automatic start. Refer to the Engine Protection Devices section of this publication for additional information.

## Fuel Control Linkage

### Check/Lubricate Linkages

Check and adjust if necessary, all fuel control linkages. Refer to the Service Manual for check/adjust procedure.



Fuel Control Linkage Grease Fittings

Lubricate the grease fittings on the fuel control linkage. Caterpillar recommends Multipurpose Lithium Grease, part no. 1P0808, suitable for light duty applications where a high temperature up to 175°C (350°F) is required.

## Every 2000 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.*

Before proceeding with this maintenance, perform all previous maintenance interval requirements.

### Engine Valve Lash, Valve Rotators, Fuel Ratio Control, Set Point, and Low Idle

#### Check/Adjust

#### WARNING

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

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

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.

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

#### WARNING

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

#### NOTICE

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.

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.

For the complete engine valve lash, fuel ratio control, set point, and low idle check/adjust procedures, refer to the Service Manual or contact your Caterpillar dealer.

## Fuel Injection Nozzles

### Test/Clean/Replace

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#### NOTICE

The engine will be damaged if a defective fuel injection nozzle is used because of the shape of fuel (spray pattern) that comes out of the nozzles will not be correct.

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Fuel injection nozzles are subject to tip wear as a result of fuel contamination. This damage can cause an increase in fuel consumption, the engine to emit black smoke, misfire or run rough. Inspect, test and replace if necessary.

Whenever the engine performs in such a manner that a fuel injection nozzle is suspected of causing irregular running, smoking or knocking, each fuel injection nozzle must be isolated, one at a time, to determine the malfunctioning nozzle. Special tooling is required to remove fuel injection nozzles.

NOTE: Refer to the Service Manual or contact your Caterpillar dealer for fuel injection nozzle testing and cleaning procedures.

## Turbocharger

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

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

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

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#### 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.

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.

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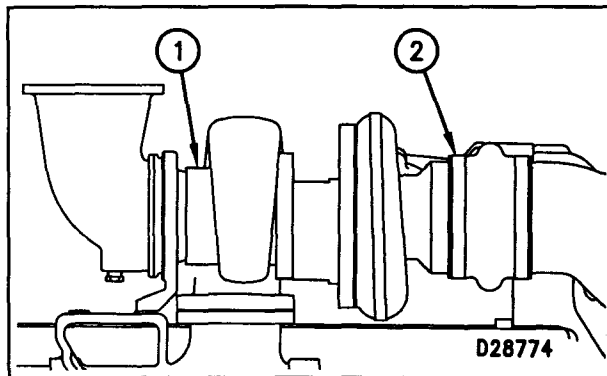
Minor leakage of a turbocharger housing under extended low idle operation will not cause problems as long as no turbocharger bearing failure occurred.

### Inspect for Proper Operation

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

The following conditions can indicate severe service operation.

- Frequent high altitude operation above 5,000 ft (1525 m).
- Arctic operation (regular cold starts at temperatures below 0°C [32°F]).
- Extending lubrication and intake air system maintenance intervals.



**1.** Remove the exhaust outlet piping (1) and inlet piping (2) from the turbocharger. Visually check for oil leaks.

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

**3.** Use a dial indicator to check end clearance on the shaft. Attach the dial indicator point on the end of turbocharger shaft. Push and pull the other end of the shaft. Note the total dial indicator reading. If the measured end play is greater than the Service Manual specifications, repair or replace the turbocharger. Measured end play less than the minimum Service Manual specifications could indicate carbon build up on the turbine wheel. The turbocharger should be disassembled for cleaning and inspection if the measured end play is less than the minimum Service Manual specifications.

**4.** 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 properly. If oil is found only on the back side of the wheel, an oil seal leak is indicated. The leak may be the result of extended engine operation at low idle, or an intake air line restriction (plugged air filter).

**5.** Inspect the turbine housing bore for corrosion.

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

**7.** Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing. Refer to the Torque Specification section in this manual for correct fastener torques.

### Severe Service Operation

Turbocharger components require precision clearances and balancing due to operation at high rotation speeds. Severe Service Applications can accelerate component wear. Engines operating under severe conditions may need more frequent Inspect/Repair/Replace the cartridge intervals to ensure maximum reliability and retention of full core value.

The following conditions can indicate severe service operation:

- Extended operation at low idle.
- Extending lube and air system maintenance intervals.
- Frequent hot shutdowns (minimum cool down periods after high load factor operation).

