

SEBU6356-05 July 2004



# Operation and Maintenance Manual

G3304 and G3306 Engines

N4F1-Up (Engine) G6X1-Up (Engine) 07Y1-Up (Engine) 37Y1-Up (Engine)

# Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.

# **MARNING**

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Gaterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.

#### **A WARNING**

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.



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#### **Foreword**

#### Literature Information

This manual contains safety, operation instructions, lubrication and maintenance information. This manual should be stored in or near the engine area in a literature holder or literature storage area. Read, study and keep it with the literature and engine information.

English is the primary language for all Caterpillar publications. The English used facilitates translation and consistency in electronic media delivery.

Some photographs or illustrations in this manual show details or attachments that may be different from your engine. Guards and covers may have been removed for illustrative purposes. Continuing improvement and advancement of product design may have caused changes to your engine which are not included in this manual. Whenever a question arises regarding your engine, or this manual, please consult with your Caterpillar dealer for the latest available information.

# Safety

This safety section lists basic safety precautions. In addition, this section identifies hazardous, warning situations. Read and understand the basic precautions listed in the safety section before operating or performing lubrication, maintenance and repair on this product.

# Operation

Operating techniques outlined in this manual are basic. They assist with developing the skills and techniques required to operate the engine more efficiently and economically. Skill and techniques develop as the operator gains knowledge of the engine and its capabilities.

The operation section is a reference for operators. Photographs and illustrations guide the operator through procedures of inspecting, starting, operating and stopping the engine. This section also includes a discussion of electronic diagnostic information.

#### **Maintenance**

The maintenance section is a guide to engine care. The illustrated, step-by-step instructions are grouped by service hours and/or calendar time maintenance intervals. Items in the maintenance schedule are referenced to detailed instructions that follow.

Use service hours to determine intervals. Calendar intervals shown (daily, annually, etc) may be used instead of service meter intervals if they provide more convenient schedules and approximate the indicated service meter reading.

Recommended service should always be performed at the service hour interval. The actual operating environment of the engine also governs the maintenance schedule. Therefore, under extremely severe, dusty, wet or freezing cold operating conditions, more frequent lubrication and maintenance than is specified in the maintenance schedule may be necessary.

The maintenance schedule items are organized for a preventive maintenance management program. If the preventive maintenance program is followed, a periodic tune-up is not required. The implementation of a preventive maintenance management program should minimize operating costs through cost avoidances resulting from reductions in unscheduled downtime and failures.

#### **Maintenance Intervals**

Perform maintenance on items at multiples of the original requirement. Each level and/or individual items in each level should be shifted ahead or back depending upon your specific maintenance practices, operation and application. We recommend that the maintenance schedules be reproduced and displayed near the engine as a convenient reminder. We also recommend that a maintenance record be maintained as part of the engine's permanent record.

See the section in the Operation and Maintenance Manual, "Maintenance Records" for information regarding documents that are generally accepted as proof of maintenance or repair. Your authorized Caterpillar dealer can assist you in adjusting your maintenance schedule to meet the needs of your operating environment.

# California Proposition 65 Warning

Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.

#### **Overhaul**

Major engine overhaul details are not covered in the Operation and Maintenance Manual except for the interval and the maintenance items in that interval. Major repairs are best left to trained personnel or an authorized Caterpillar dealer. Your Caterpillar dealer offers a variety of options regarding overhaul programs. If you experience a major engine failure, there are also numerous after failure overhaul options available from your Caterpillar dealer. Consult with your dealer for information regarding these options.

# **Safety Section**

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# **Safety Messages**

SMCS Code: 1000: 7405

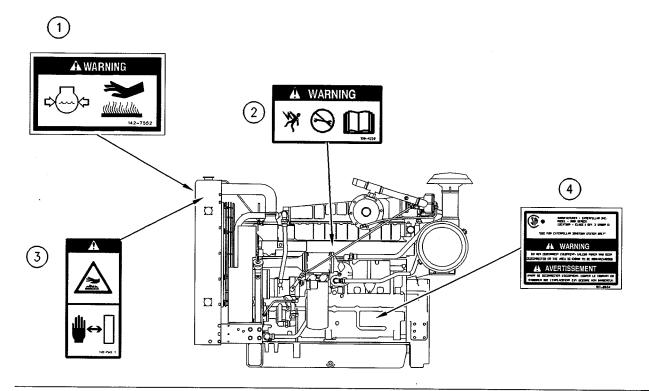


Illustration 1 G3306 engine g00904648

There may be several specific safety messages on an engine. The exact location of the safety messages and the description of the safety messages are reviewed in this section. Please become familiar with all safety messages.

Ensure that all of the safety messages are legible. Clean the safety messages or replace the safety messages if the words cannot be read or if the illustrations are not visible. When the safety messages are cleaned, use a cloth, water, and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the safety signs. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the safety messages. The safety messages that are loosened could drop off of the engine.

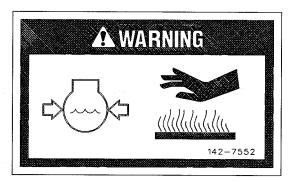
Replace any safety messages that are damaged or missing. If a safety message is attached to a part of the engine that is replaced, install a new safety message on the replacement part. Any Caterpillar dealer can provide new safety messages.

# **WARNING**

Do not operate or work on this engine unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings could result in injury or death. Contact any Caterpillar dealer for replacement manuals. Proper care is your responsibility.

# (1) Coolant Under Pressure / Hot Surface

The warning label for the coolant under pressure and the hot surface is located near the top of the radiator on the front.



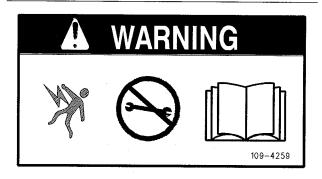
g00107971

#### **WARNING**

The coolant is hot and the coolant is under pressure. Do not touch the hot surfaces. Refer to the Operation and Maintenance Manual for the procedure to follow when you check the radiator.

# (2) Electrical Shock

The warning labels for electrical shock are located on the valve covers on each side of the engine near the center.



g00305892

#### **A WARNING**

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

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

# (3) Hot Surface / Do Not Touch!

The warning label for hot surface / do not touch is located on both sides of the radiator.



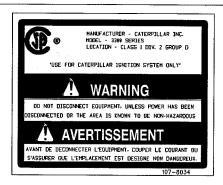
g00905976

#### **WARNING**

Hot surface! Do not touch!

# (4) CSA Hazardous Atmosphere

The warning label for the Canadian Standards Association (CSA) hazardous atmosphere is located on the left side of the G3306 engine on a flat surface.



g00524055

#### **WARNING**

Do not disconnect equipment unless power has been disconnected or the area is known to be non-hazardous

Approval by the CSA is a requirement for engines that operate in hazardous locations. Volatile flammable gases are present in these locations. The gases are normally confined within closed systems. The gases can only escape if the system accidentally breaks down. The CSA warning is intended to prevent a hazardous atmosphere from igniting.

Volatile flammable gas that is contacted by a spark will cause an explosion. This could result in personal injury or death. Also, property could be damaged.

Do not disconnect electrical equipment unless the power has been disconnected. Otherwise, ensure that the atmosphere is not hazardous.

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# **General Hazard Information**

SMCS Code: 1000; 4450; 7405

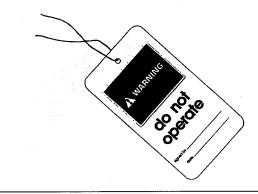


Illustration 2

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Attach a "Do Not Operate" warning tag or a similar warning tag to the start switch or to the controls before the engine is serviced or before the engine is repaired. These warning tags (Special Instruction, SEHS7332) are available from your Caterpillar dealer. Attach the warning tags to the engine and to each operator control station. When it is appropriate, disconnect the starting controls.

Do not allow unauthorized personnel on the engine, or around the engine when the engine is being serviced.

Engine exhaust contains products of combustion which may be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is in an enclosed area, vent the engine exhaust to the outside.

Cautiously remove the following parts. To help prevent spraying or splashing of pressurized fluids, hold a rag over the part that is being removed.

- Filler caps
- · Grease fittings
- Pressure taps
- Breathers
- Drain plugs

Use caution when cover plates are removed. Gradually loosen, but do not remove the last two bolts or nuts that are located at opposite ends of the cover plate or the device. Before removing the last two bolts or nuts, pry the cover loose in order to relieve any spring pressure or other pressure.

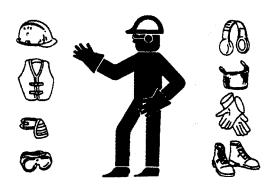


Illustration 3

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- Wear a hard hat, protective glasses, and other protective equipment, as required.
- When work is performed around an engine that is operating, wear protective devices for ears in order to help prevent damage to hearing.
- Do not wear loose clothing or jewelry that can snag on controls or on other parts of the engine.
- Ensure that all protective guards and all covers are secured in place on the engine.
- Never put maintenance fluids into glass containers.
   Glass containers can break.
- · Use all cleaning solutions with care.
- · Report all necessary repairs.

# Unless other instructions are provided, perform the maintenance under the following conditions:

- The engine is stopped. Ensure that the engine cannot be started.
- Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads in order to help prevent sparks.
- Do not attempt any repairs that are not understood.
   Use the proper tools. Replace any equipment that is damaged or repair the equipment.

#### **California Proposition 65 Warning**

Some engine exhaust constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

#### **Pressure Air and Water**

Pressurized air and/or water can cause debris and/or hot water to be blown out. This could result in personal injury.

When pressure air and/or pressure water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield.

The maximum air pressure for cleaning purposes must be below 205 kPa (30 psi). The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

#### Fluid Penetration

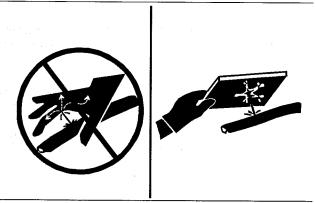


Illustration 4

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Always use a board or cardboard when you check for a leak. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

# **Containing Fluid Spillage**

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

Refer to Special Publication, NENG2500, "Tools and Shop Products Guide" for the following items:

- Tools that are suitable for collecting fluids and equipment that is suitable for collecting fluids
- Tools that are suitable for containing fluids and equipment that is suitable for containing fluids

Obey all local regulations for the disposal of liquids.

#### **Asbestos Information**

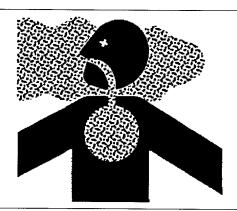


Illustration 5

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Caterpillar equipment and replacement parts that are shipped from Caterpillar are asbestos free. Caterpillar recommends the use of only genuine Caterpillar replacement parts. Use the following guidelines when you handle any replacement parts that contain asbestos or when you handle asbestos debris.

Use caution. Avoid inhaling dust that might be generated when you handle components that contain asbestos fibers. Inhaling this dust can be hazardous to your health. The components that may contain asbestos fibers are brake pads, brake bands, lining material, clutch plates, and some gaskets. The asbestos that is used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous unless airborne dust that contains asbestos is generated.

If dust that may contain asbestos is present, there are several guidelines that should be followed:

- Never use compressed air for cleaning.
- Avoid brushing materials that contain asbestos.
- · Avoid grinding materials that contain asbestos.
- Use a wet method in order to clean up asbestos materials.
- A vacuum cleaner that is equipped with a high efficiency particulate air filter (HEPA) can also be used.
- Use exhaust ventilation on permanent machining jobs.
- Wear an approved respirator if there is no other way to control the dust.

- Comply with applicable rules and regulations for the work place. In the United States, use Occupational Safety and Health Administration (OSHA) requirements. These OSHA requirements can be found in "29 CFR 1910.1001".
- Obey environmental regulations for the disposal of asbestos.
- Stay away from areas that might have asbestos particles in the air.

#### **Dispose of Waste Properly**

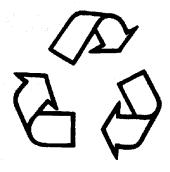


Illustration 6

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Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of according to local regulations.

Always use leakproof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

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# **Burn Prevention**

SMCS Code: 1000; 4450; 7405

Do not touch any part of an operating engine. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the hydraulic system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings or related items are disconnected.

#### Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check the coolant level after the engine has stopped and the engine has been allowed to cool.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly in order to relieve pressure.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

#### Oils

Hot oil and hot lubricating components can cause personal injury. Do not allow hot oil to contact the skin. Also, do not allow hot components to contact the skin.

#### **Batteries**

Electrolyte is an acid. Electrolyte can cause personal injury. Do not allow electrolyte to contact the skin or the eyes. Always wear protective glasses for servicing batteries. Wash hands after touching the batteries and connectors. Use of gloves is recommended.

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# Fire Prevention and Explosion Prevention

SMCS Code: 1000; 4450; 7405



Illustration 7

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All fuels, most lubricants, and some coolant mixtures are flammable.

Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. Fire may cause personal injury and property damage.

A flash fire may result if the covers for the engine crankcase are removed within fifteen minutes after an emergency shutdown.

Determine whether the engine will be operated in an environment that allows combustible gases to be drawn into the air inlet system. These gases could cause the engine to overspeed. Personal injury, property damage, or engine damage could result.

If the application involves the presence of combustible gases, consult your Caterpillar dealer for additional information about suitable protection devices.

Remove all flammable materials such as fuel, oil, and debris from the engine. Do not allow any flammable materials to accumulate on the engine.

Store fuels and lubricants in properly marked containers away from unauthorized persons. Store oily rags and any flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.

Do not expose the engine to any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil or fuel spray in case of a line, a hose, or a seal failure. Exhaust shields must be installed correctly.

Do not weld on lines or tanks that contain flammable fluids. Do not flame cut lines that contain flammable fluid. Clean any such lines thoroughly with a nonflammable solvent prior to welding or flame cutting.

Wiring must be kept in good condition. All electrical wires must be properly routed and securely attached. Check all electrical wires daily. Repair any wires that are loose or frayed before you operate the engine. Clean all electrical connections and tighten all electrical connections.

Eliminate all wiring that is unattached or unnecessary. Do not use any wires or cables that are smaller than the recommended gauge. Do not bypass any fuses and/or circuit breakers.

Arcing or sparking could cause a fire. Secure connections, recommended wiring, and properly maintained battery cables will help to prevent arcing or sparking.

Inspect all lines and hoses for wear or for deterioration. The hoses must be properly routed. The lines and hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

Oil filters and fuel filters must be properly installed. The filter housings must be tightened to the proper torque.



Illustration 8

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Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter or a hydrometer.

Improper jumper cable connections can cause an explosion that can result in injury. Refer to the Operation Section of this manual for specific instructions.

Do not charge a frozen battery. This may cause an explosion.

The batteries must be kept clean. The covers (if equipped) must be kept on the cells. Use the recommended cables, connections, and battery box covers when the engine is operated.

# Fire Extinguisher

Make sure that a fire extinguisher is available. Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Obey the recommendations on the instruction plate.

#### Lines, Tubes and Hoses

Do not bend high pressure lines. Do not strike high pressure lines. Do not install any lines that are bent or damaged.

Repair any lines that are loose or damaged. Leaks can cause fires. Consult your Caterpillar dealer for repair or for replacement parts.

Check lines, tubes and hoses carefully. Do not use your bare hand to check for leaks. Use a board or cardboard to check for leaks. Tighten all connections to the recommended torque.

Replace the parts if any of the following conditions are present:

- End fittings are damaged or leaking.
- · Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are ballooning.
- Flexible part of the hoses are kinked.
- · Outer covers have embedded armoring.
- End fittings are displaced.

Make sure that all clamps, guards, and heat shields are installed correctly. During engine operation, this will help to prevent vibration, rubbing against other parts, and excessive heat.

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# **Crushing Prevention and Cutting Prevention**

SMCS Code: 1000; 4450; 7405

Support the component properly when work beneath the component is performed.

Unless other maintenance instructions are provided, never attempt adjustments while the engine is running.

Stay clear of all rotating parts and of all moving parts. Leave the guards in place until maintenance is performed. After the maintenance is performed, reinstall the guards.

Keep objects away from moving fan blades. The fan blades will throw objects or cut objects.

When objects are struck, wear protective glasses in order to avoid injury to the eyes.

Chips or other debris may fly off objects when objects are struck. Before objects are struck, ensure that no one will be injured by flying debris.

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# **Mounting and Dismounting**

SMCS Code: 1000; 4450; 7405

Inspect the steps, the handholds, and the work area before mounting the engine. Keep these items clean and keep these items in good repair.

Mount the engine and dismount the engine only at locations that have steps and/or handholds. Do not climb on the engine, and do not jump off the engine.

Face the engine in order to mount the engine or dismount the engine. Maintain a three-point contact with the steps and handholds. Use two feet and one hand or use one foot and two hands. Do not use any controls as handholds.

Do not stand on components which cannot support your weight. Use an adequate ladder or use a work platform. Secure the climbing equipment so that the equipment will not move.

Do not carry tools or supplies when you mount the engine or when you dismount the engine. Use a hand line to raise and lower tools or supplies.

i00998909

# **Ignition Systems**

SMCS Code: 1550

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

# **Magneto**

The storage capacitor in a breakerless magneto can be charged by turning the magneto by hand. The storage capacitor can be charged even when the wiring harness is disconnected from the magneto.

If the ignition switch is in the ON position and the wiring harness is being connected, the storage capacitor may discharge and a spark plug will ignite. The spark plug will ignite any gas that has accumulated in that cylinder. The crankshaft and the driven equipment can move. Personal injury may result. The driven equipment could be damaged. Gas that has accumulated in the exhaust system can also be ignited.

Before connecting the wiring harness to a breakerless magneto, discharge the storage capacitor to the ground. Use the following procedure to discharge the storage capacitor:

- 1. Attach one end of a wire to the magneto housing.
- 2. Contact the other end of the wire to the connector pins for the wiring harness that is on the magneto.

You will hear a "snap" when the storage capacitor discharges.

3. Ground all of the connector pins.

This will ensure that no charge is in the magneto. Some breakerless magnetos have more than one storage capacitor.

Turn the ignition switch to the OFF position before connecting the wiring harness. If the ignition switch is in the OFF position, the storage capacitor is immediately discharged to the ground when the wiring harness is connected to the magneto.

i00659904

# **Before Starting Engine**

SMCS Code: 1000

Inspect the engine for potential hazards.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

Ensure that the engine is equipped with a lighting system that is suitable for the conditions. Ensure that all lights work properly.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided in order to help prevent personal injury. The circuits are also provided in order to help prevent engine damage.

On the initial start-up of a new engine or an engine that has been serviced, be prepared to stop the engine if an overspeed condition occurs. This may be accomplished by shutting off the fuel supply to the engine, or shutting off the ignition system.

See the Service Manual for repairs and for adjustments.

i02136012

# **Engine Starting**

SMCS Code: 1000

If a warning tag is attached to the engine start switch or to the controls, DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

If there is a possibility that unburned gas remains in the exhaust system, refer to the purge procedure in this Operation and Maintenance Manual, "Engine Starting" topic in the Operation Section.

Start the engine from the operator's compartment or from the engine start switch.

Always start the engine according to the procedure that is described in the Operation and Maintenance Manual, "Engine Starting" topic in the Operation Section. Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working properly, check the water temperature and the oil temperature during heater operation.

Engine exhaust contains products of combustion which can be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

i00659907

# **Engine Stopping**

SMCS Code: 1000

To avoid overheating of the engine and accelerated wear of the engine components, stop the engine according to the instructions in this Operation and Maintenance Manual, "Engine Stopping" topic (Operation Section).

Use the Emergency Stop Button (if equipped) ONLY in an emergency situation. Do not use the Emergency Stop Button for normal engine stopping. After an emergency stop, DO NOT start the engine until the problem that caused the emergency stop has been corrected.

On the initial start-up of a new engine or an engine that has been serviced, make provisions to stop the engine if an overspeed occurs. This may be accomplished by shutting off the fuel supply to the engine, or shutting off the ignition system.

Rubber couplings may connect the steel piping of the cooling system and the radiator. This causes the piping and the radiator to be electrically isolated. Ensure that the piping and the radiator is continuously grounded to the engine. Use ground straps that bypass the rubber couplings.

Ensure that all grounds are secure and free of corrosion.

i00887114

# **Electrical System**

SMCS Code: 1000; 1400

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operating. A spark can cause the combustible gases that are produced by some batteries to ignite.

Check the electrical wires daily for wires that are loose or frayed. Tighten all loose electrical wires before the engine is operated. Repair all frayed electrical wires before the engine is started.

# **Grounding Practices**

Proper grounding is necessary for optimum engine performance and reliability. Improper grounding will result in uncontrolled electrical circuit paths and in unreliable electrical circuit paths.

Uncontrolled electrical circuit paths can result in damage to main bearings, to crankshaft journal surfaces, and to aluminum components. Uncontrolled electrical circuit paths can also cause electrical activity that may degrade the engine electronics and communications.

For the starting motor, do not attach the battery negative terminal to the engine block.

Use a ground strap to ground the case of all control panels to the engine block.

Ground the engine block with a ground strap that is furnished by the customer. Connect this ground strap to the ground plane.

Use a separate ground strap to ground the battery negative terminal for the control system to the ground plane.

# **Product Information Section**

# Model Views and **Specifications**

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# **Model View Illustrations**

SMCS Code: 1000; 4450

The illustrations show various typical features of G3300 Engines. The illustrations do not show all of the options that are available.

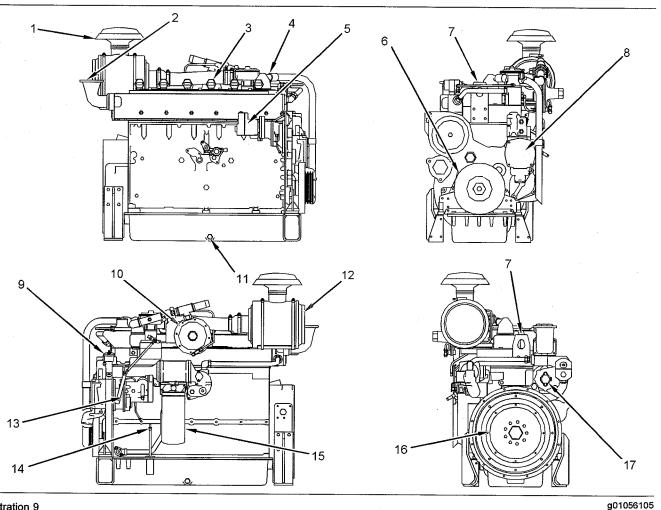


Illustration 9

Naturally aspirated engine

- (1) Air inlet
- (2) Exhaust
- (3) Ignition transformer
- (4) Crankcase breather
- (5) Magneto
- (6) Crankshaft vibration damper
- (7) Lifting eye
- (8) Water pump
- (9) Oil filler
- (10) Gas pressure regulator
- (11) Oil drain
- (12) Air cleaner

- (13) Governor
- (14) Oil level gauge (dipstick) (15) Oil filter
- (16) Flywheel
- (17) Service hour meter

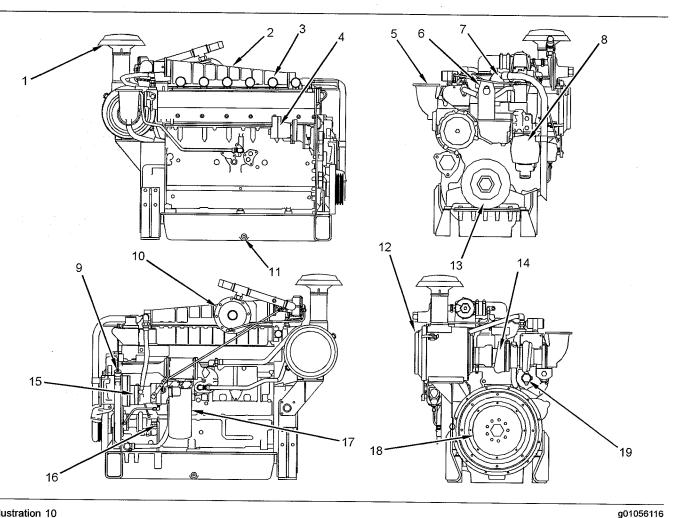


Illustration 10

Turbocharged engine with a separate circuit aftercooler

- (1) Air inlet
- (2) Aftercooler
- (3) Ignition transformer
- (4) Magneto
- (5) Exhaust
- (6) Lifting eye
- (7) Crankcase breather

- (8) Water pump
- (9) Oil filler
- (10) Gas pressure regulator
- (11) Oil drain
- (12) Air cleaner
- (13) Crankshaft vibration damper
- (14) Turbocharger

- (15) Governor
- (16) Oil level gauge (dipstick)
- (17) Oil filter
- (18) Flywheel
- (19) Service hour meter

i02061007

# **Product Description**

SMCS Code: 1000: 4450

Caterpillar G3304 and G3306 Engines were developed in order to provide gas engines for industrial applications and for generator set applications. The engines have the ability to burn a wide variety of gaseous fuels.

# **Ignition System**

The ignition system has five basic components: magneto, an ignition transformer for each cylinder, wiring harness, spark plugs, and control panel.

The magneto generates the electric current that is necessary for spark ignition. The current from the magneto travels through the wiring harness to the ignition transformer. The transformer increases the voltage. The transformer creates an electrical impulse that arcs across the electrodes of the spark plug. Engine operation is monitored by the control panel.

# Inlet Air and Fuel System

Inlet air is filtered by an air cleaner. The G3304 Engine is naturally aspirated. Naturally aspirated G3306 Engines are also available.

G3306 Engines are also available with these types of aspiration: turbocharged, turbocharged with separate circuit aftercooling, and turbocharged with air-to-air aftercooling.

For turbocharged engines, the inlet air is compressed by the turbocharger. The turbocharger is driven by the engine exhaust. The air is cooled in an aftercooler (if equipped) after the air enters the carburetor. The compressed air becomes more dense from being cooled. This provides more oxygen for combustion.

Air is mixed with fuel in the carburetor before combustion. The carburetor is controlled by a governor. The governor efficiently maintains the engine rpm that is selected by the operator.

The valves and the valve mechanism control the flow of air and exhaust gases in the cylinder during engine operation. Each cylinder has one inlet valve and one exhaust valve. The camshaft actuates the rocker arms and valves through mechanical lifters and pushrods.

#### **Lubrication System**

The engine lubrication oil is circulated by a gear-driven pump. The oil is cooled and the oil is filtered. However, bypass valves provide an unrestricted flow of lubrication oil to the engine if the following conditions occur:

- The viscosity of the oil is high because the oil is cold.
- The oil cooler becomes plugged.
- · The oil filter becomes plugged.

# **Cooling System**

The jacket water coolant is circulated by a gear-driven centrifugal pump. A 90 °C (194 °F) temperature regulator regulates the temperature of the coolant. Heat can be removed from the coolant by a radiator or a heat exchanger.

For engines with a Separate Circuit Aftercooler (SCAC), the air is cooled by a heat exchanger. The water that cools the air in the heat exchanger is in a circuit that is separate from the jacket water. The aftercooler coolant is pumped by an auxiliary water pump. The SCAC is required to operate at one of the following temperatures. The engine rating depends on the temperature and the application.

- 32 °C (90 °F)
- 54 °C (129 °F)

For engines with air-to-air aftercooling, the aftercooler is supplied by the customer. This aftercooler is similar to a radiator. The inlet air is cooled by a fan that moves the ambient air through the radiator.

#### **Engine Service Life**

Engine efficiency and maximum utilization of engine performance depend on adherence to proper operation and maintenance recommendations. This includes the use of recommended lubricants, fuels, and coolants.

For the engine maintenance that is required, refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).

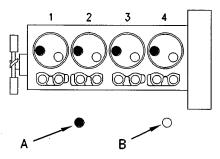
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# **Specifications**

SMCS Code: 1000

Table 1

G3304 Engine Specifications		
Cylinders and arrangement	4 in-line	
Aspiration	Naturally Aspirated	
Bore	121 mm (4.75 inch)	
Stroke	152 mm (6 inch)	
Total displacement	7 L (425 cubic inch)	
Firing order	1-3-4-2	
Rotation (flywheel end)	Counterclockwise	
Inlet valve lash	.38 mm (.015 inch)	
Exhaust valve lash	.76 mm (.030 inch)	



g00511194

Illustration 11

G3304 Engine design

- (A) Exhaust valves
- (B) Inlet valves

Table 2

G3306 Engine Specifications		
Cylinders and Arrangement	6 in-line	
Aspiration	Naturally Aspirated	
	Turbocharged	
	Turbocharged with Jacket Water Aftercooling	
	Turbocharged with Separate Circuit Aftercooling	
Bore	121 mm (4.75 inch)	
Stroke	152 mm (6 inch)	
Total displacement	10.5 L (638 cubic inch)	
Firing order	1-5-3-6-2-4	
Rotation (flywheel end)	Counterclockwise	
Inlet valve lash	.38 mm (.015 inch)	
Exhaust valve lash	.76 mm (.030 inch)	

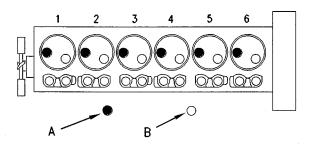


Illustration 12 G3306 Engine design

(A) Exhaust valves (B) Inlet valves

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# Product Identification Information

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# Plate Locations and Film Locations

SMCS Code: 1000: 4450

# **Engine Identification**

Caterpillar engines are identified with serial numbers, with performance specification numbers, and with arrangement numbers. In some of the cases, modification numbers are used. These numbers are shown on the Serial Number Plate and the Information Plate that are mounted on the engine.

Caterpillar dealers need these numbers in order to determine the components that were included with the engine. This permits accurate identification of replacement part numbers.

#### **Serial Number Plate**

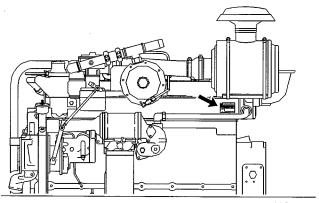


Illustration 13

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Location of the Serial Number Plate

The Serial Number Plate is on the left side of the cylinder block near the rear of the engine.

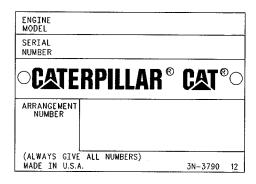


Illustration 14

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The following information is stamped on the Serial Number Plate: engine serial number, model, and arrangement number.

#### Information Plate

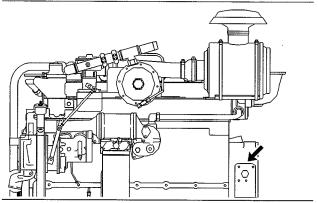


Illustration 15

g00513136

Location of the Information Plate

The Information Plate is on the top surface of the flywheel housing above the timing window.

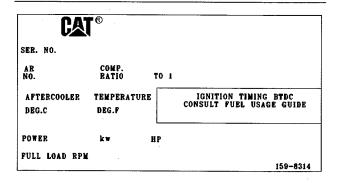


Illustration 16

g00361974

Typical Information Plate

The following information is stamped on the Information Plate: compression ratio, aftercooler temperature, power (kilowatts and horsepower), full load rpm, and other information.

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#### Reference Information

SMCS Code: 1000: 4450

Identification of the items in Table 3 may be needed in order to obtain parts and service. Some of the numbers are on the engine Serial Number Plate and/or Information Plate. Locate the information for your engine. Record the information on the appropriate space in Table 3. Make a copy of this list for a record. Retain the information for future reference.

The top level part numbers in the Parts Manual for the engine are listed with the engine arrangement number.

The packaging arrangement may also be called a pricing arrangement or a customer arrangement. This is the total package with attachments and options that are not included in the engine arrangement.

The performance specification can be used by your Caterpillar dealer with the Technical Marketing Information system. Before the engine leaves the factory, the engine performance is tested. Detailed performance data is recorded. The performance specification number can be used for obtaining the data.

#### Table 3

Reference	Numbers
Engine Model	
Serial Number	
Arrangement Number	
Packaging Arrangement	
Turbocharger	
Fuel Filter Element	
Lubrication Oil Filter Element	
Auxiliary Oil Filter Element	****
Air Cleaner Element	
Fan Drive Belt	
Alternator Belt	
Capacity of the Lubrication System	
Oil type	
Capacity of the Cooling System	
Performance Specification Number	
Low Idle rpm	
High Idle rpm	
Full Load rpm	
Power Rating	

# **Operation Section**

# Lifting and Storage

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# **Engine Lifting**

SMCS Code: 1000; 1122

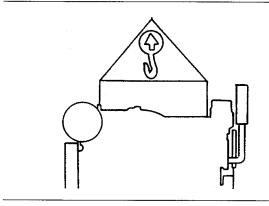


Illustration 17

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#### NOTICE

Never bend the eyebolts and the brackets. Only load the eyebolts and the brackets under tension. Remember that the capacity of an eyebolt is less as the angle between the supporting members and the object becomes less than 90 degrees.

When it is necessary to remove a component at an angle, only use a link bracket that is properly rated for the weight.

Use a hoist to remove heavy components. Use an adjustable lifting beam to lift the engine. All supporting members (chains and cables) should be parallel to each other. The chains and cables should be perpendicular to the top of the object that is being lifted.

Some removals require lifting fixtures in order to obtain proper balance and safety.

To remove the engine ONLY, use the lifting eyes that are on the engine.

Lifting eyes are designed and installed for the specific engine arrangement. Alterations to the lifting eyes and/or the engine make the lifting eyes and the lifting fixtures obsolete. If alterations are made, ensure that proper lifting devices are provided. Consult your Caterpillar dealer for information regarding fixtures for proper engine lifting.

# **Engine Lifting with a Generator**

#### NOTICE

Do not use the engine lifting eyes to remove the engine and generator together.

A lifting plate is provided with the package generator set. Instructions for lifting the package generator set are stamped on the lifting plate.

Consult your Caterpillar dealer for information regarding proper fixtures and lifting devices.

Lifting packaged generator sets will not be level if you lift the unit with a single point lift. A counterweight can be added between the package frame rails whenever the application requires frequent relocation of the unit. For complete information about adding the counterweight, consult your Caterpillar dealer.

The single point lifting eye is secured from the factory before the enclosure is shipped. The correct orientation of the single point lifting eye will allow you to look through the eye when you stand at the side of the enclosure. The lifting eye may stretch when the package is lifted. This may cause the locking nuts to loosen. This could cause the lifting eye to swivel. Ensure that the lifting eye is correctly oriented on the packaged generator set. Ensure that the lifting eye is tightened to the correct torque before you lift the packaged generator set.

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# **Engine Storage**

SMCS Code: 1000

If the engine will not be started for several weeks, the lubricating oil will drain from the cylinder walls and from the piston rings. Rust can form on the cylinder liner surface, which will increase engine wear which can reduce engine service life.

To help prevent excessive engine wear, use the following guidelines:

- Complete all of the lubrication recommendations that are listed in this Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).
- If freezing temperatures are expected, check the cooling system for adequate protection against freezing. See the Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations".

If an engine is out of operation and if use of the engine is not planned, special precautions should be made. If the engine will be stored for more than one month, a complete protection procedure is recommended.

Your Caterpillar dealer will have instructions for preparing the engine for extended storage periods.

For more detailed information on engine storage, see Special Instruction, SEHS9031, "Storage Procedure for Caterpillar Products".

# **Generator Storage**

For information on generator storage, see the literature that is provided by the OEM of the generator. Consult your Caterpillar dealer for assistance.

# **Gauges and Indicators**

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# **Gauges and Indicators**

SMCS Code: 7450

Gauges provide indications of engine performance. Ensure that the gauges are in good working order. Determine the normal operating range by observing the gauges over a period of time.

Noticeable changes in gauge readings can indicate potential gauge or engine problems. Problems may also be indicated by gauge readings that change even if the readings are within specifications. Determine and correct the cause of any significant change in the readings. Consult your Caterpillar dealer for assistance.

Your engine may not have the same gauges or all of the gauges that are described below.

#### NOTICE

If no oil pressure is indicated, STOP the engine. The engine will be damaged from operating without oil pressure.

Engine Oil Pressure – This gauge indicates the pressure of the engine oil. This pressure will be highest after a cold engine is started. The pressure will decrease as the engine warms up. The pressure will increase when the engine rpm is increased. The pressure will stabilize when the engine rpm and temperature are stable.

For G3304 Engines, the typical oil pressure at rated rpm is 280 to 520 kPa (40 to 75 psi).

For G3306 Engines, the typical oil pressure at rated rpm is 240 to 480 kPa (35 to 70 psi).

Oil Filter Differential Pressure – This gauge indicates the difference in pressure between the inlet side and the outlet side of the engine oil filters. As the oil filter elements become plugged, the pressure will increase. Replace the engine oil filter elements when the oil filter differential pressure reaches 103 kPa (15 psi).

Jacket Water Coolant Temperature – This gauge indicates the temperature of the engine coolant at the outlet for the jacket water. The temperature may vary according to the load. The temperature should never be allowed to exceed the boiling temperature of the pressurized cooling system. The operating range is 88 to 98 °C (190 to 205 °F). Higher temperatures may occur under certain conditions.

The engine should operate within the normal temperature range. The sensor for jacket water coolant temperature must be fully submerged in order to detect the temperature correctly. If the engine is operating above the normal temperature range, perform the following procedure:

- 1. Reduce the load and/or the engine rpm.
- 2. Inspect the cooling system for leaks.
- Determine if the engine must be shut down immediately or if the engine can be cooled by reducing the load and/or rpm.



**Inlet Manifold Air Temperature** – This gauge indicates the inlet manifold air temperature to the cylinders.

#### NOTICE

High inlet manifold air temperature increases the risk of detonation. Detonation can cause damage to the engine. Ensure that the aftercooling system is operating properly.

The inlet manifold air temperature depends on the engine's aspiration and the water temperature regulator for the separate circuit aftercooler (if equipped). If the maximum temperature is exceeded, the engine will be unable to provide rated power. Derating occurs at temperatures that are greater than the maximum. See Table 4 for maximum temperatures of different engines.

Maximum Inlet Manifold Air Temperatures for G3300 Engines			
Aspiration	Water Temperature Regulator	Maximum Inlet Manifold Air Temperature	
Naturally aspirated	n/a	25 °C (77 °F) <sup>(1)</sup>	
Air-To-Air Aftercooling	n/a	49 °C (120 °F)	
Separate Circuit Aftercooling	32 °C (90 °F) Ø	43 °C (110 °F)	
Separate Circuit Aftercooling	54 °C (130 °F) <sup>(2)</sup>	65 °C (150 °F)	

- (1) This temperature is for an engine at an altitude of 152 m (500 ft) above sea level. A greater temperature or a higher altitude requires derating.
- (2) Water inlet to the aftercooler



Inlet Manifold Air Pressure (TA **Engines) and Inlet Manifold Vacuum** (NA Engines) - For TA engines, this

gauge indicates the air pressure (turbocharger boost pressure) in the air plenum (air inlet manifold) after the aftercooler. For NA engines, this gauge is the pressure of the inlet manifold vacuum. For all engines, this pressure is relative to the load. This pressure may be used for estimating power output. Several factors affect the inlet manifold air pressure. All of these factors must be accounted for when power is estimated from inlet manifold air pressure: air restriction, exhaust restriction, jacket water coolant temperature, ambient air temperature, variation of the fuel, air/fuel ratio, ignition timing, and condition of the valves.

For more information, see the performance curves in the Engine Performance manual. The manual is available from your Caterpillar dealer.



Tachometer - This gauge indicates the engine rpm.

#### NOTICE

An overspeed can result in serious damage to the engine. To help prevent engine damage, never allow the engine to exceed the rated rpm.

Note: The rated rpm is stamped on the engine Information Plate.



hours.