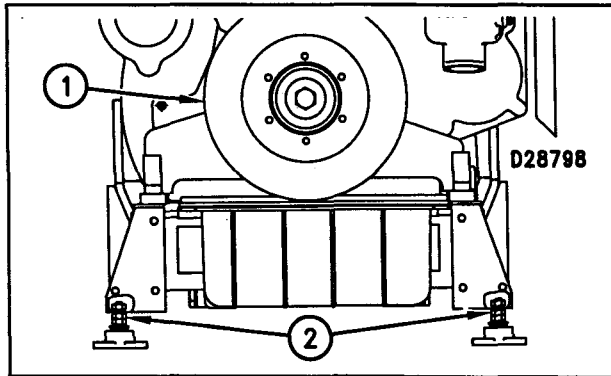
### Removal and Installation

For removal and installation, or repair/replacement options of turbochargers, see your Caterpillar dealer.

Refer to the Service Manual for this engine or consult your Caterpillar dealer for the procedure and specifications.

## Engine Mounts

### Inspect



Crankshaft Vibration Damper (1) and Engine Mounts (2).

Caterpillar recommends checking the engine mounts for deterioration and proper bolt torque. This will prevent excessive engine vibration caused from improper mounting. See your Service Manual or Caterpillar dealer for recommended torque values.

## Crankshaft Vibration Damper

### Inspect

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

The 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.

If your engine is equipped with a rubber damper, inspect the damper for:

- rubber deterioration, cracking.
- movement of the rubber from the original location.

### Visconic Damper

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

NOTE: To see if the amount of wobble is acceptable, or replacement is necessary, check the damper with the procedure in the Testing and Adjusting section of the Service Manual.

## **SR4 Generator (If Equipped)**

### **Lubricate Bearings**

For all information regarding lubrication and maintenance of SR4 Generators supplied by Caterpillar, refer to the SR4 Generator and Control Panel Operation and Maintenance Manual, SEBU6150. If further assistance is required, contact your Caterpillar dealer.

Note: Some engines equipped with generators may be equipped with a sealed prelubed bearing. These generator set bearings will not require lubrication every 2000 service hours.

- Lubricate small frame generators with a hand held grease gun using two pumps of grease.
- Wipe fittings of excess grease. Start the engine and run at low idle. Engage driven equipment and allow the grease to expand.

Use Special Purpose Grease (SPG) 2S3230. NLGI No. 2 Grade is suitable for most temperatures. Use NLGI No. 1 or 0 Grade for extremely low temperatures.

Perform the SR4 Generator bearings lubrication instructions as per SEBU6150, SR4 Generators and Control Panels Operation and Maintenance Manual.



## Every 3000 Hours

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

Before proceeding with this maintenance, perform all previous maintenance requirements.

### Cooling System

#### NOTICE

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

#### Add Extender (Long Life Coolant/Antifreeze Only)

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

Extender should be added to LLCA after 3,000 service hours or two years, whichever comes first. The cooling system should be treated with .95 L (1 qt) of Extender for every 46 L (12 US gal) of cooling system capacity. A 15 percent over or under treatment will not create any cooling system problems.

For more Extender information, refer to the Cooling System Specifications LLCA Extender topic in this manual.

#### Drain/Clean/Replace Coolant (Conventional Antifreeze Only)

#### NOTICE

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

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

- Coolant is heavily contaminated.
- The engine overheats frequently.
- Foaming is observed in the radiator.
- The oil cooler has failed, allowing oil to contaminate the coolant.
- Fuel has entered the cooling system and contaminated the coolant.
- Commercial cooling system products other than Caterpillar products are used.

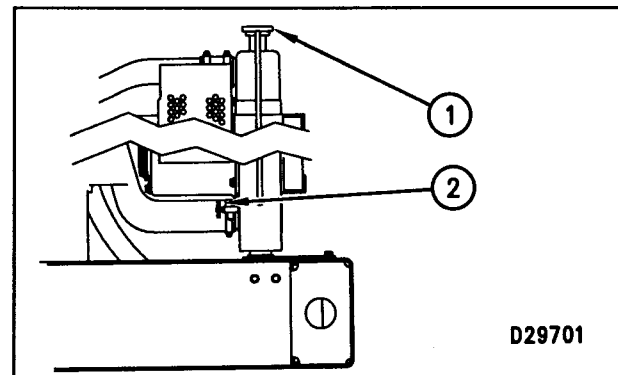
#### NOTICE

When using commercial antifreeze/coolant products from a manufacturer other than Caterpillar, drain, clean, and refill the cooling system every year or 1,500 service hours, whichever comes first.

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

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

#### Drain



Filler Cap (1), Drain Valve (2).

**1.** Stop the engine and allow the engine to cool. Loosen the coolant filler cap slowly to relieve any pressure, and remove the cap.

2. Remove the cooling system drain plug(s) or open the drain valve. Remove the drain plug from the bottom of the water pump housing (if equipped) and/or radiator. Allow the coolant to drain.

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#### NOTICE

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

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For information regarding disposal and recycling of used coolant:

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

#### Clean

3. Flush the cooling system with clean water to remove any debris.
4. Clean and install all drain plugs and/or close the drain valve(s).