Service Hour Meter - This meter shows the total number of service meter units that the engine has operated. Table 5 lists the factors for converting service meter units to clock

Table 5

Factors for Converting Service Meter Units to Clock Hours		
Operating Speed	Factor	
Engines That Are Rated From 1000 RPM to 1400 RPM		
1000 rpm	1.200	
1200 rpm	1.000	
1400 rpm	0.857	
Engines That Are Rated From 1500 RPM to 1800 RPM		
1500 rpm	1.200	
1600 rpm	1.125	
1800 rpm	1.000	

For example, an engine that is rated at 1800 rpm has been operating at 1500 rpm. To determine the number of clock hours, multiply the number of service meter units by the correct factor. In this example, one service meter unit is equivalent to 1.2 clock hours.



Fuel Filter Differential Pressure - This gauge is provided by the customer. This gauge indicates the difference in fuel pressure between the inlet side and the outlet side of the fuel filter. As the fuel filter element becomes plugged, the difference in pressure between the two sides of the fuel filter increases.

Service the fuel filter when the fuel filter differential pressure reaches 34 kPa (5 psi).



Air Cleaner Differential Pressure -This gauge indicates the difference in air pressure between the inlet side and the engine side of the air filter element. The pressure is measured from the turbocharger air inlet. As the

air filter element becomes plugged, the difference in pressure between the two sides of the air cleaner element will increase. For optimum engine performance, replace the air cleaner elements when the air cleaner differential pressure reaches 4 kPa (15 inches of H<sub>2</sub>O). Maximum air cleaner differential pressure is 7.5 kPa (30 inches of H<sub>2</sub>O).

Ammeter - This gauge indicates the amount of charge or discharge in the battery charging circuit. Operation of the indicator should be to the right side of "0"(zero).



Engine Oil Temperature - This gauge indicates the engine oil temperature after the oil has passed through the oil cooler.

The maximum oil temperature at rated rpm and rated load is 110 °C (230 °F).

The engine oil is cooled by the jacket water. If the cooling system cannot remove the heat from the jacket water, the oil will not cool properly. Oil will degrade rapidly at temperatures above 99 °C (210 °F). Oil temperatures that are higher than normal indicate a problem in the lubrication system and/or in the cooling system. This can damage these components: cylinder heads, cylinder liners, pistons, and crankshaft bearings.

# **Features and Controls**

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#### **Performance Parameters**

SMCS Code: 1000

Note: Refer to the Service Manual, "Systems Operation/Testing and Adjusting" or Special Instruction, REHS0371, "Installation and Initial Start-Up Procedure for G3300 & G3400 Engines" for information on the following topics:

- Adjusting the carburetor
- · Adjusting the control linkage for the carburetor
- Adjusting the exhaust bypass

Consult your Caterpillar dealer for assistance.

#### Air/Fuel Ratio

The correct air/fuel ratio is very important for the following considerations:

- Margin of detonation
- · Control of emissions
- Achieving optimum service life for the engine

If the air/fuel ratio is not appropriate for the fuel and the operating conditions, a failure of the engine may occur. The service life of the turbocharger, the valves, and other components may be reduced.

#### **Fuel Supply Pressure**

Fluctuations of the fuel pressure can change the air/fuel ratio. The maximum fluctuation that is allowed in the fuel pressure is 3.4 kPa (0.50 psi). Ensure a stable fuel pressure to the engine by installing a second gas pressure regulator prior to the gas pressure regulator on the engine.

Table 6 lists the fuel pressure that is required for the gas pressure regulator.

Table 6

Requirements for Fuel Pressure To the Gas Pressure Regulator		
Fuel System	Pressure	
Low pressure gas	10.3 to 34 ± 2 kPa 1.50 to 5 ± 0.25 psi	
High pressure gas	172 to 207 ± 7 kPa 25 to 30 ± 1 psi	

#### **Gas Pressure Regulator**

The gas pressure regulator maintains a pressure differential between the air and the fuel that is supplied to the carburetor. Set the pressure of the fuel supply to a maximum of 1 to 1.2 kPa (4 to 4.5 inches of  $H_2O$ ) higher than the pressure of the air supply. The gas pressure regulator will maintain the pressure differential in response to changes in the air pressure, if the gas pressure regulator is installed properly.

A water manometer is used to measure the pressure differential. This measurement is taken when the engine is operating at high idle rpm. After a load is applied, the fuel pressure will usually decrease by approximately 0.1 to 0.25 kPa (0.50 to 1 inches of  $H_2O$ ). If the performance of the gas pressure regulator is erratic, the gas pressure regulator may require service.

#### **Temperature of the Fuel Supply**

Changes in the temperature of the fuel supply affects the air/fuel ratio. Warmer fuel is less dense than cold fuel. This results in a leaner mixture that causes a noticeable reduction of power.

#### **Temperature of the Air Supply**

Changes in the temperature of the air supply affects the air/fuel ratio. In addition to seasonal changes, the air temperature changes overnight. Control of the temperature in the engine room will help to maintain the air/fuel ratio.

To optimize the inlet air temperature, use ducting and a heat exchanger. This will help to avoid exposure to hot air from a generator. For more information, refer to Application and Installation Guide, LEKQ7250, "Air Intake". Consult your Caterpillar dealer for assistance.

# **Angle of the Throttle Plate**

On turbocharged engines, the angle of the throttle plate is adjusted for full load operation. The angle is adjusted by changing the setting of the exhaust bypass valve, if equipped. The proper angle at full load is 70 degrees.

The following factors affect the angle of the throttle:

- LHV of the fuel
- Setting of the air/fuel ratio (inlet manifold air pressure)
- Setting of the exhaust bypass (if equipped)

Altitude

Ensure that the angle of the throttle plate is properly set. This will maintain the margin for detonation. This will also enable the engine to accept load changes without lugging.

# **Exhaust Bypass (Wastegate)**

Some turbocharged engines are equipped with exhaust bypass valves that are adjustable. This enables the throttle position to be correctly set for the application. Adjustments must be made for the following variables:

- Altitude
- Setting of the air/fuel ratio
- Methane number of the fuel

The exhaust bypass is adjusted in order to achieve the proper angle of the throttle plate when the engine is operating under a rated load. The exhaust bypass will also limit the power output if the exhaust bypass is set properly for the given ambient conditions.

Some engines only have a boost limit valve that is not adjustable.

# **Oil Consumption**

Low loads will cause the engine to consume more oil.

The rate of oil consumption is called the Brake Specific Oil Consumption (BSOC). The unit of measure is grams per brake kilowatt hour or pounds per brake horsepower hour. The BSOC depends on the following factors: engine model, aspiration, and operating load.

Consult your Caterpillar dealer for information on your engine's BSOC.

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# **Alarms and Shutoffs**

SMCS Code: 7400

This section contains some general information about typical engine protective devices.

The operation of all alarms and shutoffs utilize components which are actuated by a sensing unit. The alarms and shutoffs are set at critical operating temperatures, pressures, or speeds in order to protect the engine from damage.

Alarms function in order to warn the operator when an abnormal operating condition occurs. Shutoffs function in order to shut down the engine when a more critical abnormal operating condition occurs. The shutoffs help to prevent damage to the equipment.

If an engine protective device shuts off the engine, always determine the cause of the shutoff. Make the necessary repairs before attempting to start the engine.

Shutoffs may cause unburned gas to remain in the air inlet and in the exhaust manifold.

#### **WARNING**

Unburned gas in the air inlet and exhaust system may ignite when the engine is started. Personal injury and/or property damage may result.

Before starting an engine that may contain unburned gas, purge the unburned gas from the air inlet and exhaust system. Refer to the topic on purging unburned gas in the "Starting the Engine" section.

Become familiar with the following information:

- Types of the alarm and shutoff controls
- · Locations of the alarm and shutoff controls
- Conditions which cause each control to function
- Resetting procedure that is required before starting the engine

On G3300 Engines, protective devices are available for the following conditions:

- · Low oil pressure
- · High coolant temperature
- Overspeed
- · Low coolant level

Further protection is supplied by an emergency stop button.

Three basic protection systems are available:

- Self-powered shutoff
- Automatic start/stop system
- · Customer supplied shutoff

**Note:** For an energize-to-shutoff system, the gas shutoff valve must be energized to shut off gas to the engine. For an energize-to-run system, the gas shutoff valve must be energized in order to supply gas to the engine.

Power for the self-powered system is supplied by the magneto. The self-powered system can be used with an air starting motor or an electric starting motor. An energize-to-shutoff gas valve and an instrument panel are required for this system.

Power for the automatic start/stop system is supplied by an external 24 volt electrical source. The automatic start/stop system can be used with an air starting motor or an electric starting motor. An energize-to-run gas valve and one of these controls are required:

- Automatic start/stop switchgear
- · Engine Control Logic

For the customer supplied shutoff system, the customer must supply all of the wiring and the shutoffs. This includes the emergency stop button and wiring.

The features of the shutoff systems are listed in Table 7.

Table 7

G3300 Engine Protective Systems			
ltem	Type of System		
	Self- Powered	Automatic Start/Stop	Customer Supplied
High coolant temperature	Yes	Yes	Yes
Low oil pressure	Yes	Yes	Yes
Overspeed	No (2)	Yes	Yes
High inlet manifold air temperature	No	No	Yes <sup>(3)</sup>
High aftercooler water temperature	No	No	Yes <sup>(3)</sup>
Emergency stop	Yes	Yes	Yes

<sup>(1)</sup> The customer is responsible for supplying the shutoffs and the wiring.

#### **Sensing Devices**

The sensing devices that are described in this section are typical. The devices may be in different locations for different applications. Also, different applications may have different devices.

Engines that use different generator set control panels will have different sensing devices.

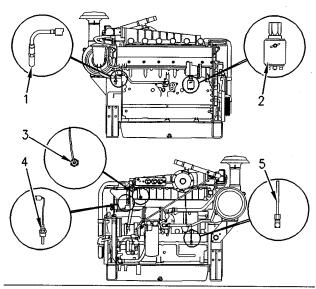


Illustration 18

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- (1) Speed sensor
- (2) Overspeed contactor
- (3) Air temperature switch (aftercooler)
- (4) Coolant temperature switch
- (5) Oil line

#### Overspeed

Speed sensor (1) (Illustration 18) helps to monitor the engine rpm. The speed sensor senses the motion of the flywheel ring gear. The speed sensor is used with a tachometer in order to display the engine rpm.

The speed sensor can also be used with an electrical overspeed switch. An external power source of 24 volts DC is required.

<sup>(2)</sup> Overspeed protection is available as an option.

<sup>(3)</sup> The customer is responsible for supplying the protection for either high inlet manifold temperature or high aftercooler water temperature.

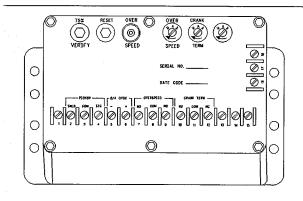


Illustration 19

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Overspeed switch

The overspeed switch is mounted in the junction box. The recommended setpoint is 110 percent of the rated rpm. If an overspeed occurs, the "RESET" button on the switch must be reset before the engine can be started.

The switch also has a "VERIFY" button. The button enables the operation of the switch to be tested at 75 percent of the rated rpm.

Overspeed contactor (2) (Illustration 18) can be installed behind the magneto on the tachometer drive. The overspeed contactor is an mechanical device. Excessive engine rpm activates the contactor with centrifugal force.

#### **Temperature**

Air temperature switch (3) (Illustration 18) for the aftercooler is installed in the housing of the aftercooler. The shutoff is supplied by the customer.

Coolant temperature switch (4) (Illustration 18) is located next to the housing for the water temperature regulator. An excessive water temperature will activate a shutdown. The setpoint that is recommended for a high coolant temperature shutdown is 104 °C (220 °F).

#### Oil Pressure

Oil lines (5) (Illustration 18) for sending oil pressure can be located in various places on the side of the engine block. The oil lines are connected to the bearing oil gallery. The oil lines can be connected to these different components:

- Instrument panel
- Junction box
- · Oil pressure switch

Low oil pressure will activate a shutoff. The recommended setpoint for low oil pressure is 55 kPa (8 psi).

#### **Coolant Level**

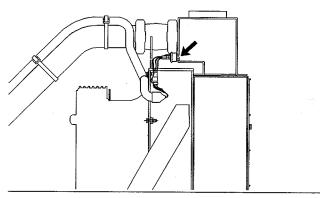


Illustration 20

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Coolant loss sensor

The coolant loss sensor is an optional feature. The sensor is usually mounted near the top of the radiator. A lack of sufficient coolant can activate an alarm or a shutoff. Coolant must be added to the cooling system in order to correct the condition.

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# **Governors and Actuators**

SMCS Code: 1264

**Isochronous** – The engine rpm remains constant from high idle at no load to full load operation. This is known as zero percent droop.

**Droop** – Droop represents a decrease in rpm from high idle at no load to full load operation.

The governor controls the engine rpm. For detailed information on governor operation, see the Service Manual, "Systems Operation/Testing and Adjusting" module.

#### **Woodward PSG Governor**

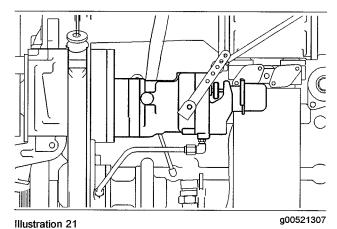


illustration 21

Woodward PSG Governor

The Woodward PSG Governor is the standard governor for G3306 Generator Set Engines. This hydraulic governor can be used in the droop mode or in the isochronous mode. A 24 volt DC motor is optional for remote speed control. The governor is lubricated with oil from the engine lubrication system.

# Mechanical governor

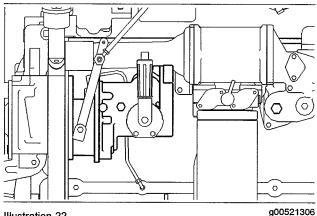


Illustration 22

g0052130

Mechanical governor with manual control

The mechanical governor is the standard governor for G3304 and G3306 Industrial Engines. This governor is manually operated. The governor has approximately seven percent droop at 1800 rpm. Springs can be ordered in order to reduce the droop, if necessary. The governor cannot be used for isochronous operation. The governor is lubricated with oil from the engine lubrication system.

# **Engine Starting**

i02155494

# **Before Starting Engine**

SMCS Code: 1000; 1400; 1450

**Note:** Certain procedures are required before an engine is started for the first time. Refer to the Special Instruction, REHS0371, "Installation and Initial Start-Up Procedure for G3300 and G3400 Engines".

Perform the required daily maintenance and other periodic maintenance before starting the engine. This can prevent major repairs at a later date. Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).

# Walk-Around Inspection

#### NOTICE

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

To obtain maximum service life for your engine, make a thorough inspection before starting the engine. Make a walk-around inspection of the installation. Look for items such as oil or coolant leaks, loose bolts and trash buildup. Remove any trash. Make repairs, if necessary.

- Inspect the drive belts for cracks and wear.
- The guards must be in the proper place. Repair damaged guards or replace missing guards.
- Ensure that the areas around the rotating parts are clear.

# **Air Inlet System**

# **WARNING**

Unburned gas in the air inlet and exhaust system may ignite when the engine is started. Personal injury and/or property damage may result.

Before starting an engine that may contain unburned gas, purge the unburned gas from the air inlet and exhaust system. Refer to the topic on purging unburned gas in the "Starting the Engine" section.

- Ensure that the air inlet piping and the air filters are in place.
- Ensure that all clamps and connections are secure.
- Inspect the air cleaner service indicator (if equipped). Service the air cleaner filter element when the yellow diaphragm enters the red zone, or the red piston locks in the visible position.
- · Inspect flexible piping for cracks and leaks.

# **Cooling System**

- Inspect the cooling system for leaks or loose connections. Inspect the condition of all the hoses and pipes for the cooling system. Ensure that the connections are properly clamped.
- Inspect the water pumps for evidence of leaks.
- Check the coolant level. Add coolant, if necessary.
   For information on the proper coolant to use, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" (Maintenance Section).
- For engines with separate circuit aftercooling, open the water supply.

# **Driven Equipment**

- Check the oil levels of the driven equipment.
   Perform any maintenance that is required for the driven equipment. Refer to the literature that is provided by the OEM of the driven equipment.
- If the engine is equipped with a clutch, ensure that the clutch is disengaged.
- For generator set engines, ensure that the main circuit breaker is open.

# **Electrical System**

Inspect the wiring for the following conditions:

- Loose connections
- · Wiring that is worn or frayed

Inspect the gauge panel and the control panel for good condition. Reset any shutoff or alarm components.

#### **Fuel System**

#### **MARNING**

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

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

- Check the fuel system for leaks with a gas detector.
- Inspect the fuel lines for loose fittings. Ensure that the fuel lines are properly clamped.
- Ensure that the fuel is supplied to the engine at the correct pressure for the engine.

# **Lubrication System**

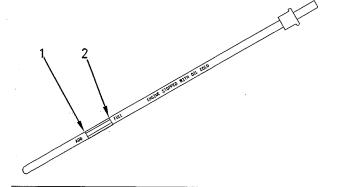


Illustration 23

g00760044

Oil level gauge (dipstick)

- (1) "ADD" mark
- (2) "FULL" mark

#### **NOTICE**

Excessive engine oil will increase oil consumption and result in excessive deposits in the combustion chamber. Do not overfill the engine with oil.

- Check the engine crankcase oil level. Maintain the oil level between the "ADD" and "FULL" marks on the "ENGINE STOPPED" side of the oil level gauge. For information on the proper oil to use, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" (Maintenance Section).
- Check for leaks at the following components: crankshaft seals, crankcase, oil filters, oil gallery plugs, sensors, and valve cover.
- Inspect the tubes, and the clamps on the crankcase breathers.

# **Starting System**

**Note:** If the engine is equipped with a system for external support, prepare the system before starting the engine. Ensure that all of the systems for engine support are enabled. Perform all prestart checks for the control system.

#### **Air Starting Motor**

- Drain moisture and sediment from the air tank and from any other air piping.
- Check the oil level in the lubricator. Keep the lubricator at least half full. Add oil, if necessary. For temperatures above 0 °C (32 °F), use a nondetergent 10W oil. For temperatures below 0 °C (32 °F), use air tool oil.
- Check the air pressure for starting. The air starting motor requires a minimum of 690 kPa (100 psi).
   The maximum allowable air pressure is 1030 kPa (150 psi). Open the air supply valve.

#### **Electric Starting Motor**

 Disconnect any battery chargers that are not protected against the high current drain that is created when the electric starting motor engages.

Inspect the wiring, the electrical cables, and the battery for the following conditions:

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

i01857649

# **Cold Weather Starting**

SMCS Code: 1000; 1250; 1450; 1453; 1456; 1900

**Note:** Oil pan immersion heaters are not recommended for heating the lube oil. To ensure the compatibility of the components, only use equipment that is recommended by Caterpillar.

A jacket water heater is required for starting in temperatures as low as 0 °C (32 °F). The jacket water heater can maintain the water temperature at approximately 32 °C (90 °F). The heated water will help to keep the oil in the engine block warm enough to flow when the engine is started. A jacket water heater is required for starting when the temperature is less than 16 °C (60 °F).

For air starting motors, a larger volume of starting air and/or a higher air pressure may be necessary in order to start the engine at colder temperatures.

For electric starting, extra battery capacity may be necessary.

Consult your Caterpillar dealer for more information on the starting aids that are available for cold weather starting.

i02141975

# **Starting the Engine**

**SMCS Code:** 1000; 1450

# **WARNING**

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

#### NOTICE

For initial start-up of a new or rebuilt engine, and for start-up of an engine that has been serviced, make provision to shut the engine off should an overspeed occur. This may be accomplished by shutting off the fuel supply and/or the ignition to the engine.

#### **WARNING**

Unburned gas in the air inlet and exhaust system may ignite when the engine is started. Personal injury and/or property damage may result.

Before starting an engine that may contain unburned gas, purge the unburned gas from the air inlet and exhaust system. Refer to the topic on purging unburned gas in the "Starting the Engine" section.

Do not start the engine or move any of the controls if there is a "DO NOT OPERATE" warning tag or similar warning tag attached to the start switch or to the controls.

Ensure that no one will be endangered before the engine is started and when the engine is started.