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#### NOTICE

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

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5. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .5 L (1 pt) of Cleaner per 15 L (4 US gal) of cooling system capacity. Install the radiator filler cap.
6. Start and run the engine for a minimum of 30 minutes with the coolant temperature at 82°C (180°F). Stop the engine and allow the engine to cool.
7. Loosen the filler cap slowly to relieve any pressure, and remove the cap. Remove the cooling system drain plug(s) or open the drain valve(s). Allow the cleaning solution to drain. 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(s).

#### Fill

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

8. Fill the system with the recommended coolant/antifreeze mixture.
9. Start and run the engine with the filler cap removed. Allow the coolant to warm, the thermostat to open and the coolant level to stabilize. Check the coolant level. Add coolant mixture if necessary to bring the coolant to within 13 mm (½ in) below the bottom of the fill tube or the correct level on the sight glass (if equipped).
10. Check the condition of the filler cap gasket. If the gasket is damaged, discard the old filler cap and install a new filler cap. If the gasket is not damaged, use a 9S8140 Service Tool (available from your Caterpillar dealer) to pressure test the filler cap. The correct filler cap pressure is stamped on the face of the filler cap. If the filler cap does not hold the correct pressure, install a new filler cap.
11. Start the engine and inspect for coolant leaks and proper operating temperature. Check for coolant leaks at the oil cooler connections. Stop the engine.

#### Cooling Systems with Heavy Deposits or Plugging

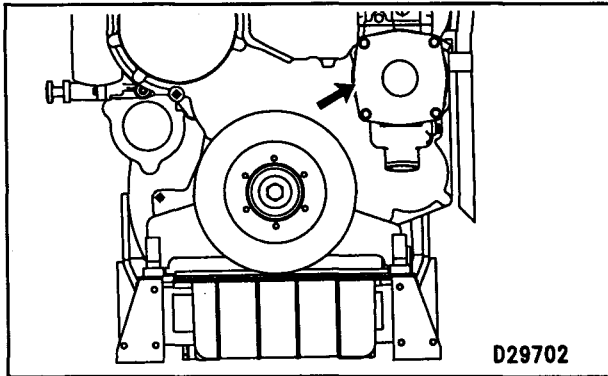
NOTE: For the following procedure to be effective, there must be some active flow through the radiator and the other cooling system components.

Follow the same steps as outlined above, with the following modifications to steps 5 and 6:

5. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .5 L (1 pt) of Cleaner per 3.8 to 7.6 L (1 to 2 US gal) of cooling system capacity. Install the radiator filler cap.
6. Start and run the engine for a minimum of 90 minutes with the coolant temperature at 82°C (180°F). Stop the engine and allow the engine to cool.

## Water Pump Seal

### Inspect/Replace



Water Pump

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.

Check the water pump breather filter for blockage or debris. Replace the filter if necessary. Refer to the Service Manual for the complete water pump inspection procedure.

### Replace Hoses

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

1. Loosen the radiator filler cap slowly to relieve any pressure and remove the cap. Drain the coolant from the cooling system to a level below the hose being replaced.
2. Remove the hose clamps, disconnect the old hose. Install the new hose.
3. Install the hose clamps. See the Torque Specifications section of this publication for the appropriate torque.

4. Refill the cooling system with the recommended coolant/antifreeze mixture.

NOTE: Fill the cooling system with the coolant solution at 19 L (5 US gal) or less per minute to avoid air locks. See the Refill Capacities chart in this publication for the capacity of your cooling system.

5. Start and run the engine with the filler cap removed. Allow the coolant to warm, the thermostat to open and the coolant level to stabilize. Inspect for leaks and proper operating temperature. Check for coolant leaks at the oil cooler connections.
6. Check the coolant 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).
7. Check the condition of the filler cap gasket before installing the cap. If the gasket is damaged, discard the old filler cap and install a new filler cap.

### Replace Thermostat

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

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#### NOTICE

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

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#### NOTICE

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

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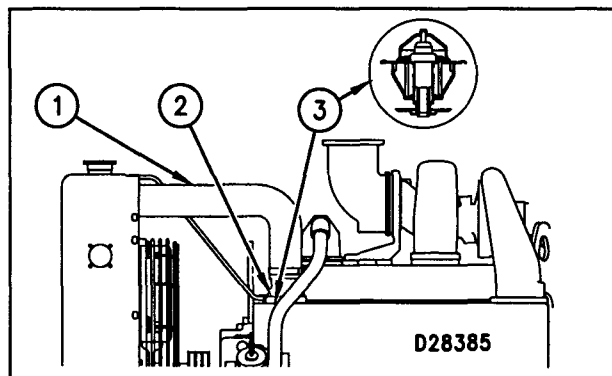
Depending on load, a thermostat that fails in a partially opened position will cause either an overheating or an over cooling condition.

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

If the thermostat fails in the open position, it will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon build-up inside the cylinder. This excessive carbon build-up could result in accelerated ring and liner wear.

NOTE: Refer to the Service Manual for fully open and closed thermostat temperature ratings.

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



1. Disconnect the hose assembly (1) from radiator inlet tube to engine water outlet pipe (2).
2. Remove the engine water outlet pipe (2) from the cylinder head.
3. Remove the thermostat (3) and gasket.

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

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#### NOTICE

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

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4. Install a new thermostat and gasket in position on the cylinder head.
5. Install engine water outlet pipe (2) on the cylinder head. Connect the radiator inlet tube with the hose assembly (1).

Refer to the Cooling System Specifications in this publication for all information regarding acceptable water, antifreeze and supplemental coolant additive requirements, or contact your Caterpillar dealer for assistance.

6. Add the proper coolant/antifreeze mixture to the cooling system. 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).

NOTE: Fill the cooling system with the coolant solution at 19 L (5 US gal) or less per minute to avoid air locks. See the Refill Capacities chart in this publication for the capacity of your cooling system.

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#### NOTICE

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

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7. Start and run the engine with the filler cap removed. Allow the coolant to warm, the thermostat to open and the coolant level to stabilize. Inspect for leaks and proper operating temperature.
8. Check the coolant level. If the coolant level is low, add coolant the proper coolant mixture.
9. Check the condition of the filler cap gasket. If the gasket is damaged, discard the old cap and install a new cap.

## Every 4000 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.*

Before proceeding with this maintenance, perform all previous maintenance interval requirements.

### Magnetic Pickup

#### Inspect/Clean

Refer to the Magnetic Pickup topic in the Every 250 Hours interval in this manual.

### SR4 Generator (If Equipped)

#### Inspect/Clean/Check/Lubricate

- Inspect and clean the voltage regulator. Refer to the SR4 topic in the Daily and Every 1000 Hours intervals in this manual.
- Check generator winding insulation resistance. Refer to the SR4 topic in the Every 1000 Hours interval in this manual.
- Lubricate generator components (if necessary). Perform the SR4 Generator bearings lubrication instructions as per SEBU6150, SR4 Generators and Control Panels Operation and Maintenance Manual.
- Check generator space heaters for proper operation. Refer to the Generator Space Heater topic in the Every 125 Hours interval in this manual.

## Every 6,000 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.*

Before proceeding with this maintenance, perform all previous maintenance interval requirements.

### Cooling System

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#### NOTICE

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

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#### Drain/Flush/Replace Coolant (Long Life Coolant/Antifreeze Only)

Caterpillar Long Life Coolant/Antifreeze should be replaced every 6,000 Service Hours or 4 Years, whichever comes first. Only clean water is needed to clean and flush the cooling system when LLCA is drained and replaced.

#### Drain

1. Stop the engine and allow the engine to cool. Loosen the coolant filler cap slowly to relieve any pressure, and remove the cap.
2. Remove the cooling system drain plug(s) or open the drain valve. Remove the drain plug from the bottom of the water pump housing (if equipped) and/or radiator. Allow the coolant to drain.

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#### NOTICE

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

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For information regarding disposal and recycling of used coolant:

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#### Flush

4. Flush the cooling system with clean water to remove any debris.
5. Clean and install all drain plugs and/or close the drain valve(s).
6. Fill the cooling system with clean water. Install the filler cap. Operate the engine until warm 49 to 66°C (150 to 120°F).
7. Stop the engine and allow the engine to cool. Loosen the coolant filler cap slowly to relieve any pressure, and remove the cap. Remove the cooling system drain plug(s) or open the drain valve. Allow the water to drain. Flush the cooling system with clean water.
8. Repeat steps 6 and 7.

#### Fill

9. Fill the cooling system with LLCA. Refer to the refill capacities chart in this manual for the amount of LLCA needed to refill your system.
10. Start and run the engine with the filler cap removed. Allow the LLCA to warm, the thermostat to open, and the coolant level to stabilize. Add LLCA if necessary to bring the coolant to the proper level.
11. Check the condition of the filler cap gasket. If the gasket is damaged, discard the old filler cap and install a new filler cap. If the gasket is not damaged, use a 9S8140 Service Tool (available from your Caterpillar dealer) to pressure test the filler cap. The correct filler cap pressure is stamped on the face of the filler cap. If the filler cap does not hold the correct pressure, install a new filler cap.
12. Start the engine and inspect for coolant leaks and proper operating temperature. Stop the engine.

# Standby Generator Preventive Maintenance Recommendations

## Introduction

The objective of this topic is to assist users in establishing a Preventive Maintenance Program for Standby Generator Sets or as an aid in evaluating their present programs.