Perform the procedures that are described in this Operation and Maintenance Manual, "Before Starting Engine" (Operation Section).

#### **Purging Unburned Gas**

The following events cause unburned gas to remain in the air inlet and in the exhaust manifold:

- Emergency stop
- · Engine overspeed
- Unsuccessful successive attempts to start the engine

Unburned gas may remain in the air inlet and exhaust system after several unsuccessful attempts to start the engine. The unburned gas may increase to a concentration that may ignite during a successive attempt to start the engine.

Perform the following procedure in order to purge the unburned gas:

- Turn the manual gas shutoff valve to the CLOSED position.
- 2. Disable the ignition by grounding the G lead on the ignition harness.
- 3. Turn the engine control switch to the START position. Crank the engine for one full crank cycle in order to purge the unburned gas.
- Turn the engine control switch to the OFF/RESET position.
- Enable the ignition by disconnecting the "G" lead from ground.

- 6. Turn the manual gas shutoff valve to the OPEN position.
- 7. Continue with your previous procedure.

# Operation of the Generator Set Control Panel

For information on operation for a specific generator set control panel, refer to the Operation and Maintenance Manual for the generator and the control panel.

# **Automatic Starting**

#### **WARNING**

When the engine is in the AUTOMATIC mode, the engine can start at any moment. To avoid personal injury, always remain clear of the the engine when the engine is in the AUTOMATIC mode.

If the engine control switch is in the "AUTO" position, the engine will automatically start when the remote start/stop initiate contact closes. The engine will accelerate to rated rpm when the oil pressure is sufficient.

# **Manual Starting**

- Ensure that fuel is supplied to the engine. Ensure that no gas is leaking.
- 2. Ensure that the driven equipment is unloaded.
  - For generator set engines, open the main circuit breaker.
  - b. For industrial engines, unload the compressor or pump. Disengage the clutch (if equipped). Place the transmission and/or other attachments for the power take-off in NEUTRAL.

**Note:** Before starting an industrial engine, move the governor control lever to the position for 1/2 of rated rpm.

#### NOTICE

Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again. **3.** The method that is used for starting depends on the equipment:

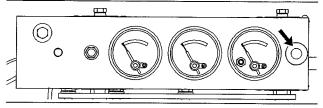


Illustration 24

g00523542

Typical "START" button on an instrument panel

a. For electric starting, press the "START" button or turn the start/stop switch to the "START" position.

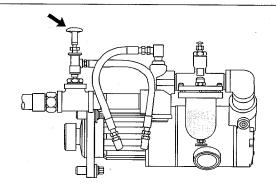


Illustration 25

g00523569

"START" valve on an air starting motor

**b.** For starting with air, push the "START" valve. Release the valve as soon as the engine starts. Shut off the air supply to the starting motor.

**Note:** After starting an industrial engine, move the governor control lever to the position for low idle rpm.

4. Allow the engine to idle for three to five minutes. The engine speed should stabilize at low idle rpm. Check all of the pressure gauges. Inspect the engine for leaks and listen for unusual noises. When all systems are normal, the rpm may be increased.

# **Starting Failure**

If the engine fails to start after cranking for 30 seconds, stop cranking. Perform the following procedure:

- 1. Turn the start switch to the "OFF" position.
- 2. Turn the gas supply OFF.

- Allow the starting motor to cool for two minutes. Crank the engine for approximately 15 seconds in order to disperse any unburned gas from the engine and the exhaust system.
- Allow the starting motor to cool for two minutes. Turn the gas supply ON. Repeat the starting procedure.

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# Starting with Jump Start Cables

SMCS Code: 1000; 1401; 1402; 1900

# **WARNING**

Improper jump start cable connections can cause an explosion resulting in personal injury.

Prevent sparks near the batteries. Sparks could cause vapors to explode. Do not allow jump start cable ends to contact each other or the engine.

If the installation is not equipped with a backup battery system, it may be necessary to start the engine from an external electrical source.

Many batteries which are considered unusable are still rechargeable. After jump starting, the alternator may not be able to fully recharge batteries that are severely discharged. The batteries must be charged to the proper voltage with a battery charger. For information on testing and charging, refer to the Special Instruction, SEHS7633, "Battery Test Procedure".

#### NOTICE

Using a battery source with the same voltage as the electric starting motor. Use ONLY equal voltage for jump starting. The use of higher voltage will damage the electrical system.

Do not reverse the battery cables. The alternator can be damaged. Attach ground cable last and remove first.

When using an external electrical source to start the engine, turn the engine control switch to the "OFF" position. Turn all electrical accessories OFF before attaching the jump start cables.

Ensure that the main power switch is in the OFF position before attaching the jump start cables to the engine being started.

 Turn the start switch on the stalled engine to the OFF position. Turn off all accessories.

- Connect one positive end of the jump start cable to the positive cable terminal of the discharged battery. Connect the other positive end of the jump start cable to the positive cable terminal of the electrical source.
- 3. Connect one negative end of the jump start cable to the negative cable terminal of the electrical source. Connect the other negative end of the jump start cable to the engine block or to the chassis ground. This procedure helps to prevent potential sparks from igniting combustible gases that are produced by some batteries.
- Charge the batteries. The engine will not continue to run after starting if the batteries have not been charged.
- 5. Start the engine.
- **6.** Immediately after the stalled engine is started, disconnect the jump start cables in reverse order.

Refer to the Electrical Schematic for your engine. Consult your Caterpillar dealer for more information. i01028507

## **After Starting Engine**

SMCS Code: 1000

For new installations and engines that are recently rebuilt, carefully monitor the engine in order to detect any unusual engine performance.

The engine rpm can be increased from low idle rpm to rated rpm after one minute.

It may be necessary to apply some load in order to attain normal operating temperatures. The operator can ramp the load manually. For automatic loading, programmable logic control can be used.

## **Engaging the Driven Equipment**

#### **Generator Set Engines**

- 1. Increase the engine speed to rated rpm.
- **2.** Ensure that the gauges are in the normal ranges for the engine rpm.
- Close the main circuit breaker in order to apply the load.

#### **Industrial Engines**

- 1. Increase the engine rpm. Ensure that the gauges are in the normal ranges for the engine rpm.
- 2. Engage the driven equipment with no load on the driven equipment.
- Increase the engine rpm and the load, as needed.

## **Engine Operation**

i02061036

## **Engine Operation**

SMCS Code: 1000

Proper operation and maintenance are key factors in attaining the maximum service life and economy for the engine. Follow the instructions in this Operation and Maintenance Manual in order to minimize operating costs and maximize the service life of the engine.

Observe the gauges frequently while the engine is operating. Record the data from the gauges in a log regularly. Compare the data to the specifications for normal engine operation. Comparing the data over time will help to detect changes in engine performance.

Investigate any significant change in the gauge readings. Monitor the engine operation and take action when discrepancies are found.

## Operating the Engine and the Driven Equipment

Check the gauges and the driven equipment frequently while the engine is operating under a load. The engine can be operated for extended periods of time at full load.

## **Partial Load Operation**

Extended operation at low idle or at a reduced load will cause increased oil consumption and carbon buildup in the cylinders. Carbon buildup results in the following effects:

- Power loss
- · Poor performance
- · Accelerated wear of components

Caterpillar Engines can be operated at very light loads (torques) for limited times with no harmful effects. Table 8 lists the limits for hours of operation at various torques.

After the time limit for reduced load operation has expired, operate the engine for a minimum of two hours at a torque that is more than 70 percent.

For example, an engine is operating at 20 percent of the rated torque. The engine may be operated at this load factor for a maximum of one-half hour. After the one-half hour, operate this engine for at least two hours at a load factor of more than 70 percent.

To keep engine maintenance at a minimum, follow the guidelines that are listed in Table 8.

Table 8

Time Limits For Low Load Operation		
Engine Torque	NA Engines	TA Engines
0 to 30%	1/2 hour	1/2 hour
31 to 60%	2 hours	2 hours
61 to 70%	24 hours	Continuous(1)
71 to 100%	Continuous	Continuous(1)

<sup>(1)</sup> For continuous operation of TA engines, the manifold air pressure should be greater than the atmospheric pressure.

## **Engine Stopping**

i02155498

## **Emergency Stopping**

SMCS Code: 1000; 7418

#### NOTICE

Emergency shutoff controls are for EMERGENCY use ONLY. DO NOT use emergency shutoff devices or controls for normal stopping procedure.

Ensure that any system that provides external support to the engine is secured after the engine is stopped.

#### NOTICE

Do not start the engine until the problem necessitating the emergency stop has been located and corrected.

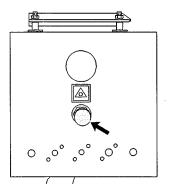
Pressing the Emergency Stop Button may cause unburned gas to remain in the air inlet and in the exhaust manifold.

### **WARNING**

Unburned gas in the air inlet and exhaust system may ignite when the engine is started. Personal injury and/or property damage may result.

Before starting an engine that may contain unburned gas, purge the unburned gas from the air inlet and exhaust system. Refer to the topic on purging unburned gas in the "Starting the Engine" section.

## **Emergency Stop Button**



g00520710

Illustration 26

Emergency stop button on the junction box

For the junction box, the emergency stop button is in the OUT position for normal engine operation. For an emergency stop, push the emergency stop button. The button must be reset before the engine can be started.

To reset the button, turn the button clockwise. The spring-loaded button will return to the OUT position.

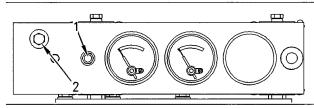


Illustration 27

g00841956

Emergency stop button on the instrument panel

- (1) "STOP" button
- (2) "RESET" button

For the instrument panel, push the "STOP" button in order to perform an emergency stop.

The instrument panel must be reset before the engine can be started. To reset the instrument panel, press the "RESET" button.

i01020551

## **Manual Stop Procedure**

SMCS Code: 1000; 7418

#### NOTICE

Stopping the engine immediately after the engine has been operating under a load can result in overheating and accelerated wear of the engine components.

Allow the engine to gradually cool before stopping the engine.

Note: Remove the load at a rate that will avoid detonation.

- 1. Disengage the driven equipment.
  - a. For generator set engines, open the main circuit breaker.
  - b. For industrial engines, unload the compressor or pump. Disengage the clutch (if equipped).
     Place the transmission and/or other attachments for the power take-off in NEUTRAL.

**Note:** Extended idling can cause excessive oil consumption and related problems. See this Operation and Maintenance Manual, "Engine Operation" topic (Operation Section).

- 2. Reduce the engine rpm to low idle.
- **3.** Operate the engine at low idle rpm for a cool down period.

If the engine has been operated at a low load, operate the engine at low idle for approximately 30 seconds before stopping the engine.

If the engine has been operated at a high load, operate the engine at low idle for three to five minutes before stopping the engine.

4. To stop the engine, shut off the fuel supply.

The engine will coast to a stop. Ensure that any system that provides external support to the engine is secured after the engine is stopped.

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## **After Stopping Engine**

SMCS Code: 1000

- Check the engine crankcase oil level. Maintain the oil level between the "ADD" and "FULL" marks on the "ENGINE STOPPED" side of the oil level gauge.
- If necessary, perform minor adjustments. Repair any leaks and tighten loose bolts.
- Note the service hour meter reading. Perform the maintenance that is scheduled in this Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).

#### NOTICE

Only use antifreeze/coolant mixtures recommended in the Refill Capacities and Recommendations section of this manual. Failure to do so can cause engine damage.

- Allow the engine to cool. Check the coolant level.
- If freezing temperatures are expected, check the coolant for protection against freezing. The cooling system must be protected against freezing to the lowest expected outside temperature. Add the proper coolant/water mixture, if necessary.
- Perform all required periodic maintenance on all driven equipment. Refer to the instructions that are provided by the OEM of the driven equipment.

## **Maintenance Section**

## **Refill Capacities**

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## Refill Capacities and Recommendations

SMCS Code: 1348; 1395; 7560

### **Lubrication System**

#### **Lubricant Recommendations**

Due to significant variations in the quality and in the performance of commercially available oils, Caterpillar makes the following recommendations:

- Caterpillar Natural Gas Engine Oil (NGEO)
- Caterpillar EL250 Natural Gas Engine Oil (NGEO)
- Caterpillar EL350 Natural Gas Engine Oil (NGEO)

The proper SAE viscosity grade of oil is determined by the minimum ambient temperature during cold engine start-up, and the maximum ambient temperature during engine operation. To determine the oil viscosity that is required for starting a cold soaked engine, refer to the minimum temperature in Table 9. To select the oil viscosity for operation at the highest anticipated ambient temperature, refer to the maximum temperature in the Table. Use the highest oil viscosity that is available in order to meet the required temperature during start-up.

Table 9

E	Engine Oil Viscosi	ty	
Caterpillar	Ambient Temperature		
NGEO Grade of Viscosity	Minimum	Maximum	
SAE 30(1)	0 °C (32 °F)	40 °C (104 °F)	
SAE 40 <sup>(1)</sup>	5 °C (41 °F)	50 °C (122 °F)	

(1) Caterpillar NGEO is available in these grades only. Multigrade oils are NOT recommended for use in Caterpillar Gas Engines. If other grades of viscosity are selected, ensure that the oil meets the requirements for Caterpillar Gas Engines.

For further information about oils, see Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations".

#### **Lubricant Capacities**

The capacity of the engine crankcase includes the capacity of the oil filters that are installed at the factory.

Table 10

Approximate Refill Ca Engine Lubric		
Engine Serial Number	Liters	Quarts
(S/N: 37Y1-1017) (S/N: N4F1-Up)	19	20
(S/N: 37Y1018-Up)	31	33

Table 11

Approximate Refill Ca Engine Lubri		
Engine Serial Number	Liters	Quarts
(S/N: 07Y1-1833) (S/N: G6X1-Up)	27.5	29
(S/N: 07Y1834-Up)	44.5	47

#### **Fuel**

#### **Fuel Recommendations**

Caterpillar gas engines will operate successfully on a broad range of gaseous fuels. Pipeline natural gas has been used for many years. Commercial fuel gases are mixtures of gases. These fuels consist primarily of hydrocarbons (combinations of hydrogen and carbon) and some inert gases. The compositions of these gas mixtures have extreme variations. Fuels such as wellhead gas, bio-gas, and manufactured gas need to be reviewed for acceptability. Analyze the fuel in order to determine the following characteristics:

- Composition
- Contaminants
- Heat value
- Methane number
- Specific gravity

Field gas can have varying characteristics of combustion. Field gas can contain numerous harmful impurities. The impurities can alter the BTU content. The impurities can also alter the methane number. The impurities include everything from water up to complex hydrocarbons that can lead to detonation and severe engine damage. To minimize these effects, Caterpillar recommends the following guidelines:

1. Evaluate the fuel with the Caterpillar Methane Number Program, LEKQ6378.

Methane values below 30 are not recommended for use in a Caterpillar engine. Fuels with a methane number that is below 30 must first be processed in order to remove harmful impurities in the fuel and raising the methane number into the acceptable range.

- 2. If necessary, use an engine that is configured for a fuel that has a high energy. Consult your local Caterpillar Dealer in order to determine the recommended engine timing.
- **3.** Reduce the oil change interval according to the results of the oil analysis.

For further information on fuels, see Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations".

### **Cooling System**

#### **Coolant Recommendations**

During shipping and storage, the engine must be protected from damage that can be caused by freezing of the cooling system. If the engine is shipped to a site with freezing temperatures and/or if the engine is stored in a location with freezing temperatures, the cooling system must contain antifreeze that will withstand the lowest ambient temperature. Frequently check the concentration of glycol in the coolant/antifreeze. Make sure that the concentration is adequate in order to prevent freezing. Otherwise, the cooling system must be completely drained.

Coolant/antifreeze is normally composed of three elements: water, glycol, and additives. Each element must meet specific guidelines.

#### Water

Deionized water or distilled water is recommended for use in engine cooling systems. If distilled water or deionized water is not available, use water with the properties that are listed in Table 12.

Table 12

Caterpillar Minimum Acceptable Water Requirements		
Property	Maximum Limit	ASTM Test
Chloride (CI)	40 mg/L (2.4 grains per US gal)	"D512", "D4327"
Sulfate (SO₄)	100 mg/L (5.9 grains per US gal)	"D516"
Total Hardness	170 mg/L (10 grains per US gal)	"D1126"
Total Solids	340 mg/L (20 grains per US gal)	"D1888"
Acidity	pH of 5.5 to 9.0	"D1293"

#### NOTICE

Use of water that does not meet the recommendations for the cooling system will damage the cooling system.

Do not use these types of water in the cooling system: sea water, softened water that has been conditioned with salt, hard water, and tap water.

Only use water that meets the recommendations for the cooling system.

If you are not sure about the properties of your water, consult one of the following sources for a water analysis:

- · Caterpillar dealer
- Local water utility company
- · Agricultural agent
- · Independent laboratory

#### **Glycol**

#### NOTICE

Do not use Extended Life Coolant (ELC) with Caterpillar Gas Engines.

ELC was not formulated for use in Caterpillar Gas Engines.

Use only the coolant/antifreeze that is recommended.

**Preferred** – Caterpillar Natural Gas Engine Coolant (NGEC)

Alternatively, use Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) or a commercial heavy-duty coolant/antifreeze that meets "ASTM D6210" or "ASTM D4985" specifications.

#### NOTICE

Do not use a commercial coolant/antifreeze that only meets the ASTM "D3306" specification. This type of coolant/antifreeze is made for light duty automotive applications.

Use only the coolant/antifreeze that is recommended.

Acceptable – In applications that do not require protection from boiling or from freezing, a mixture of Caterpillar SCA and water that meets the properties that are listed in Table 12 is acceptable.

**Note:** The preferred coolant/antifreeze and the acceptable mixture of SCA and water require different concentrations of SCA. Refer to the Special Publication, SEBU6400, "Supplemental Coolant Additive (SCA)" topic.

Table 13 is a list of the coolant/antifreeze that is recommended for Caterpillar Gas Engines. The service life of the coolant/antifreeze that is used in Caterpillar Gas Engines is also listed. To achieve this service life, the coolants must be properly maintained. The maintenance program includes S·O·S coolant analysis.

Table 13

Recommended Coolant/Antifreeze and Service Life of the Coolant/Antifreeze		
Coolant/Antifreeze	Service Life (1)	
Caterpillar NGEC	Th V	
Caterpillar DEAC	Three Years	
Commercial Heavy-Duty Coolant/Antifreeze that meets "ASTM D6210"	Two Years	
Commercial Heavy-Duty Coolant/Antifreeze that meets "ASTM D4985"	One Year	
Caterpillar SCA and Water	Two Years	
Commercial SCA and Water	One Year	

<sup>(1)</sup> The service life of coolant is also limited by use (service hours). Refer to the specific engine's Operation and Maintenance Manual, "Maintenance Interval Schedule".

#### **Additives**

**Preferred** – Caterpillar Supplemental Coolant Additive (SCA)

**Acceptable** – A commercial SCA that provides 1200 mg/L (70 grains per US gal) or 1200 ppm of nitrites in the final mixture of coolant/antifreeze

Note: A 50/50 concentration of Caterpillar NGEC or of Caterpillar DEAC does not require a treatment with an SCA at the initial fill. Commercial heavy-duty coolant/antifreeze that meets "ASTM D6210" or "ASTM D4985" specifications may require a treatment with an SCA at the initial fill. Read the label or the instructions that are provided by the OEM of the product.

To ensure that the correct amount of SCA is in the cooling system, the concentration of SCA must be tested on a scheduled basis. Obtain an S·O·S coolant analysis (Level 1) or use a test kit to check the concentration of the SCA according to this Operation and Maintenance Manual, "Maintenance Interval Schedule".

For further information on coolant, see Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations".