Standby Generator Sets may not be needed very often, but when they are, it is usually under emergency conditions. Maintenance of these standby units is very important. They must always be in excellent operating condition, ready to work under load at any time.

Establishing a Preventive Maintenance Program will provide maximum availability of a standby generator set when needed, longer engine and generator life, and a minimum of expensive repairs.

The recommended WEEKLY maintenance checks can be performed by an operator. The checks consist of basic maintenance requirements to ensure the standby generator set will be ready for immediate use should the need arise.

All YEARLY and THREE YEAR maintenance should be performed by an authorized mechanic or your Caterpillar dealer. These checks and maintenance requirements will require that the standby generator be run under load conditions, and may require special test equipment.

These guidelines are to be used with the information contained in the Operation and Maintenance sections of this manual. The Operation and Maintenance sections of the manual will provide the necessary information on how to perform the checks and routine maintenance.

Refer to the Generator and Engine Service Manuals and Recommended Preventive Maintenance Schedules for Standby Generator Sets, SEBU6042 for additional information, or contact your Caterpillar dealer for assistance.

## Inspection and Maintenance Agreements

Your Caterpillar dealer can establish an Inspection and Preventive Maintenance Program for your generator set to provide maximum reliability, increased engine and generator life, and minimize expensive repairs. Contact your Caterpillar dealer for details.

## General Recommendations

### Safety

#### WARNING

**The stop-manual-automatic switch on the cranking panel must be set at STOP position when performing maintenance or repair work on a standby generator set. This prevents the unit from starting if a power failure or voltage drop should occur while working on the unit.**

**To prevent personal injury due to accidental starting of the engine, disconnect the batteries or disable the starting system before doing maintenance or repair work.**

**Lock out all switch gear and automatic transfer switches associated with the generator while performing any generator maintenance or repairs. Make sure no shock hazard exists.**

**Failure to comply could result in personal injury or death.**

Always make repairs with the engine stopped and the starting system disabled. When servicing the generator, make sure that switch gear and automatic transfer switches will not present a shock hazard. Lock them out on the generator being serviced.

### Record Keeping

Maintain a log or record keeping system to document all gauge readings, problems, repairs, and maintenance performed on the equipment.

### Space Heaters

Moisture is a natural enemy of generators and all electrical equipment. Every effort must be made to keep the generator as dry as possible. Space heaters should be operated inside the generator when it is not in use to maintain the integrity of the generator windings.

## Maintenance Schedule for Standby Generator Set Engines

NOTE: Refer to the topics in the Operation & Maintenance Manual, SEBU6150, SR4 Generators and Control Panels, and the Maintenance Schedules in this manual for page numbers and information to perform the maintenance specified in the following schedules.

### Weekly (Before Starting Engine)

Walk-Around Inspection – Inspect engine for leaks and loose connections

Engine Crankcase – Check oil level

Cooling System – Check coolant level

Battery Charger – Check for proper operation

Batteries – Clean/Check electrolyte level

Air Starter System (if equipped) – Check lubricator oil level, air pressure and drain condensation

Engine Air Cleaner – Check service indicator

Block Heater – Check for proper operation, maintain 32°C (90°F) temperature

Aftercooler – Inspect ATAAC

Belts – Inspect/Replace

Engine Protection Devices – Inspect system and gauges for proper operation

Generator and Control Panel – Inspect components

### Weekly (With Engine Running)\*

Walk-Around Inspection – Inspect engine for leaks and loose connections and generator louvers for proper operation

Engine Crankcase – Check oil level

Oil Pressure – Check gauge reading

Generator – Check frequency (rpm) and generated voltage

### Weekly (After Stopping Engine)\*

Walk-Around Inspection – Inspect engine and report malfunction and make necessary repairs

Automatic Switches – Check for proper position to execute auto-start

Battery Charger – Record charging amperage reading

### Yearly (Before Starting Engine)\*

Cooling System – Check coolant level, Test for concentration of supplemental coolant additive

Crankcase Breather – Clean

Valve Lash – Check/Adjust

Governor – Inspect for leaks

Governor Linkage – Check/Adjust and Lubricate

Air Inlet Piping – Inspect

Engine Air Cleaner – Check service indicator, Replace element if necessary

Generator – Lubricate bearing

### Yearly (With Engine Running)\*

Engine Protection Devices – Inspect system and gauges for proper operation;bs/, Record gauge readings

Radiator (If Equipped) – Inspect for leaks and loose connections and louvers for proper operation

Load Test – Operate the engine at a minimum of 30% of rated load for minimum of two hours

Engine Mounts – Inspect

### Yearly (After Stopping Engine)\*

Scheduled Oil Sampling (S•O•S) Analysis – Obtain Engine Oil and Filters – Replace