#### **Coolant Capacities**

To properly maintain the cooling system, the Total Cooling System capacity must be determined. The Total Cooling System capacity will vary between individual installations. The External System capacity includes the following components: engine, expansion tank, heat exchanger, radiator, and piping. Refer to the specifications that are provided by Caterpillar or by the OEM of the equipment. Record the Total Cooling System capacity in the following Table:

Table 14

Approximate Refill Ca Engine Cool		
Compartment or System	Liters	Quart
Jacket Water	16	18
External System		,
Total Cooling System		

Table 15

Approximate Refill Capacities for the G3306 Engine Cooling System		
Compartment or System	Liters	Quarts
Jacket Water	20	21
External System		
Total Cooling System		

i021555	
<b>Maintenance Interval Schedul</b>	Engine Valve Rotators - Inspect
	Exhaust i iping - inspect
(Turbocharged Engines)	Gas Pressure Regulator - Check
0H00 0 . I. 1000 1450 7500	Hoses and Clamps - Inspect/Replace
<b>SMCS Code:</b> 1000; 4450; 7500	Replace
Before performing any operation or maintenance	Invite of Contains Time of Charles Adjust
procedures, ensure that the Safety Information,	~~ 1 1 4 A C O C
warnings, and instructions are read and	' Radiator - Clean 85
understood.	
	Initial 750 Service Hours
Before each consecutive interval is performed, all of the maintenance requirements from the previous interval must be performed.	
	Every 1500 Service Hours
Note: For information on generator maintenance,	Actuator Control Linkage - Lubricate
see the Operation and Maintenance Manual for the	Carburetor Air/Fuel Ratio - Check/Adjust 54
generator.	Crankcase Blowby - Measure/Record 59
	Cylinder Pressure - Measure/Record 60
When Required	Engine Protective Devices - Check 70
Engine Air Cleaner Flament - Benlese	Speed Sensor - Clean/Inspect 85
Engine Air Cleaner Element - Replace	83 Every Veer
	Cooling System Coolant Analysis (Level II) -
Daily	Obtain 57
Air Starting Motor Lubricator Oil Level - Check	50 Every 3000 Service Hours
Control Panel - Inspect	
Cooling System Coolant Level - Check	
Driven Equipment - Inspect/Replace/Lubricate	
Engine Air Cleaner Service Indicator - Inspect	lgnition System Transformer Resistance - Test 78
Engine Air Precleaner - Clean	Starting Motor - Inspect 86
Engine Oil Level - Check	Water Pump - Inspect
Fuel System Fuel Filter Differential Pressure -	· ·
Check	
Instrument Panel - Inspect	78
Power Take-Off Clutch - Check/Adjust/Lubricate  Walk-Around Inspection	
Every 250 Service Hours	Every 4000 Service Hours
Cooling System Supplemental Coolant Additive	Alternator - Inspect50
(SCA) - Test/Add	58 Exhaust Bypass - Inspect
Engine Oil Sample - Obtain	
From: 500 Comice House	Every 8000 Service Hours
Every 500 Service Hours	Turbocharger - Inspect 87
Cooling System Coolant Analysis (Level I) -	-
Obtain	Between 9000 and 12 000 Service Hours
Every 750 Service Hours	Overhaul (Top End) 81
Aftercooler Core - Clean/Test	
Battery Electrolyte Level - Check	
Belts - Inspect/Adjust/Replace	
Crankshaft Vibration Damper - Inspect	
Engine - Clean	61
Engine Crankcase Breather - Clean	
Engine Oil and Filter - Change	δŏ

46 Maintenance Section Maintenance Interval Schedule **Maintenance Interval Schedule** (Standby Generator Set **Engines**) Before performing any operation or maintenance understood. generator.

SMCS Code: 1000; 4450; 7500

procedures, ensure that the Safety Information, warnings, and instructions are read and

i02155515

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

The maintenance that is recommended for Every Week can be performed by an authorized operator. The maintenance that is recommended for the subsequent maintenance intervals must be performed by an authorized service technician or by your Caterpillar dealer.

Before each consecutive interval is performed, all of the maintenance requirements from the previous interval must be performed.

#### **Every Week**

Air Starting Motor Lubricator Oil Level - Check Air Tank Moisture and Sediment - Drain Automatic Start/Stop - Inspect Battery Charger - Check Battery Electrolyte Level - Check Control Panel - Inspect Cooling System Coolant Level - Check Engine Air Cleaner Service Indicator - Inspect	50 50 51 52 54 57
Engine Air Precleaner - Clean	
Engine Oil Level - CheckFuel System Fuel Filter Differential Pressure -	66
Check	72 78
Jacket Water Heater - Check	
Standby Generator Set Maintenance Recommendations	
Walk-Around Inspection	90
Every 250 Service Hours or 1 Year	
Engine Oil and Filter - Change	68
Every 500 Service Hours	
Cooling System Coolant Analysis (Level I) - Obtain	56
Every Year	
Actuator Control Linkage - Lubricate	48

Air Starting Motor Lubricator Bowl - Clean	48
Alternator - Inspect	50
Belts - Inspect/Adjust/Replace	52
Carburetor Air/Fuel Ratio - Check/Adjust	54
Cooling System Coolant Analysis (Level II) -	
Obtain	57
Cooling System Supplemental Coolant Additive	
(SCA) - Test/Add	58
Crankcase Blowby - Measure/Record	59
Crankshaft Vibration Damper - Inspect	59
Cylinder Pressure - Measure/Record	
Engine - Clean	
Engine Air Cleaner Element - Replace	
Engine Crankcase Breather - Clean	
Engine Mounts - Check	66
Engine Oil Sample - Obtain	67
Engine Performance - Test	
Engine Protective Devices - Check	
Engine Valve Lash - Inspect/Adjust	71
Engine Valve Rotators - Inspect	
Gas Pressure Regulator - Check	
Hoses and Clamps - Inspect/Replace	73
Ignition System Spark Plugs - Check/Adjust/	
Replace	75
Ignition System Timing - Check/Adjust	78
Inlet Air System - Inspect	
Radiator - Clean	85
Speed Sensor - Clean/Inspect	85
Starting Motor - Inspect	86
Turbocharger - Inspect	87
Water Pump - Inspect	91
Every 3 Years	
Batteries - Replace	51
Belts - Replace	
Carburetor - Inspect/Recondition	
Cooling System Coolant (DEAC) - Change	54
Cooling System Coolant (NGEC) - Change	
Exhaust Bypass - Inspect	/1
Exhaust Piping - Inspect	
Governor - Inspect	
Hoses and Clamps - Replace	/4
Ignition System Spark Plug Wires - Replace	
Ignition System Transformer Resistance - Test	78

i02155509 **Maintenance Interval Schedule** (Naturally Aspirated Engines) SMCS Code: 1000: 4450: 7500 Before performing any operation or maintenance procedures, ensure that the Safety Information, warnings, and instructions are read and understood. Before each consecutive interval is performed, all of the maintenance requirements from the previous interval must be performed. Note: For information on generator maintenance, see the Operation and Maintenance Manual for the generator. When Required Engine Air Cleaner Element - Replace ...... 62 Overhaul Considerations ...... 83 Valve Stem Projection - Measure/Record ...... 88 Daily Air Starting Motor Lubricator Oil Level - Check .... 49 Air Tank Moisture and Sediment - Drain ...... 50 Control Panel - Inspect ...... 54 Cooling System Coolant Level - Check ...... 57 Driven Equipment - Inspect/Replace/Lubricate ... 61 Engine Air Cleaner Service Indicator - Inspect ..... 64 Engine Air Precleaner - Clean ...... 65 Fuel System Fuel Filter Differential Pressure -Check ...... 72 Instrument Panel - Inspect ...... 78 Power Take-Off Clutch - Check/Adjust/Lubricate .. 84 Walk-Around Inspection ...... 89 **Every 250 Service Hours** Cooling System Supplemental Coolant Additive (SCA) - Test/Add ...... 58 Engine Oil Sample - Obtain ...... 67 **Every 500 Service Hours** Cooling System Coolant Analysis (Level I) -Obtain ...... 56 **Every 750 Service Hours** Battery Electrolyte Level - Check ...... 52 Belts - Inspect/Adjust/Replace ...... 52 Crankshaft Vibration Damper - Inspect ...... 59 Engine - Clean ...... 61 Engine Crankcase Breather - Clean ...... 65 Engine Oil and Filter - Change ...... 68

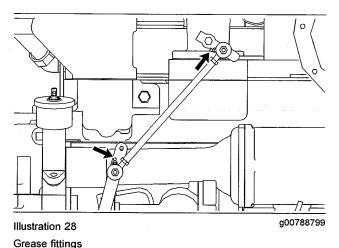
Exhaust Piping - Inspect ...... 72

Hoses and Clamps - Inspect/Replace Ignition System Spark Plugs - Check/Adjust/	73
Replace Ignition System Timing - Check/Adjust	78
Inlet Air System - Inspect	78
Initial 750 Service Hours	
Engine Valve Lash - Inspect/Adjust	71 73
Initial 1500 Service Hours	
Valve Stem Projection - Measure/Record	88
Every 1500 Service Hours	
Actuator Control Linkage - Lubricate Carburetor Air/Fuel Ratio - Check/Adjust Crankcase Blowby - Measure/Record Cylinder Pressure - Measure/Record Engine Protective Devices - Check Engine Valve Lash - Inspect/Adjust Engine Valve Rotators - Inspect Gas Pressure Regulator - Check Speed Sensor - Clean/Inspect	54 59 60 70 71 71 73
Every Year	
Every real	
Cooling System Coolant Analysis (Level II) - Obtain	57
Cooling System Coolant Analysis (Level II) -	57
Cooling System Coolant Analysis (Level II) - Obtain	48 50 61 66 78 86
Cooling System Coolant Analysis (Level II) - Obtain	48 50 61 66 78 86
Cooling System Coolant Analysis (Level II) - Obtain	48 50 61 66 78 86 91
Cooling System Coolant Analysis (Level II) - Obtain	48 50 61 66 78 86 91
Cooling System Coolant Analysis (Level II) - Obtain	48 50 61 66 78 86 91 54 56
Cooling System Coolant Analysis (Level II) - Obtain	48 50 61 66 78 86 91 54 56

i01519288

## Actuator Control Linkage - Lubricate

SMCS Code: 1265-086



Apply grease to the grease fittings. Use a hand grease gun and lubricate the grease fittings with MPGM.

## Check the Linkage

Check the linkage for proper operation. Adjust the linkage, if necessary. For the adjustment procedure, see the Service Manual, "Systems Operation/Testing and Adjusting" module.

i01371758

# Aftercooler Core - Clean/Test (Air-To-Air Aftercooler)

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

**S/N**: G6X1-Up **S/N**: 07Y1-Up

**Note:** Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the aftercooler for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the aftercooler, if necessary.

For air-to-air aftercoolers, use the same methods that are used for cleaning radiators.

### **A WARNING**

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a "comb".

**Note:** If parts of the aftercooler system are repaired or replaced, a leak test is highly recommended.

Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, see Special Publication, SEBD0518, "Know Your Cooling System".

i01924136

## Air Starting Motor Lubricator Bowl - Clean

SMCS Code: 1451-070

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

## **A WARNING**

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

Failure to relieve pressure can cause personal injury.

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

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

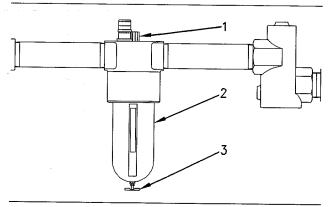


Illustration 29

g00745554

- (1) Filler plug
- (2) Bowl
- (3) Drain valve
- Slowly loosen filler plug (1) in order to release the pressure from the lubricator.

#### NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

- Place a suitable container under bowl (2) and open drain valve (3) in order to drain the oil from the bowl.
- 4. Remove bowl (2). Clean the bowl with warm water.
- Dry the bowl. Inspect the bowl for cracks. If the bowl is cracked, replace the damaged bowl with a new bowl.

- 6. Install the bowl.
- 7. Make sure that drain valve (3) is closed.
- 8. For instructions on filling the lubricator, see this Operation and Maintenance Manual, "Air Starting Motor Lubricator Oil Level Check" topic.

i01924142

## Air Starting Motor Lubricator Oil Level - Check

SMCS Code: 1451-535

#### NOTICE

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

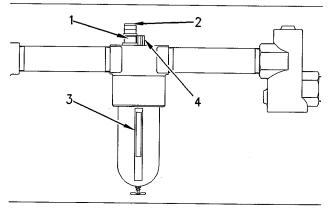


Illustration 30

g00745561

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

## **A** WARNING

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

Failure to relieve pressure can cause personal injury.

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

- 2. Ensure that the air supply to the lubricator is OFF. Slowly loosen filler plug (4) in order to release pressure from the lubricator bowl.
- 3. Remove filler plug (4). Pour oil into the lubricator bowl. Use nondetergent "10W" oil for temperatures that are greater than 0 °C (32 °F). Use air tool oil for temperatures that are below 0 °C (32 °F).

4. Install filler plug (4).

## Adjust the Lubricator

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

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

#### NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

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

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

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

i00351324

## Air Tank Moisture and Sediment - Drain

SMCS Code: 1466-543-M&S

Moisture and sediment in the air starting system can cause the following conditions:

- Freezing
- · Corrosion of internal parts
- · Malfunction of the air starting system

## **WARNING**

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

- Open the drain valve that is on the bottom of the air tank. Allow the moisture and sediment to drain.
- 2. Close the drain valve.

i02084374

## Alternator - Inspect

**SMCS Code:** 1405-040

Inspect the alternator for the following conditions:

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

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

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

i0103967

## Automatic Start/Stop - Inspect (Generator Set)

SMCS Code: 4462

The generator set must be ready to operate under a load at any time. After performing maintenance on the generator set, inspect the position of the control switches. Ensure the following conditions:

- · The starting system is enabled.
- The control switches are in the correct position for automatic starting.
- The switchgear and the automatic transfer switches that are associated with the generator are enabled.

For more information, see the Operation and Maintenance Manual for the generator and the control panel.

i01041029

## **Batteries - Replace**

SMCS Code: 1401-510

#### **WARNING**

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

- 1. Turn the key start switch to the OFF position. Remove the key and all electrical loads.
- 2. Turn OFF the battery charger. Disconnect the charger.
- 3. The NEGATIVE "-" cable connects the NEGATIVE "-" battery terminal to the ground plane. Disconnect the cable from the NEGATIVE "-" battery terminal.
- 4. The POSITIVE "+" cable connects the POSITIVE "+" battery terminal to the starting motor. Disconnect the cable from the POSITIVE "+" battery terminal.

**Note:** Always recycle a battery. Never discard a battery. Return used batteries to an appropriate recycling facility.

- 5. Remove the used battery.
- 6. Install the new battery.

**Note:** Before connecting the cables, ensure that the key start switch is OFF.

- 7. Connect the cable from the starting motor to the POSITIVE "+" battery terminal.
- **8.** Connect the cable from the ground plane to the NEGATIVE "-" battery terminal.

i01039758

## **Battery Charger - Check**

SMCS Code: 1401-535

### **Checking Before Start-Up**

Check the battery charger for proper operation. If the batteries are properly charged, the needle of the ammeter will register near "0" (zero).

The battery charger must not produce excessive current during start-up. Alternatively, the charger must be automatically disconnected for start-up. If the engine has an alternator, the charger must be automatically disconnected during start-up and during engine operation.

### Charging the Battery

### **A WARNING**

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operated. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Injury to personnel can be the result.

Perform the following procedure to charge the battery:

- 1. Ensure that the charger is turned OFF.
- **2.** Adjust the voltage of the charger in order to match the voltage of the battery.
- Connect the POSITIVE "+" lead of the charger to the POSITIVE "+" battery terminal. Connect the NEGATIVE "-" lead of the charger to the NEGATIVE "-" battery terminal.
- 4. Turn ON the battery charger.

#### Overcharging of Batteries

Overcharging reduces the service life of batteries. Use a battery charger that will not overcharge the battery. DO NOT charge the battery if the meter of the battery charger is in the RED zone.

Overcharging is indicated by the following symptoms:

- The battery is very warm to the touch.
- · A strong odor of acid is present.
- The battery emits smoke or a dense vapor (gas).

Perform one of the following procedures if the battery shows symptoms of overcharging:

- Reduce the rate of charging by a significant amount. Complete the charging at the reduced rate.
- · Turn OFF the charger.

Table 16 describes the effects of overcharging on different types of batteries.

Table 16

Effects of Overcharging Batteries		
Type of Battery	Effect	
Caterpillar General Service Batteries Caterpillar Premium High Output Batteries	All of the battery cells have a low level of electrolyte.	
	When the plates of the battery are inspected through the filler holes, the plates may appear to be warped. This is caused by an excessive temperature.	
	The battery may not pass a load test.	
Caterpillar Maintenance Free Batteries	The battery may not accept a charging current.	
	The battery may not pass a load test.	

## **Checking After Stopping**

Ensure that the battery charger is connected properly. Observe the meter of the charger. Record the amperage.

i01639002

## Battery Electrolyte Level - Check

SMCS Code: 1401-535-FLV

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing. If batteries are properly charged, ammeter reading should be very near zero.

#### **A WARNING**

All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.

1. Remove the filler caps. Maintain the electrolyte level to the "FULL" mark on the battery.

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.

- 2. Check the condition of the electrolyte with the 1U-7298 Coolant/Battery Tester (°C) or the 1U-7297 Coolant/Battery Tester (°F).
- 3. Keep the batteries clean.

Clean the battery case with one of the following cleaning solutions:

- A mixture of 0.1 kg (0.2 lb) of baking soda and 1 L (1 qt) of clean water
- A mixture of 0.1 L (0.11 qt) of ammonia and 1 L (1 qt) of clean water

Thoroughly rinse the battery case with clean water.

Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit properly. Coat the clamps and the terminals with 5N-5561 Silicone Lubricant, petroleum jelly or MPGM grease.

i02042962

## Belts - Inspect/Adjust/Replace

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

## Inspection

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

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

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

- Belts
- Pulleys
- Bearings

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

### Replacement

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

## **Alternator Belt Adjustment**

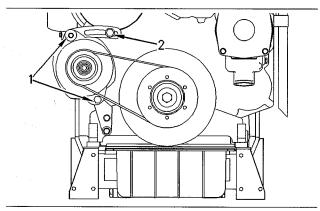


Illustration 31

g00788814

- 1. Remove the belt guard.
- 2. Loosen mounting bolts (1) and adjusting bolt (2).
- Move the assembly in order to increase or decrease the belt tension.
- **4.** Tighten adjusting bolt (2). Tighten mounting bolts (1).
- 5. Reinstall the belt quard.

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

## Adjustment of the Fan Drive Belt

- 1. Remove the belt guard.
- 2. Loosen the mounting bolt for the pulley.
- 3. Loosen the adjusting nut for the pulley.

- **4.** Move the pulley in order to adjust the belt tension.
- 5. Tighten the adjusting nut.
- 6. Tighten the mounting bolt.
- 7. Reinstall the belt guard.

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

i01041135

## **Belts - Replace**

SMCS Code: 1357-510

Remove the used fan drive belt and the accessory drive belt. Install new belts.

For applications that require multiple drive belts, replace the belts in matched sets. Used belts are stretched. Replacing only one belt of a matched set will cause the new belt to carry an excessive load. The additional load on the new belt could cause the new belt to break.

Check the belt tension according to the information in the Service Manual, "Specifications" module. To adjust the belt tension, see this Operation and Maintenance Manual, "Alternator and Fan Belts - Inspect/Adjust/Replace" topic (Maintenance Section).

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

i01519364

## Carburetor - Inspect/ Recondition

**SMCS Code:** 1512-020

**Note:** See the Service Manual, "Disassembly and Assembly" module for information on these topics: removal, disassembly, assembly, and installation.

- 1. Remove the carburetor.
- 2. Disassemble the carburetor.