### Every Three Years (Before Starting Engine)\*

Turbocharger – Inspect/Check bearing end play and radial clearance

Governor – Inspect for leaks

Thermostat – Replace

Coolant Hoses – Replace

Cooling System – Clean/Flush coolant

Batteries – Replace

### Every Three Years (With Engine Running)\*

Walk-Around Inspection – Inspect engine for leaks and loose connections

Engine Protection Devices – Inspect system and gauges for proper operation, Record gauge readings

Engine Crankcase – Check oil level

Radiator (If Equipped) – Inspect for leaks and loose connections and louvers for proper operation

Load Test – Operate at a minimum of 30% of rated load for minimum of two hours

Exhaust System – Check for leaks

### Every Three Years (After Stopping Engine)\*

Walk-Around Inspection – Inspect engine and report malfunction and make necessary repairs

Scheduled Oil Sampling (S•O•S) Analysis – Obtain Engine Oil and Filters – Replace

Battery Charger – Record charging amp reading

Automatic Switches – Check for proper position to execute auto-start

Coolant Analysis – Obtain

**Every Four Years** – Drain/Replace Engine Coolant (Long Life Coolant/Antifreeze Only)

\*First Perform Previous Maintenance Items



## Troubleshooting

Troubleshooting a failure on an engine can be a difficult procedure. For a troubleshooting manual, see the Service Manual for your engine. All repairs should be made by a properly trained mechanic. Your Caterpillar dealer has the personnel and special tools needed to troubleshoot and make repairs to your engine.

See the Service Manual for a troubleshooting manual. The list of problems, causes and corrections given in the Service Manual, will only give an indication of where a possible problem can be, and what repairs may be needed.

Remember that a problem is not normally caused only by one part, but by the relation of one part with other parts.

The Service Manual can not give all possible problems and corrections. The serviceman must find the problem and its source, then make the necessary repairs.

Your Caterpillar dealer is equipped with the necessary tools and personnel to provide assistance when necessary.

## Performance Analysis

### Obtain at Every 3000 Hour Interval

Approximately 85 percent of your engine's operation and maintenance cost is the cost of the fuel. Therefore, substantial cost reductions can be achieved by keeping your engine operating at peak efficiency. The fuel economy and performance of the engine is affected by the application and specifications, how it is operated and the condition of the engine. Each plays an important part in minimizing your overall owning and operating cost.

Caterpillar recommends a regularly scheduled analysis to monitor the condition and maintenance requirements of your engine and to ensure your engine is operating at peak efficiency.

Potential problems can be identified early, thus preventing unnecessary repair costs and unscheduled downtime. Consult your Caterpillar dealer for complete information and assistance in conducting a performance analysis of your engine.

Tests normally conducted by your Caterpillar dealer can:

- confirm your engine is operating efficiently and within specification.
- identify potential problems.
- determine components or systems that should be adjusted, replaced, etc.

Fuel rate and boost are the primary indicators of your engine's performance and the analysis of this data will help pinpoint potential problems faster.

Regular performance testing of your engine can be cost effective to help lower fuel costs and lower costs associated with maintenance, repairs and overhauls.

## Value Planned Repair (Repair Before Failure)

Until recently, engine maintenance and repair management involved changing the oil when it was convenient and repairing the engine when it was damaged. This seemed to be the accepted way of managing a maintenance operation.

However, due to a variety of circumstances, increasing competition have caused users to look for ways to prolong equipment life and lower operating costs so that they could be competitive.

To assist Caterpillar engine users in prolonging engine life and reducing operating costs, the Value Planned Repair approach to engine maintenance was developed.

The Value Planned Repair approach can be tailored for any engine. This approach, when properly structured, outlines every maintenance and repair service required to support an engine from the day it enters service until the day it is retired.

To ensure the repair is performed efficiently and expediently, the Value Planned Repair concept approaches a given repair in three basic steps:

1. Repair determination
2. Evaluation of repair options
3. Selection of the most appropriate option

The Value Planned Repair approach addresses:

- Services required to maintain an engine at optimum efficiency.
- Scheduled maintenance, repairs and overhauls to minimize unscheduled downtime.
- Preplanned repairs and overhauls that can be flat-rated, putting you in charge of costs.
- Repair or overhaul options designed to restore the engine to proper operating condition.
- Repair or overhaul options designed to renew the engine if a failure has occurred.

Part of the Value Planned Repair approach is the repair before failure concept. The objective of the repair before failure concept is to repair the engine before a failure takes place.

The fact that a failure has not taken place makes the repair before failure concept more economical since a high degree of parts such as pistons, liners, valves, etc., and major castings such as cylinder blocks, cylinder heads, etc., can be reused.