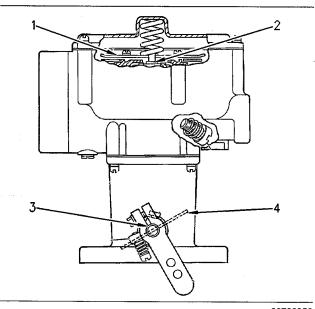


Illustration 32

g00788856

- 3. Inspect diaphragm (1). If the diaphragm is worn or damaged, replace the diaphragm.
- Inspect piston (2). If the piston is excessively worn, replace the carburetor body and the diaphragm assembly.
- Inspect throttle shaft (3) for wear near the bearing. Inspect throttle plate (4) and the throttle body for wear and/or damage. Replace any component that is worn or damaged.
- **6.** Assemble the carburetor. Use new gaskets for assembly.
- 7. Install the carburetor.
- Adjust the carburetor according to Special Instruction, REHS0371, "Installation and Intitial Start-Up Procedure for G3300 and G3400 Engines".

i01005891

## Carburetor Air/Fuel Ratio - Check/Adjust

SMCS Code: 1266-535; 1266

An engine failure may occur if the air/fuel ratio is not appropriate for the fuel and for the operating conditions. The service life of the turbocharger, of the valves, and of the other components may be reduced.

Ensure that the carburetor is adjusted properly so that the air/fuel ratio is correct.

For information on adjusting the carburetor, refer to the Service Manual, "Systems Operation/Testing and Adjusting", or refer to the Special Instruction, "Installation and Initial Start-Up Procedure".

i01762721

## **Control Panel - Inspect**

SMCS Code: 4490-040; 7451-040

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

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

## Record the Data and Review the Data

If equipped, check the gauges and check the indicators frequently during normal operation. Record the data in a log. Compare the new data to the data that was previously recorded. Comparing the new data to the recorded data will establish the normal gauge readings for the engine. A gauge reading that is abnormal may indicate a problem with operation or with the gauge.

i02155505

# **Cooling System Coolant** (DEAC) - Change

SMCS Code: 1350-044

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

- · The engine overheats frequently.
- Foaming is observed.
- Oil has entered the cooling system and the coolant is contaminated.

## **Drain the Cooling System**

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

**Note:** When maintenance for the jacket water system is performed, perform the same maintenance for the aftercooler's cooling system (if equipped).

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

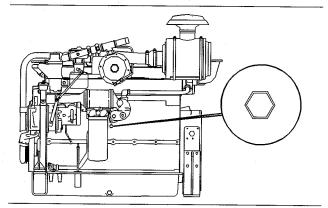


Illustration 33

g00518449

Engine block drain plug

Open the cooling system drain valve. Remove the engine block drain plug.

#### NOTICE

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

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

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

## **Clean the Cooling System**

- After the cooling system has been drained, flush the cooling system with clean water in order to remove any debris.
- Close the cooling system drain valve. Clean the engine block drain plug and install the plug.

#### NOTICE

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

#### NOTICE

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

- Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Install the cooling system filler cap.
- **4.** Start the engine. Operate the engine for a minimum of 30 minutes with a coolant temperature of at least 82 °C (180 °F).
- 5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the cooling system drain valve. Remove the engine block drain plug.

#### NOTICE

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

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

6. Allow the water to drain. Flush the cooling system with clean water until the water that drains is clean. Close the cooling system drain valve. Clean the engine block drain plug and install the plug.

## Cleaning a Cooling System that has Heavy Deposits or Plugging

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

- After the cooling system has been drained, flush the cooling system with clean water in order to remove any debris.
- 2. Close the cooling system drain valve. Clean the engine block drain plug and install the plug.

#### **NOTICE**

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

#### NOTICE

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

- 3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity. Install the cooling system filler cap. Install vent plug (4).
- Start the engine. Operate the engine for a minimum of 90 minutes with a coolant temperature of at least 82 °C (180 °F).
- 5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the cooling system drain valve. Remove the engine block drain plug. Allow the water to drain.

#### NOTICE

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

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

6. Flush the cooling system with clean water until the water that drains is clean. Close the cooling system drain valve. Clean the engine block drain plug and install the plug.

## Fill the Cooling System

#### **NOTICE**

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

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

- **1.** Fill the cooling system with coolant/antifreeze. Do not install the cooling system filler cap.
- 2. Start the engine. Operate the engine in order to purge the air from the cavities of the engine block. Allow the coolant to warm and allow the coolant level to stabilize. Stop the engine.
- 3. Check the coolant level. Maintain the coolant to the proper level on the sight gauge (if equipped). If a sight gauge is not equipped, maintain the coolant within 13 mm (0.5 inch) below the bottom of the filler pipe.

- 4. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets of the cooling system filler cap are damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gaskets of the cooling system filler cap are not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not maintain the correct pressure, install a new cooling system filler cap.
- **5.** Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i02068741

## Cooling System Coolant (NGEC) - Change

SMCS Code: 1350-044

The procedure that is used to change Natural Gas Engine Coolant (NGEC) is identical to the procedure that is used to change Diesel Engine Antifreeze/Coolant (DEAC). Refer to Operation and Maintenance Manual, "Cooling System Coolant (DEAC) - Change" for the proper procedure.

i01934272

## Cooling System Coolant Analysis (Level I) - Obtain

SMCS Code: 1350

#### NOTICE

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

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

Obtain the sample of the coolant as close as possible to the recommended sampling interval. In order to receive the full effect of S·O·S analysis, you must establish a consistent trend of data. In order to establish a pertinent history of data, perform consistent samplings that are evenly spaced. Supplies for collecting samples can be obtained from your Caterpillar dealer.

Use the following guidelines for proper sampling of the coolant:

- Complete the information on the label for the sampling bottle before you begin to take the samples.
- Keep the unused sampling bottles stored in plastic bags.
- Obtain coolant samples directly from the coolant sample port. You should not obtain the samples from any other location.
- Keep the lids on empty sampling bottles until you are ready to collect the sample.
- Place the sample in the mailing tube immediately after obtaining the sample in order to avoid contamination.
- · Never collect samples from expansion bottles.
- Never collect samples from the drain for a system.

Submit the sample for Level 1 analysis.

For additional information about coolant analysis, see Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" or consult your Caterpillar dealer.

i01934327

## Cooling System Coolant Analysis (Level II) - Obtain

SMCS Code: 1350

#### NOTICE

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

Refer to Operation and Maintenance Manual, "Cooling System Coolant Sample (Level 1) - Obtain" for the guidelines for proper sampling of the coolant.

Submit the sample for Level 2 analysis.

For additional information about coolant analysis, see Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engines Fluids Recommendations" or consult your Caterpillar dealer.

i01197583

## Cooling System Coolant Level - Check

SMCS Code: 1350-535-FLV

Check the coolant level when the engine is stopped and cool.

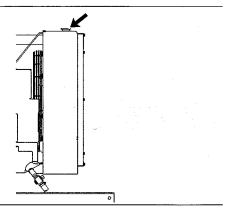


Illustration 34

Cooling system filler cap

g00285520

### **A** WARNING

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

- 1. Remove the cooling system filler cap slowly in order to relieve pressure.
- 2. Maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level to the proper level in the sight glass.

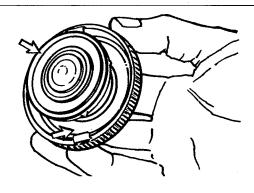


Illustration 35

g00103639

Typical filler cap gaskets

- Clean the cooling system filler cap and check the condition of the filler cap gaskets. Replace the cooling system filler cap if the filler cap gaskets are damaged. Reinstall the cooling system filler cap.
- 4. Inspect the cooling system for leaks.

i02017557

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

SMCS Code: 1352-045; 1395-081

### **WARNING**

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

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

### **Test the Concentration of the SCA**

#### Coolant/Antifreeze and SCA

#### NOTICE

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

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

#### Water and SCA

#### **NOTICE**

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

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

- 1. Fill the syringe to the "1.0 ml" mark with the coolant.
- 2. Dispense the 1.0 mL coolant sample from the syringe into the empty mixing bottle.
- 3. Add tap water to the mixing bottle in order to bring the level up to the "10 ml" mark. Place the cap on the bottle and shake the bottle.

- **4.** Add 2 to 3 drops of the "NITRITE INDICATOR SOLUTION B" to the mixing bottle. Move the bottle in a circular motion in order to mix the solution.
- **5.** Add 1 drop of "NITRITE TEST SOLUTION A" to the mixing bottle. Move the bottle in a circular motion in order to mix the solution.
- 6. Repeat 5 until the solution changes color from red to light gray, green, or blue. Record the number of drops of "NITRITE TEST SOLUTION A" that were required to cause the color change.
- 7. Use Table 17 to interpret the results.

Table 17

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

## Add the SCA, If Necessary

### **A** WARNING

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

1. Remove the cooling system filler cap slowly.

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

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

#### NOTICE

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

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

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

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

i01012683

## Crankcase Blowby - Measure/Record

SMCS Code: 1317

**Note:** For a new G3304 Engine that is operating at 1800 rpm, the typical range for crankcase blowby is approximately 30 to 45 L/min (1 to 1.5 ft³/min). For a new G3306 Engine that is operating at 1800 rpm, the typical range for crankcase blowby is approximately 60 to 120 L/min (2 to 4 ft³/min).

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

**Note:** Crankcase blowby is one of the three factors that help to determine the major overhaul interval. For more information, see this Operation and Maintenance manual, "Overhaul (Major)" topic (Maintenance Section).

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

- · piston rings
- · cylinder liners

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

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

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

- · Worn valve guides
- · A turbocharger seal that leaks

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

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

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

To measure the blowby, use the 8T-2700 Blowby/Air Flow Indicator. Refer to Special Instruction, SEHS8712, "Using the 8T-2700 Blowby/Airflow Indicator Group". The instruction is provided with the tool.

Keep a record of the results.

For more information, see the Service Manual, "Systems Operation/Testing and Adjusting". For assistance, consult your Caterpillar dealer.

i00894991

# **Crankshaft Vibration Damper** - **Inspect**

SMCS Code: 1205-040

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

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

### **Rubber Damper**

Your engine may be equipped with a rubber damper. The rubber damper uses a ring which is mounted in rubber in order to reduce vibrations in the crankshaft.

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

- · There is deterioration and cracking of the rubber.
- There is slippage of the outer ring from the original position.
- The engine has had a failure because of a broken crankshaft.
- Analysis of the oil has revealed that the front main bearing is badly worn.
- There is a large amount of gear train wear that is not caused by lack of oil.

Refer to the Service Manual or consult your Caterpillar dealer for information about damper replacement.

### Visconic Damper

Your engine may be equipped with a visconic damper. The visconic damper has a weight that is located inside a fluid filled case. The weight moves in the case in order to limit torsional vibration.

Inspect the damper for evidence of fluid leaks. If a fluid leak is found, determine the type of fluid. The fluid in the damper is silicone. Silicone has the following characteristics: transparent, viscous, smooth, and difficult to remove from surfaces.

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

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

- · The damper is dented, cracked, or leaking.
- The paint on the damper is discolored from heat.
- The engine has had a failure because of a broken crankshaft.
- Analysis of the oil has revealed that the front main bearing is badly worn.
- There is a large amount of gear train wear that is not caused by a lack of oil.

Refer to the Service Manual or consult your Caterpillar dealer for information about damper replacement.

i01519864

## Cylinder Pressure - Measure/Record

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

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

**Note:** Cylinder pressure is one of the three factors that help to determine the major overhaul interval. For more information, see this Operation and Maintenance manual, "Overhaul (Major)" (Maintenance Section).

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

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

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

- · Excessive deposits
- · Guttering of valves
- A broken valve
- A piston ring that sticks
- · A broken piston ring
- · Worn piston rings
- · Worn cylinder liners

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

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

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

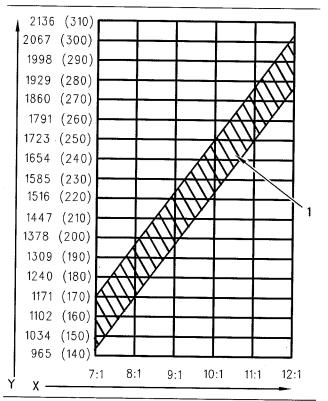


Illustration 36

g00760309

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

i00449093

## **Driven Equipment - Check**

SMCS Code: 3279-535

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

Check the alignment according to the instructions that are provided by the following manufacturers:

- Caterpillar
- OEM of the coupling

· OEM of the driven equipment

i00935098

## Driven Equipment - Inspect/Replace/Lubricate

**SMCS Code:** 3279-040

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

- Unusual noise and vibration
- · Loose connections
- · Damaged parts

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

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

i02062908

## **Engine - Clean**

SMCS Code: 1000-070

## **WARNING**

Personal injury or death can result from high voltage.

Moisture could create paths of electrical conductivity.

Make sure the unit is off line (disconnected from utility and/or other generators), locked out and tagged "Do Not Operate".

#### NOTICE

Water or condensation can cause damage to generator components. Protect all electrical components from exposure to water.

#### NOTICE

Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- · Easy detection of fluid leaks
- · Maximum heat transfer characteristics
- Ease of maintenance

#### **NOTICE**

Water and/or condensation can cause damage to electrical components. Protect all electrical components from exposure to water.

**Note:** For more information on cleaning and drying electric generators, refer to Special Instruction, SEHS9124, "Cleaning and Drying of Electric Set Generators".

i01749609

## **Engine Air Cleaner Element - Replace**

SMCS Code: 1051-510; 1054-510

#### NOTICE

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

#### NOTICE

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

## **Servicing the Air Cleaner Elements**

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

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

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

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

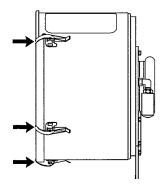


Illustration 37

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Fasteners for the air cleaner cover

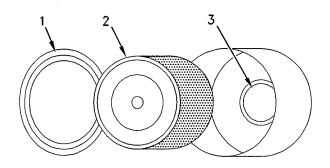


Illustration 38

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

g00781084

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

## Cleaning the Primary Air Cleaner Elements

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

Use clean elements while dirty elements are being cleaned.

#### NOTICE

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

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

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

#### **Pressurized Air**

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

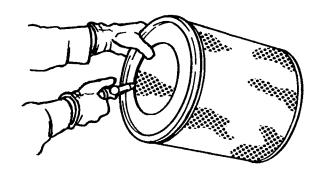


Illustration 39

q00281692

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

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

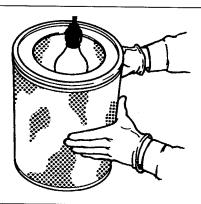
**Note:** Refer to "Inspecting the Primary Air Cleaner Elements".

#### **Vacuum Cleaning**

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

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

## Inspecting the Primary Air Cleaner Elements



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

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

#### **Storing Primary Air Cleaner Elements**

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

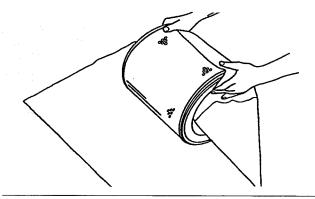


Illustration 41

g00281694

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

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

- · Date of cleaning
- Number of cleanings

Store the container in a dry location.

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

i01505252

## **Engine Air Cleaner Service Indicator - Inspect**

SMCS Code: 7452-040

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

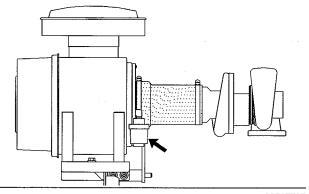


Illustration 42

g00517797

Service indicator

Some engines may be equipped with a different service indicator.

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

- · The yellow diaphragm enters the red zone.
- · The red piston locks in the visible position.
- The air restriction reaches 3.7 kPa (15 inches of H₂O).

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

#### Test the Service Indicator

Service indicators are important instruments.

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

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

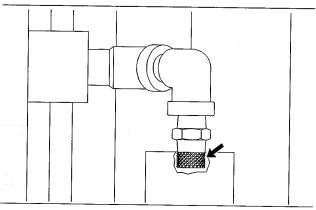


Illustration 43

g00351792

Porous filter

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

The service indicator may need to be replaced frequently in environments that are severely dusty. Replace the service indicator annually regardless of the operating conditions. Replace the service indicator when the engine is overhauled, and whenever major engine components are replaced.

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

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## **Engine Air Precleaner - Clean**

SMCS Code: 1055-070

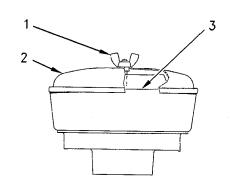


Illustration 44

g00736588

Typical precleaner

- (1) Wing nut
- (2) Cover
- (3) Body

Remove wing nut (1) and cover (2). Check for an accumulation of dirt and debris in body (3). Clean the body, if necessary.

After cleaning the precleaner, install cover (2) and wing nut (1).

**Note:** When the engine is operated in dusty applications, more frequent cleaning is required.

i01519474

## **Engine Crankcase Breather - Clean**

SMCS Code: 1317-070

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

Perform this maintenance when the engine is stopped.

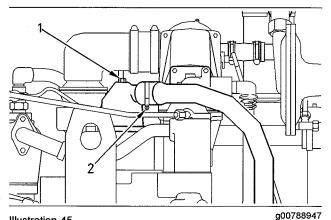


Illustration 45

- (1) Retaining bolt
- (2) Hose clamp
- 1. Loosen retaining bolt (1).
- 2. Loosen hose clamp (2). Remove the breather assembly and the seal.
- **3.** Wash the breather in clean nonflammable solvent. Allow the breather to dry.
- **4.** Inspect the seal for good condition. Obtain a new seal, if necessary.

**Note:** Coat the rubber parts with clean engine oil or petroleum jelly in order to make installation easier.

**5.** Install the seal and the breather in the original position.

Tighten the hose clamp. For the proper torque, see this Operation and Maintenance Manual, "Torque Specifications" (Maintenance Section).

Install the retaining bolt. For the proper torque, see the Service Manual, "Specifications" module.

i02017664

## **Engine Mounts - Check**

SMCS Code: 1152-535

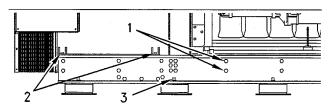


Illustration 46

g00736591

- (1) Mounting bolts for the engine
- (2) Mounting bolts for the generator
- (3) Levelling bolts for the isolators

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

- · Improper mounting
- · Loose bolts
- · Deterioration of the isolators

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

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

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

i02150939

## **Engine Oil Level - Check**

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

The most accurate check of the oil level is performed when the engine is stopped. Perform this maintenance on a surface that is as level as possible.

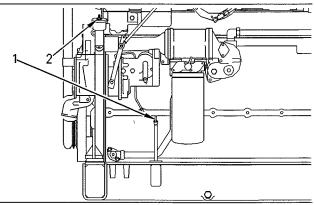


Illustration 47

q00788953

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

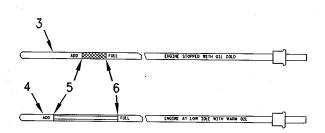


Illustration 48

g00735162

- (3) "ENGINE STOPPED" side
- (4) "LOW IDLE" side
- (5) "ADD" mark
- (6) "FULL" mark
- 1. Ensure that oil level gauge (1) is seated.
  - a. If the engine is stopped, remove oil level gauge (1). Observe the oil level on "ENGINE STOPPED" side (3).
  - b. If the engine is operating, reduce the engine speed to low idle. Remove oil level gauge (1) and observe the oil level on "LOW IDLE" side (4).

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

#### NOTICE

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

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

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

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

- 2. If necessary, remove oil filler cap (2) and add oil. For the correct oil to use, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section). Do not fill the crankcase above "FULL" mark (6). Clean the oil filler cap. Install the oil filler cap.
- Record the amount of oil that is added. For the next oil sample and analysis, include the total amount of oil that has been added since the previous oil sample. This will help to provide the most accurate oil analysis.

i01004097

## **Engine Oil Sample - Obtain**

SMCS Code: 1348-554-SM

In addition to a good preventive maintenance program, Caterpillar recommends using S-O-S oil analysis at regularly scheduled intervals in order to monitor the condition of the engine and the maintenance requirements of the engine.

## Obtain the Sample and the Analysis

### **WARNING**

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

Before taking the sample, complete the Label, PEEP5031 for identification of the sample. To help obtain the most accurate analysis, provide the following information:

- Engine model
- Service hours on the engine
- · The oil's hours of use
- The amount of oil that has been added since the last oil change

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

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



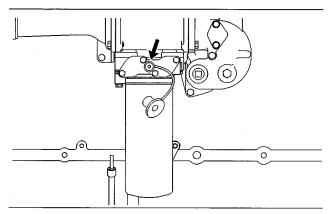


Illustration 49

g00403338

Oil sampling valve

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

The 8T-9190 Fluid Sampling Bottle Group is recommended for use with the sampling valve. The bottle group includes the parts that are needed for obtaining oil samples. Instructions are also provided.

#### NOTICE

Do not use the same vacuum sampling pump for extracting oil samples that is used for extracting coolant samples.

A small residue of either type sample may remain in the pump and may cause a false positive analysis for the sample being taken.

Always use a designated pump for oil sampling and a designated pump for coolant sampling.

Failure to do so may cause a false analysis which could lead to customer and dealer concerns.

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

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

## **Engine Oil and Filter - Change**

SMCS Code: 1318-510

### **WARNING**

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

#### NOTICE

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

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

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

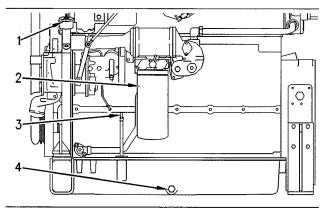


Illustration 50

g00788965

- (1) Oil filler
- (2) Oil filter
- (3) Oil level gauge (dipstick)
- (4) Oil drain plug

## **Drain the Engine Oil**

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

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

2. Drain the oil.

- a. If the engine has an oil drain valve, open the valve in order to drain the oil. After the oil has drained, close the valve.
- b. If the engine does not have a drain valve, remove an oil drain plug. Allow the oil to drain.

After the oil has drained, install the oil drain plug and tighten the plug according to the engine's Specifications.

## Replace the Oil Filter

- 1. Remove the oil filter with a 1U-8760 Chain Wrench.
- 2. Cut the oil filter open with a 4C-5084 Oil Filter Cutter. Break apart the pleats and inspect the oil filter for metal debris.

An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

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

Nonferrous metals may indicate wear on the aluminum parts, brass parts or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

Aluminum debris may indicate problems with the bearings of the front gears. If you find aluminum debris, inspect the vibration damper and the bearings of the front idler gear.

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

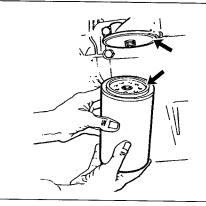


Illustration 51

g00103713

Typical filter mounting base and filter gasket

Clean the sealing surface of the filter mounting base. Ensure that all of the old oil filter gasket is removed.

#### NOTICE

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

4. Apply clean engine oil to the new oil filter gasket.

#### NOTICE

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

5. Install the oil filter. Tighten the oil filter until the oil filter gasket contacts the base. Tighten the oil filter by hand according to the instructions that are shown on the oil filter. Do not overtighten the oil filter.

## Fill the Engine Crankcase

#### NOTICE

Only use oils that are recommended by Caterpillar. For the proper oil to use, refer to this Operation and Maintenance Manual, "Engine Oil" topic (Maintenance Section).

NOTICE

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

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

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

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

 Remove the oil filler cap. Fill the crankcase with the proper amount of oil. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section).

#### NOTICE

To prevent crankshaft damage or bearing damage, crank the engine with the fuel supply line closed. This will ensure that all of the oil filters are filled with oil before the engine is started. Do not crank the engine for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking again.

- 2. Close the fuel supply line. Crank the engine until normal oil pressure shows on the oil pressure gauge. Open the fuel supply line.
- 3. Start the engine according to this Operating and Maintenance Manual, "Starting the Engine" procedure (Operation Section). Operate the engine at low idle rpm for two minutes.

This will ensure that the lubrication system has oil and that the oil filters are filled. Inspect the engine for oil leaks.

- **4.** Stop the engine and allow the oil to drain back to the sump for a minimum of ten minutes.
- 5. Remove the oil level gauge and check the oil level. Maintain the oil level between the "ADD" and "FULL" marks on the "ENGINE STOPPED" side of the oil level gauge.

i01042067

## **Engine Performance - Test**

SMCS Code: 1000-081

Operate the engine for a minimum of two hours at a minimum load of 60 percent.

- Monitor the operation of the generator set.
- Observe the gauges. Ensure that the gauges are in the normal ranges.
- Record the data. Maintain a record of the data for the engine performance.

i00626013

## **Engine Protective Devices - Check**

**SMCS Code:** 7400-535

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

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

#### **NOTICE**

During testing, abnormal operating conditions must be simulated.

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

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

## Visual Inspection

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

i01626234

## Engine Valve Lash - Inspect/Adjust

**SMCS Code:** 1102-025

#### **A** WARNING

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

For procedures on adjusting the engine valve lash, refer to the engine's Service Manual, "Systems Operation/Testing and Adjusting".

Consult your Caterpillar dealer for assistance.

#### NOTICE

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

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

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

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

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

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

For the valve lash setting, refer to the Operation and Maintenance Manual, "Engine Description" topic (Product Information Section).

i01765711

## **Engine Valve Rotators - Inspect**

SMCS Code: 1109-040

#### NOTICE

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

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

Perform this procedure after the valve lash has been set.

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

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

i01505507

## **Exhaust Bypass - Inspect**

SMCS Code: 1057-040

**S/N**: G6X1-Up **S/N**: 07Y1-Up

For instructions on removal and installation, see the Service Manual, "Disassembly and Assembly".

1. Remove the exhaust bypass valve.

## **WARNING**

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

2. Disassemble the valve.

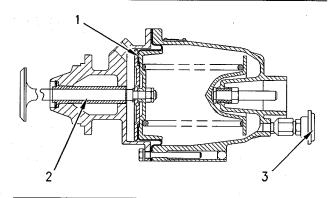


Illustration 52

g00781274

Exhaust bypass valve

- (1) Diaphragm
- (2) Valve stem
- (3) Breather
- 3. Inspect diaphragm (1). If the diaphragm is worn or cracked, replace the diaphragm.
- **4.** Inspect valve stem (2) and the valve guide. If the parts are excessively worn, replace the parts.
- 5. Clean breather (3).
- 6. Assemble the valve.
- 7. Install the valve.

i00721010

## **Exhaust Piping - Inspect**

SMCS Code: 1061-040

## **⚠** WARNING

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

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

- Damage
- Cracks
- Leaks
- Loose connections

Consult your Caterpillar dealer for assistance.

#### Water Cooled Exhaust Manifolds

The water cooled exhaust manifolds do not require maintenance unless excessive deposits build up in the exhaust passages. Buildup of deposits cause an increase in back pressure that will cause the following conditions:

- · Increased fuel consumption
- · Reduced boost pressure

If excessive deposits build up in the exhaust passages, clean the passages in order to remove the deposits.

i01505536

## Fuel System Fuel Filter Differential Pressure - Check

**SMCS Code:** 1261-535

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

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

Operate the engine at the rated speed and at the normal operating temperature. Check the fuel filter differential pressure. Service of the fuel filter depends on the pressure of the fuel system:

- For low pressure gas fuel systems, service the fuel filter when the fuel filter differential pressure reaches 1.7 kPa (0.25 psi).
- For high pressure gas fuel systems, service the fuel filter when the fuel filter differential pressure reaches 34 kPa (5 psi).

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

Gas Pressure Regulator - Check

SMCS Code: 1270-535

Check the fuel pressure before the gas pressure regulator and after the gas pressure regulator. Table 18 lists the fuel pressure that is required for the gas pressure regulator.

Table 18

Requirements for Fuel Pressure To the Gas Pressure Regulator		
Fuel System	Pressure	
Low pressure gas for naturally aspirated engines	10.3 to 34 ± 2 kPa (1.50 to 5 ± 0.25 psi)	
High pressure gas for turbocharged engines	172 to 207 ± 7 kPa (25 to 30 ± 1 psi)	

## Pressure of the Fuel Supply To the Carburetor

The gas pressure regulator maintains a pressure differential between the air and the fuel that is supplied to the carburetor. After setting, the gas pressure regulator will maintain the pressure differential in response to changes in the air pressure.

Use a water manometer for measuring the pressure differential. Obtain the measurement when the engine is operating at high idle rpm. After a load is applied, the fuel pressure will usually decrease by approximately 0.1 to 0.25 kPa (0.50 to 1 inches of  $H_2O$ ). If the performance of the gas pressure regulator is erratic, the gas pressure regulator may require service.

#### **Natural Gas**

Set the pressure of the fuel supply to a maximum of 1 to 1.2 kPa (4 to 4.5 inches of  $H_2O$ ) HIGHER than the ambient air pressure.

#### Propane

Set the pressure of the fuel supply to  $-0.37 \pm -0.06$  kPa ( $-1.5 \pm 0.250$  inches of H<sub>2</sub>O) LOWER than the ambient air pressure. Refer to Special Instruction, REHS0371, "Installation And Initial Start Up Procedures For G3300 And G3400 Engines".

i01041704

## Governor - Inspect

SMCS Code: 1264-040

Inspect the governor for oil leaks.

For service information, see the literature that is provided by the OEM of the governor.

i02121526

# Hoses and Clamps - Inspect/Replace

SMCS Code: 7554-040; 7554-510

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking
- Softness
- · Loose clamps

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

#### NOTICE

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

Check for the following conditions:

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

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

Due to extreme temperature changes, the hose will heat set. Heat setting causes hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

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

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

### Replace the Hoses and the Clamps

#### **WARNING**

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

- 1. Stop the engine. Allow the engine to cool.
- Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

**Note:** Drain the coolant into a suitable, clean container. The coolant can be reused.

- Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
- Remove the hose clamps.
- 5. Disconnect the old hose.
- 6. Replace the old hose with a new hose.
- 7. Install the hose clamps with a torque wrench.

**Note:** Refer to the Specifications, SENR3130, "Torque Specifications" in order to locate the proper torques.

- 8. Refill the cooling system.
- Clean the cooling system filler cap. Inspect the cooling system filler cap's gaskets. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.

Start the engine. Inspect the cooling system for leaks.

i01819514

## **Hoses and Clamps - Replace**

**SMCS Code:** 1380-510

Note: For instructions on draining the cooling system and filling the cooling system, see this Operation and Maintenance Manual, "Cooling System Coolant (DEAC) - Change" topic or see the Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change" topic (Maintenance Section).

- 1. Drain the cooling system.
- Remove the used hoses and clamps. Discard the items.
- Install new hoses and clamps. For the correct torque to use on the hose clamps, see the Specifications, RENR3130, "Torque Specifications", "Hose Clamps" topic.
- 4. Fill the cooling system.
- Start the engine. Inspect the hose connections for leaks.

i01042052

## Ignition System Spark Plug Wires - Replace (Standard Ignition Systems)

**SMCS Code:** 1558-510

## **WARNING**

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

#### **NOTICE**

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

- Disconnect the spark plug wire assembly from the transformer.
- Disconnect the wire assembly from the spark plug. Discard the wire assembly.
- 3. Connect the new wire assembly to the spark plug.
- Connect the wire assembly to the transformer.

# Ignition System Spark Plugs - Check/Adjust/Replace

SMCS Code: 1555-535

#### **A WARNING**

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

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

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

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

## Remove the Spark Plug

#### NOTICE

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

#### Standard Ignition System

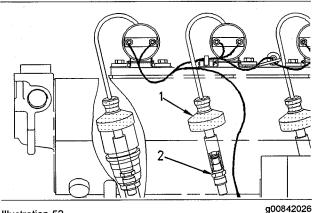


Illustration 53

Standard ignition system

- (1) Cover
- (2) Spark plug

1. Remove cover (1).

## Ignition Systems With Integral Transformers

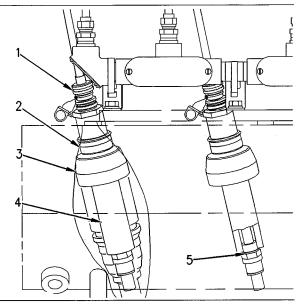


Illustration 54

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Ignition system with integral transformers

- (1) Connector
- (2) Clamp
- (3) Boot
- (4) Transformer
- (5) Gasket
- 1. Loosen connector (1).
- 2. Loosen clamp (2).
- 3. Remove boot (3).
- 4. Unscrew transformer (4).
- **5.** Remove gasket (5). Discard the gasket.

### Removing the Spark Plug

#### **A WARNING**

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

1. Debris may have collected in the spark plug well. Thoroughly remove any debris. Use compressed air. The maximum air pressure for cleaning purposes must be below 207 kPa (30 psi). Ensure that the area around the spark plug is clean and free of dirt and debris.

2. To loosen the spark plug, use a 2P-5481 Deep Well Socket. After the spark plug has been loosened, remove the spark plug by hand in order to detect problems with the threads. After the spark plug has been removed, discard the used spark plug gasket.

#### NOTICE

The use of a thread tap will remove metal unnecessarily. This will also reduce the heat transfer for the spark plug. This can result in a reduction of the spark plug service life and a reduction of the detonation margin.

If the spark plug resists removal by hand, apply penetrating oil to the threads. Use the wrench and apply steady pressure to the spark plug until the spark plug is loose.

If the spark plug can not be removed by hand, clean the threads with a 154-9521 Spark Plug Seat Cleaner. This tool scrapes debris from the seat and from the threads in the cylinder head.

## Inspecting the Spark Plug

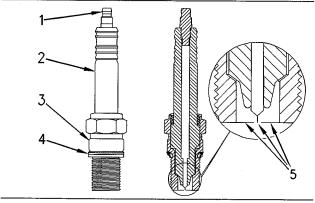


Illustration 55

g00842036

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

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

Terminal post (1) must not move. If the terminal post can be moved by hand, discard the spark plug.

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

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

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

Inspect the electrode and ground straps (5) for excessive wear. Flat surfaces with sharp edges provide the best conditions for creating a spark. An electrode will become worn from use. The surfaces erode. A higher voltage is required in order to produce a spark.

Caterpillar spark plugs have precious metal tips on the electrode and the ground straps. This material will gradually erode. Use extreme care for setting the electrode gap. Maintain even spacing between the two ground straps and the electrode.

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

Normal operation will produce a light brown deposit around the electrode.

White deposits or gray deposits may be caused by the following substances:

- Excessive oil
- Use of the wrong oil
- A substance that is introduced through the fuel system or the air system

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

## Cleaning the Spark Plug

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

Follow these guidelines for using glass beads:

- Always use clean glass beads.
- Use care in order to clean only the electrode and the insulator near the electrode

Do not use glass beads on the outside of the shell or on the upper part of the insulator.

### Installing the Spark Plug

Note: Do not use a flat feeler gauge for measuring the electrode gap of used spark plugs. A feeler gauge will falsely measure the actual electrode gap. This is due to the curvature of the used precious metal surfaces.

1. Before installing the spark plug, set the electrode gap to  $0.635 \pm 0.025$  mm (.0250  $\pm$  .0010 inch). Use the 9U-7516 Spark Plug Gauge.

Adjust the electrode gap in order to achieve proper alignment and even spacing between the precious metal surfaces. Measure the electrode gap after the alignment. Correct the electrode gap, if necessary.

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

- 2. Ensure that the spark plug is clean and free of dirt and oil.
- 3. Always use a new gasket when a spark plug is installed. If a used spark plug is installed, place a new 108-3515 Plug Gasket on the spark plug. Orient the tabs of the gasket toward the electrode. Otherwise, the gasket may not seat properly. If a gasket for a spark plug is installed incorrectly, do not increase the torque on the spark plug in order to improve the seal. Do not reuse the gasket. Install a new gasket.

#### NOTICE

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

Use the proper torque.

- 4. Install the spark plug by hand until the spark plug bottoms out. Tighten the spark plug to 30 ± 4 N·m  $(22 \pm 3 lb ft)$ .
- 5. Ensure that the cover is clean and free from dirt and oil. Inspect the connector for cleanliness.
- 6. Install the cover. Ensure a good connection for the connector and the spark plug.

#### Installing the Spark Plugs and the Integral Transformer

1. Follow Steps 1 through 4 from the "Installing the Spark Plug" instructions.

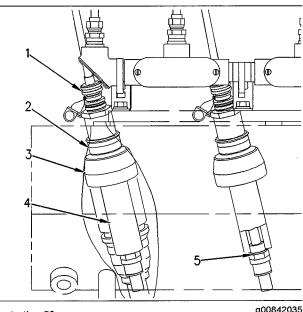


Illustration 56

g00842035

Ignition system with integral transformers

- (1) Connector
- (2) Clamp
- (3) Boot
- (4) Transformer
- (5) Gasket
- 2. Install new 108-6561 Gasket (5) on the spark plug.

The gasket is copper. Whenever the transformer is removed, always install a new gasket.

3. Ensure that transformer (4) is clean and free from dirt and oil. Screw the transformer by hand onto the spark plug.

Tighten the transformer until the transformer bottoms out on the copper gasket. Tighten the transformer for an additional 1/8 of a turn (45 degrees). Do not overtighten the transformer.

- 4. Inspect boot (3) for cleanliness and good condition. Install the boot.
- 5. Tighten clamp (2).
- 6. Inspect connector (1) for cleanliness and good condition. Reconnect the connector. Align the threads properly. For a correctly fastened connector, very little thread or no thread is visible.

# Ignition System Timing - Check/Adjust

SMCS Code: 1550-025; 1550-535

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

The optimum ignition timing for a gas engine varies according to several factors:

- · Compression ratio of the engine
- · Inlet air temperature
- · Methane number of the gas

For the proper timing, see the Engine Performance publication for the engine.

Adjust the timing according to the Service Manual, "Systems Operation/Testing and Adjusting" module. Consult your Caterpillar dealer for assistance.

i00682407

## Ignition System Transformer Resistance - Test

SMCS Code: 1550-081

The transformers produce a voltage increase. For good operation, the connections must be clean and secure. Inspect the transformers for the following conditions. If any of the conditions are found, correct the condition:

- Corrosion
- · Dirty insulator
- · Loose connections
- Moisture
- · Open circuits
- Short circuits

Test the resistance of the transformers. Test each transformer at both the side with high voltage and the side with low voltage. See the Service Manual, "Specifications" module for the procedure. Consult your Caterpillar dealer for assistance.

i01113853

## Inlet Air System - Inspect

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

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

- Cracks
- Leaks
- · Loose connections

Inspect the following components:

- · Piping between the air cleaner and the turbocharger
- Turbocharger
- Piping between the turbocharger and the aftercooler
- Aftercooler
- Connection of the aftercooler to the air plenum
- · Connection of the air plenum to the cylinder head

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

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

i01021379

## **Instrument Panel - Inspect**

SMCS Code: 7451-040

Inspect the instrument panel for good condition. Check the condition of all of the gauges. If a gauge is broken, repair the gauge or replace the gauge immediately.

Frequently monitor the following parameters during normal operation:

- Fuel filter differential pressure
- · Inlet air restriction
- Inlet manifold air temperature
- · Jacket water temperature

- Oil filter differential pressure
- · Oil pressure

Record the data in a log. Compare the new data to the data that was previously recorded. Comparing the new data to the recorded data will establish the normal gauge readings for the engine. A gauge reading that is abnormal may indicate a problem with operation or a problem with the gauge.

i01042517

### **Jacket Water Heater - Check**

SMCS Code: 1383-535

Jacket water heaters help to improve startability in ambient temperatures that are below 21 °C (70 °F). All installations that require automatic starting should have jacket water heaters.

Check the operation of the jacket water heater. For an ambient temperature of 0 °C (32 °F), the heater should maintain the jacket water temperature at approximately 32 °C (90 °F).

i02049014

## Overhaul (Major)

SMCS Code: 7595-020-MJ

## **Scheduling a Major Overhaul**

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

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

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

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

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

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

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

- · The service hours of the engine
- · The wear metal analysis of the lube oil
- An increase in the levels of noise and vibration

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

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

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

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

## **Major Overhaul Information**

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

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

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

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

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

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

**Rebuild** – The component may be reconditioned in order to comply with reusability guidelines. If the component cannot be rebuilt, replace the component.