Also, an extensive internal cleaning of the engine, which is labor intensive, is eliminated because a generating failure has not taken place.

The best part of the repair before failure concept is that unscheduled downtime is minimized and in most cases eliminated. Because the repair or overhaul can be scheduled, it allows the user to adjust his operation accordingly.

The overall benefit to a customer who repairs an engine before failure is that the customer, and not the engine, is in control of the repairs required.

To stress the importance of the Value Planned Repair approach, please consider the following example that reflects the difference in the cost of a before failure repair versus the cost of an after failure repair.

The cost to repair a turbocharger after it fails is approximately five times more than the cost of repairing a turbocharger before it fails.

However, if parts from a damaged turbocharger enters the engine, then the cost to repair your engine could be as high as ten times or more the cost of repairing a turbocharger before it fails.

By subscribing to the Value Planned Repair approach, you can avoid spending money on costly repairs that should have been prevented and utilize the money more profitably elsewhere.

Caterpillar strongly recommends the Value Planned Repair approach for maintaining and overhauling your engine.

To better illustrate what the Value Planned Repair approach means to you in terms of dollars and cents, please refer to the Engine Operating Cost Analysis section following in this publication.

## Engine Operating Cost Analysis

### Operating Cost Information

The term "Life Cycle Costs" can be defined as the sum of the individual costs experienced by an engine from the day of purchase until the day of retirement. In other words, the total Owning and Operating Costs.

**Owning Costs** are fixed costs such as initial purchase price, interest on borrowed money, depreciation and taxes.

**Operating Costs** are a combination of fixed and variable costs such as fuel, oil, operator expenses, equipment maintenance and repair, engine maintenance and repair, and downtime.

The difference between revenues generated and Life Cycle Costs (total Owning and Operating Costs) is profit.

Caterpillar and your Caterpillar dealer cannot guarantee that you will make a profit. However, Caterpillar and your Caterpillar dealer can provide you with a variety of services that can help you reduce the costs that impact your profits.

An Engine Operating Cost Analysis is a service provided by your dealer that was developed by Caterpillar to help you reduce the Life Cycle Cost of your engine. More specifically, an Engine Operating Cost Analysis is a computerized program that examines current and prospective oil, fuel, maintenance, minor repair, overhaul and downtime costs for the period of time you expect to own the engine. It also calculates the operating cost per hour.

This useful tool provides your dealer with the specific information needed to develop a customized Maintenance Management program for your operation which will minimize your engine's operating costs.

Before a cost analysis can be performed, your dealer needs to gather as much information as possible about your operation. He will need to know the length of time you plan to keep your engine, your average cost of fuel and oil as well as a variety of other ownership and cost related facts and figures.

Once this information is obtained, your dealer will enter the data into an established computerized program to produce an Engine Operating Cost Analysis printout reflecting your current and projected operating costs per hour. Current and expected cost information is reflected in the data provided by you. These are the costs that affect your engine's operating cost.

The General Information section contains basic user data such as name, business, location, ownership, usage per year, etc., information.

The Engine Operating Information section is divided into eight subsections that address fuel consumption, oil consumption, preventive maintenance, component repairs such as water pumps, turbochargers, air compressors, etc., before failure repairs, after failure repairs, user's revenue rate per hour and lastly, miscellaneous costs such as operator wages, insurance premiums, etc.

### Engine Operating Cost Summary

The Operating Cost Summary is exactly what it implies, a summary. Here the total dollar expense and percentage of the total operating expense is calculated for each subsection. The individual elements are then totaled and divided by the ownership period to yield the cost per hour. Similar calculations are also made for only the maintenance and repair portion of the total operating cost.

An Engine Operating Cost Analysis is a useful tool that can be used to:

- Project the expected operating cost of a Caterpillar engine.
- Identify the impact of individual elements on engine operating costs.
- Determine expected operating costs if Caterpillar service and overhaul recommendations are followed.
- Determine the cost per hour figures that you can obtain by having your dealer perform various levels of preventive maintenance as recommended by Caterpillar.
- Determine the savings to be realized if Caterpillar repair kits, exchange components, etc., are used by those of you who elect to perform your own maintenance.
- Determine the proper way to realize full value of your Caterpillar Engine by utilizing genuine Caterpillar parts and following Caterpillar recommended guidelines for preventive maintenance and before failure repairs.

In conclusion, an Engine Operating Cost Analysis is a tool that was designed to identify costly problem areas for the purpose of helping you reduce your operating costs.

## Maintenance Records

Caterpillar recommends that accurate maintenance records be maintained. Accurate maintenance records can be used for determining operating costs, establishing maintenance schedules for other engines being operated in the same environment and for a variety of other related business decisions.

Accurate maintenance records can also be used to show compliance with the required maintenance practices and intervals. Maintenance records are a key element of a well managed maintenance program. With accurate maintenance records your Caterpillar dealer can help you fine tune the recommended maintenance intervals to meet your specific operating situation. This should result in a lower engine operating cost.

The key elements to keep records on are:

- Fuel Consumption

This is essential for determining when load-sensitive items should be inspected or repaired and for determining overhaul intervals.

- Service Hours

This is essential for determining when revolution-sensitive items should be inspected or repaired.

- Documents

The following types of documents should be kept as proof of maintenance or repair for warranty and should not be difficult to obtain and keep in the engine history file. All documents should show date, service hours, liters (gallons) of fuel consumed, unit number and engine serial number. If the engine is sold, transfer the records with the engine.

The following types of documents should be kept as proof of maintenance or repair for warranty and should not be difficult to obtain and keep in the engine history file.

1. Dealer work orders and itemized bills.
2. Owner's repair orders.
3. Owner's receipts.
4. Maintenance log (see following example).

## Maintenance Log

Engine Model \_\_\_\_\_

**Customer Identifier**\_\_\_\_\_

**Serial Number** \_\_\_\_\_

Arrangement Number\_\_\_\_\_

[illegible]

## Reference Materials

### Caterpillar Reference Material

The following literature can be obtained through any Caterpillar dealer.

#### Oil

SEBD0640: Oil and Your Engine

PEDP7122: Question & Answer Booklet

PEDP1129: Listen To Your Oil

PEHP6001: How to Take a Good Oil Sample

SEBU6251: Lubricant Recommendations

PEHP1020: Product Data Sheet for Cat Diesel Engine Oil (CF-4) (N. America & Selected Int'l)

PEHP1026: Product Data Sheet for Cat Diesel Engine Oil (CF-4)(International Only)

PEHP1027: Product Data Sheet for Cat Diesel Engine Oil (CD)

PEHP0002: Product Data Sheet for Cat Molybdenum Grease (MPGM)

PEHP0003: Product Data Sheet for Cat Lithium Grease (MPGL)

PEHP0017: Product Data Sheet for Cat Special Purpose Grease (SPG)

PEWP9733: Cat Fluids Selector

PEDP7105: Scheduled Oil Sampling

#### Fuel

SEBD0717: Diesel Fuels and Your Engine

#### Coolant

SEBD0518: Know Your Cooling System

SEBD0970: Coolant and Your Engine

### Miscellaneous

SEBF8029: Index to Guidelines for Reusable Parts and Salvage Operations

SEBF8062: Guideline for Reusable Parts - Cleaning and Inspection of Air Filters

SEHS9031: Storage Procedure for Caterpillar Products

SENR5226: Service Manual (EMCP)

SEBU6150: SR4 Generators and Control Panels Operation and Maintenance Manual

SENR2380: Service Manual (4XB, 7JB, 64Z, 83Z & 10E300-up)

SENR2793: Service Manual (85Z, 2AJ & 2TM)

SEBP1805: Parts Manual (2AJ)

SEBP2273: Parts Manual (2TM)

SEBP1451: Parts Manual (7JB)

SEBP1452: Parts Manual (4XB)

SEBP1406: Parts Manual (85Z)

SEBP1411: Parts Manual (83Z)

SEBP1435: Parts Manual (64Z)

SEBP1400: Parts Manual (10E300-up)

SEHS7654: Alignment-General Instructions

SEHS9124: Cleaning and Drying of Caterpillar Electric Set Generators

LEBH9324: Agricultural and Material Handling Application and Installation Guide

SEHS7292: Use of 5P4150 Nozzle Testing Group

SEHS8622: Using the FT1984 Air-To-Air Aftercooler Leak Test Group

SEHS7795: Use of Pump & Governor Tool Group

SEHS8024: Governor Adjusting Tool Group

SEHS8094: Use of Nozzle Puller Group

### **Additional Reference Material**

ASTM D2896: TBN Measurements

ASTM D21768: Worked Penetration

ASTM D2982B

ASTM D3828A

ASTM D445

ASTM D893

ASTM 498589: GM-6038M Specification

ASTM Specs can normally be obtained from your local technological society, library or college.

SAE J313: Diesel Fuels

SAE J754: Nomenclature

SAE J183: Classification

Society of Automotive Engineers (SAE) Specs can be found in your SAE handbook or can be obtained from your local library, college or technological society.

- SAE handbooks can be obtained directly from:  
SAE International  
400 Commonwealth Drive  
Warrendale, PA USA 15096-0001

Engine Manufacturers Association (EMA) information for lube oil selection can be obtained from your local library, college or technological society, or contact:

- Engine Manufacturers Association  
Lubricating Oils Data Book  
401 N. Michigan Ave. Ste. 2400  
Chicago, IL 60611  
(312) 644-6610 ext. 3626



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