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

Table 19

	Major Overhaul	
Inspect	Aftercooler	
	Alternator	
	Camshafts	
	Camshaft followers	
	Connecting rods	
	Crankshaft	
	Gear train	
	Governor	
	Inlet air piping	
	Oil cooler	
	Oil pump	
	Pistons	
	Transformers	

(continued)

(Table 19, contd)

Major Overhaul				
Rebuild	Carburetor			
	Cylinder packs			
	Exhaust bypass (if equipped)			
	Gas regulator			
	Inlet air piping			
	Oil pump			
	Starting motor			
	Turbocharger			
	Water pumps			
Replace	Alternator and fan drive belts			
	Camshaft bearings			
	Connecting rod bearings			
	Crankshaft bearings			
	Crankshaft seals			
	Crankshaft vibration damper			
	Cylinder liners			
	Cylinder head and gaskets			
	Exhaust manifold			
	Gaskets and seals			
	Gear train bearings			
	Governor			
•	Hoses and clamps			
	Piston rings			
	Rod ends			
	Spark plugs			
	Spark plug wires			
	Transformers			
	Water temperature regulators			
	Wiring harnesses			

## Overhaul (Top End)

SMCS Code: 7595-020-TE

## **Scheduling a Top End Overhaul**

Top end overhauls are scheduled according to the recession of the exhaust valve stems. This measurement provides an accurate indication of the rate of valve wear. This measurement can be used to predict when a cylinder head requires replacement. For more information, see this Operation and Maintenance Manual, "Valve Stem Projection - Measure/Record" topic.

**Note:** The generator or the driven equipment may also require service when the engine overhaul is performed.

#### **Top End Overhaul Information**

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

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

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

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

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

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

Degradation of the oil cooler from hydrogen sulfide in the fuel

Inspect the following components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, "Index of Publications on Reusability or Salvage of Used Parts".

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

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

#### **Replacing of Components**

**Note:** The cylinder head may be rebuilt, when possible.

Replace the following components during a top end overhaul.

- · Alternator and fan drive belts
- · Cylinder heads and gaskets
- Hoses and clamps
- · Rod ends for the control linkage of the actuator
- · Spark plugs
- Spark plug wires
- · Water temperature regulator

#### **Rebuilding of Components**

Rebuild the following components during a top end overhaul:

- Carburetor
- Gas regulator
- Magneto
- Starting motor
- Turbocharger
- Water pumps

Note: Periodic inspection of the turbocharger is recommended for determining when the turbocharger will require an overhaul. In a few applications, the turbocharger may require rebuilding prior to the top end overhaul. An example is an application with loads that vary frequently. In these cases, rebuilding the turbocharger normally occurs separately from rebuilding the cylinder heads. Some applications can operate longer before the turbocharger requires rebuilding. Only experience can determine the actual need.

#### **Inspecting of Components**

Clean the following components. Pressure test the components. Replace the components, if necessary:

- · Aftercooler core (if equipped)
- Oil cooler core

**Note:** If proper maintenance of the cooling system is not performed, the aftercooler core can be very difficult to clean.

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

- Remove the core. For the procedure, see the Service Manual, "Disassembly and Assembly" module.
- Turn the core upside-down in order to remove debris.

#### NOTICE

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

#### NOTICE

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

3. Back flush the core with cleaner.

Caterpillar recommends the use of Hydrosolv liquid cleaner. Use a two to five percent concentration of the cleaner at temperatures up to 93 °C (200 °F). Refer to Application Guide, NEHS0526 or consult your Caterpillar dealer for more information.

Steam clean the core in order to remove any residue. Flush the fins of the core. Remove any other trapped debris. **5.** Wash the core with hot, soapy water. Rinse the core thoroughly with clean water.

#### **WARNING**

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

6. Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.

**Note:** The test pressure for the oil cooler is 790 kPa (115 psi). The maximum differential pressure of water for the aftercooler is 44 kPa (6 psi). The maximum differential pressure of air for the aftercooler is 5.1 kPa (.74 psi).

- 7. Inspect the core in order to ensure cleanliness. Pressure test the core. Many shops that service radiators are equipped to perform pressure tests. If necessary, repair the core.
- 8. Install the core. For the procedure, see the Service Manual, "Disassembly and Assembly" module.

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

#### **Exhaust Bypass**

Inspect the condition of the exhaust bypass (if equipped). Recondition the component, if necessary. See this Operation and Maintenance Manual, "Exhaust Bypass - Inspect" topic (Maintenance Section).

#### Governor

Inspect the governor for proper operation. Make any repairs that are necessary.

#### **Transformers**

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

- Dirty insulator
- Loose connections
- Loose connector

Moisture

Test the resistance of the transformers according to the Service Manual, "Specifications" module. Consult your Caterpillar dealer for assistance.

i02049051

#### **Overhaul Considerations**

SMCS Code: 7595-043

#### **Overhaul Information**

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

An overhaul also includes the following maintenance:

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

Most owners will save money by overhauling the engine at the intervals that are recommended in this Operation and Maintenance Manual. It is not practical to wait until the engine exhibits symptoms of excessive wear or failure. It is not less costly to wait. A planned overhaul before failure may be the best value for the following reasons:

- · Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the guidelines for reusable parts.
- The service life of the engine can be extended without the risk of a major catastrophe due to engine failure.
- Achieve the best cost/value relationship per hour of extended service life.

#### Overhaul Intervals

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

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

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

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

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

#### **Overhaul Inspection**

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

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

The Guidelines For Reusable Parts and Salvage Operations is part of an established Caterpillar parts reusability program. These guidelines were developed in order to assist Caterpillar dealers and customers reduce costs by avoiding unnecessary expenditures for new parts. If the engine parts comply with the established inspection specifications, the parts can be reused. New parts are not necessary if the old parts can be reused, repaired, or salvaged.

If the parts are not within the inspection specifications, the parts should be salvaged, repaired, replaced, or exchanged. The use of out-of-spec parts could result in unscheduled downtime and/or costly repairs. The use of out-of-spec parts can also contribute to increased fuel consumption and reduction of engine efficiency.

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

**Overhaul Programs** 

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

- Alternators
- Connecting rods
- · Crankshafts
- · Cylinder heads
- Oil Pumps
- · Starting motors
- Turbochargers
- Water pumps

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

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

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

#### **Overhaul Recommendation**

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

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

i01506009

# Power Take-Off Clutch - Check/Adjust/Lubricate

SMCS Code: 3055-036; 3055-086

#### NOTICE

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

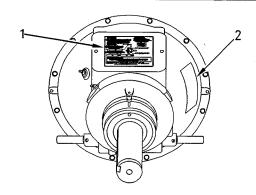


Illustration 57

g00781502

- (1) Instruction plate
- (2) Serial number plate

Check the clutch adjustment regularly after "wear in". Heavy-duty applications which have engagements that are frequent and relatively long periods of clutch slippage require more frequent adjustment than light-duty applications. The operating torque should be measured in order to determine if a clutch adjustment is required.

Refer to the OEM information and instruction plate (1) for instructions on lubrication, adjustment, and other recommendations for service. Perform the maintenance that is specified on the instruction plate.

### **WARNING**

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

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

## Radiator - Clean

**SMCS Code:** 1353-070

**Note:** Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the radiator for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the radiator, if necessary.

### **WARNING**

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a "comb". Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, refer to Special Publication, SEBD0518, "Know Your Cooling System".

i01511915

## **Speed Sensor - Clean/Inspect**

SMCS Code: 1907-040; 1907-070

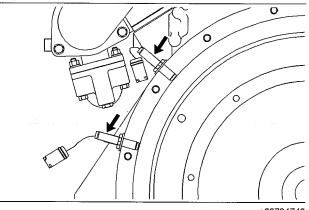


Illustration 58

Speed sensors

guu/84/40

- Remove the speed sensor from the flywheel housing. Check the condition of the end of the magnet. Check for signs of wear and contaminants.
- 2. Clean the metal shavings and other debris from the face of the magnet.
- Install the speed sensor and adjust the speed sensor according to the engine's Specifications module.

i01038735

## Standby Generator Set Maintenance Recommendations

SMCS Code: 4450-041

A standby generator set may not need to be used very often. However, the generator set is usually needed for operation in an emergency situation. Maintenance of the standby generator set is very important for the following reasons:

- The generator set must always be in excellent operating condition.
- The generator set must be ready to work under load at any time.

Establishing a Preventive Maintenance Program will provide these benefits:

Maximum availability of the standby generator set

- · Longer service life for the generator set
- Minimum of expensive repairs

Your Caterpillar dealer can help you to establish an effective Preventive Maintenance Program for your generator set. Consult your Caterpillar dealer for details.

## Maintenance and Operation Procedures

#### **MARNING**

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the "OFF" position. Attach "DO NOT OPERATE" tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

The recommended maintenance for the engine is listed in this Operation and Maintenance Manual, "Maintenance Interval Schedule (Standby Generator Set Engines)" (Maintenance Section).

For the recommended generator maintenance, see the Operation and Maintenance Manual for the generator and the control panel.

### Maintenance and Repair

The maintenance that is recommended for Every Week can be performed by an authorized operator. The maintenance that is recommended for the subsequent maintenance intervals must be performed by an authorized service technician or by your Caterpillar dealer.

Unless other instructions are provided, perform maintenance and repairs under the following conditions:

- The engine is stopped.
- The starting system is disabled.
- The generator does not pose an electrical shock hazard.

#### Operation

To ensure proper operation, the generator set must be exercised regularly. For instructions on operating the generator set, see the Operation and Maintenance Manual for the generator set control panel.

For these operation procedures, follow the instructions that are provided in this Operation and Maintenance Manual, "Operation Section": starting the engine, engine operation, and stopping the engine.

#### **Record Keeping**

Maintain a record in order to document these items: gauge readings, maintenance that is performed, problems, and repairs.

#### **Space Heaters**

Moisture causes damage to generators and other electrical equipment. Make every effort to keep the generator set as dry as possible.

Generators can operate without problems in humid environments. However, problems can occur when the generator is inactive. Moisture can condense on the windings. This can result in poor performance. Also, damage to the windings can occur.

Use space heaters in order to help keep the windings dry. When the generator is not active, ensure that the space heaters are operating. When the generator is operating, turn OFF the space heaters.

i01113939

## **Starting Motor - Inspect**

SMCS Code: 1451-040; 1453-040

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

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

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

## **Electric Starting Motor**

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

Inspect the electrical system for the following conditions:

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

Make repairs, if necessary.

## **Air Starting Motor**

### **A** WARNING

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

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

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

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

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

## Removal and Installation of the Starting Motor

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

Consult your Caterpillar dealer for assistance.

i01012850

## **Turbocharger - Inspect**

SMCS Code: 1052-040

**S/N:** G6X1-Up **S/N:** 07Y1-Up

Periodic inspection and cleaning is recommended for the turbocharger.

Fouling of the turbine wheels can contribute to loss of engine power and overall loss of engine efficiency.

If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel could allow parts from the compressor wheel to enter an engine cylinder. This can cause additional damage to the pistons, the valves, and the cylinder head.

#### NOTICE

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

Minor leakage of a turbocharger housing under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is repaired or replaced.

An inspection of the turbocharger can minimize unscheduled downtime. Also, the chance for potential damage to other engine parts is reduced.

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

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

- · The buildup of deposits
- · Chipping and/or flaking of deposits

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

- Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil.
- 2. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger should be reconditioned.
- 3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the wheel, there is a possibility of a failed turbocharger oil seal.

The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the inlet air (plugged air filters), which causes the turbocharger to slobber.

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

- 4. Inspect the turbine wheel for deposits. If deposits of 25 mm (1/16 inch) thickness are found or if the turbine is in contact with the housing, the turbocharger must be disassembled and cleaned. The deposits can be very difficult to remove.
- **5.** Inspect the bore of the turbine housing for corrosion and deposits.
- **6.** Clean the turbocharger compressor housing with standard shop solvents and a soft bristle brush.
- 7. Check the clearances of the turbocharger bearing. Compare the clearances to the Service Manual, "Specifications". If the clearances are not within the specifications, the turbocharger must be repaired.

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

i01360109

## Valve Stem Projection - Measure/Record

SMCS Code: 1105-082

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

The exhaust valves and valve seats show the greatest wear due to high operating temperatures. The top end overhaul is normally scheduled according to the exhaust valve recession.

It is difficult to obtain an accurate measurement of valve recession inside the cylinder head. Use the following method in order to determine the valve recession:

- Remove the valve cover. For instructions, see the Service Manual, "Disassembly and Assembly" module.
- 2. Move the rocker arm from the top of the valve stem.
- 3. Use a depth micrometer. Obtain the measurement from the tip of the valve stem to the cylinder head. Obtain this measurement for each exhaust valve.

Make several copies of this Operation and Maintenance Manual, "Valve Data Sheet" (Reference Materials Section). Record the measurements on the sheets.

- The projection of the exhaust valve stems should be measured after completion of the initial start-up tests and the engine commissioning. This measurement is the baseline. The baseline is a reference for subsequent measurements.
- Measure the projection of the exhaust valve rotators at the first oil change interval. Illustration 59 shows schedules for determining subsequent intervals.

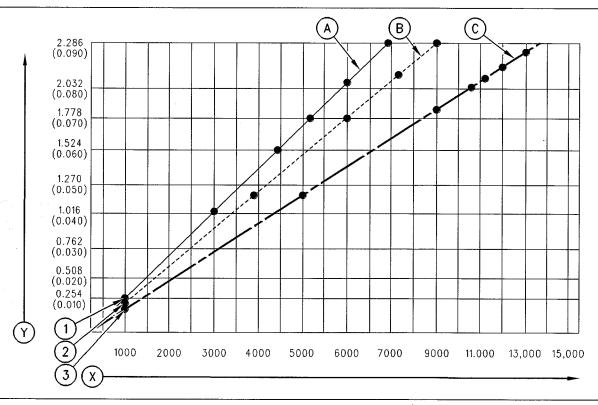


Illustration 59

(A) Schedule

(B) Schedule

(C) Schedule

(Y) Valve recession in millimeters (inches)

(X) Hours of operation

(1) 0.254 mm (0.0100 inch)

g00320513

(2) 0.218 mm (0.0086 inch) (3) 0.152 mm (0.0060 inch)

To determine intervals, use the point on the graph in Illustration 59 that is closest to the measurement for each cylinder.

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

- After 70 percent of the maximum limit has been reached, measure the projection of the exhaust valve stems at every 750 hours of operation (turbocharged engines). For Naturally aspirated engines, perform the measurement at every 1500 hours of operation.
- Plan for the top end overhaul as the valve stem projection approaches the maximum limit.
   Perform the top end overhaul when the valve stem projection has increased by a total of 2.3 mm (0.09 inch). Do not allow the valve recession to exceed this limit. The valve head can break. This will cause severe damage in the combustion chamber and the turbocharger.

Consult your Caterpillar dealer for assistance.

i01492446

## **Walk-Around Inspection**

SMCS Code: 1000-040

## Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, thoroughly inspect the engine room before starting the engine. Look for items such as leaks, loose bolts, loose connections and trash buildup. Make repairs, as needed.

- The guards must be in the proper place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

#### NOTICE

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

#### NOTICE

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

- Ensure that cooling lines are properly clamped.
   Check for leaks. Check the condition of all pipes.
- Inspect the water pumps for coolant leaks.

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

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

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

## **WARNING**

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

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

- Check the fuel system for leaks. Look for loose fuel line clamps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground straps for good connections and for good condition.
- Check the condition of the gauges. Replace any gauge that is damaged. Replace any gauge that can not be calibrated.

 Inspect the exhaust system for leaks. If a leak is found, make repairs.

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## Walk-Around Inspection (Exercise Inspection of Standby Generator Set Engines)

SMCS Code: 1000-040

#### **WARNING**

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

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

- Perform the procedures that are described in this Operation and Maintenance Manual, "Before Starting Engine" topic (Operation Section).
- Start the engine according to the instructions in this Operation and Maintenance Manual, "Engine Starting" topic (Operation Section).

#### **NOTICE**

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

- Perform an inspection of the installation after the engine is started. Look for leaks. Listen for unusual noises.
  - Check the engine oil level when the engine is operating at low idle rpm. Observe the oil level on the "LOW IDLE" side of the oil level gauge (dipstick).
  - Inspect the lubrication system for leaks at the oil pan, the oil filter, and the valve covers.
  - Inspect the cooling system for leaks at the hose connections.
  - Check the fuel system for leaks with a gas detector.
  - Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.

- · Inspect the exhaust system for leaks.
- If the enclosure has louvers, inspect the louvers for proper operation.
- Observe the gauges. Ensure the correct readings for the engine rpm. Record the engine oil pressure and the jacket water temperature.
- Record the data for the performance of the generator. See the Operation and Maintenance Manual for the generator and the control panel.
- 4. After exercising the generator set, stop the engine according to this Operation and Maintenance Manual, "Engine Stopping" topic (Operation Section).
- Perform the procedures that are described in this Operation and Maintenance Manual, "After Stopping Engine" topic (Operation Section).
- **6.** Ensure that the control switches are in the correct position for automatic starting of the generator set.

## Water Pump - Inspect

SMCS Code: 1361-040

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

Visually inspect the water pump for leaks. If leaking of the water pump seals is observed, replace all of the water pump seals. Refer to the Service Manual for the disassembly and assembly procedure.

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



# Reference Information Section

## **Customer Service**

i01028392

## **Ordering Replacement Parts**

SMCS Code: 4450; 7567

#### **WARNING**

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

Quality Caterpillar replacement parts are available from Caterpillar dealers throughout the world. Caterpillar dealers' parts inventories are up-to-date. The parts stocks include all of the parts that are normally needed to protect your Caterpillar engine investment.

When you order parts, please specify the following information:

- Part number
- Part name
- Quantity

If there is a question concerning the part number, please provide your dealer with a complete description of the needed item.

When a Caterpillar engine requires maintenance and/or repair, provide the dealer with all the information that is stamped on the Information Plate. This information is described in this Operation and Maintenance Manual (Product Information Section).

Discuss the problem with the dealer. Inform the dealer about the conditions of the problem and the nature of the problem. Inform the dealer about when the problem occurs. This will help the dealer in troubleshooting the problem and solving the problem faster.

## **Reference Materials**

· Maintenance log

i00912149

#### **Maintenance Records**

SMCS Code: 1000; 4450

Caterpillar Inc. recommends the retention of accurate maintenance records. Accurate maintenance records can be used for the following purposes:

- · Determine operating costs.
- Establish maintenance schedules for other engines that are operated in the same environment.
- Show compliance with the required maintenance practices and maintenance intervals.

Maintenance records can be used for a variety of other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is well managed. Accurate maintenance records can help your Caterpillar dealer to fine tune the recommended maintenance intervals in order to meet the specific operating situation. This should result in a lower engine operating cost.

Records should be kept for the following items:

Fuel Consumption – A record of fuel consumption is essential in order to determine when the load sensitive components should be inspected or repaired. Fuel consumption also determines overhaul intervals.

**Service Hours** – A record of service hours is essential to determine when the speed sensitive components should be inspected or repaired.

**Documents** – These items should be easy to obtain, and these items should be kept in the engine history file. All of the documents should show this information: date, service hours, fuel consumption, unit number, and engine serial number. The following types of documents should be kept as proof of maintenance or repair for warranty:

Keep the following types of documents as proof of maintenance for warranty. Also, keep these types of documents as proof of repair for warranty:

- · Dealer work orders and itemized bills
- · Owner's repair costs
- · Owner's receipts

## **Maintenance Log**

**SMCS Code:** 1000; 4450

Table 20

Engine Model			Customer Identifier				
Serial Number		Arrangement Num	ber				
Service Hours	Quantity Of Fuel	Serv	ice Item	Date	Authorization		
		10-ac-1-0-ac-1-ac-1-ac-1-ac-1-ac-1-ac-1-					
				· .			
		•					
		1444-144-144-144-144-144-144-144-144-14					
					t .		
			V-1/				
	-						
-							

### **Valve Data Sheet**

SMCS Code: 1000

Table 21

Engine Model		Serial Number	Service Hours	Service Hours		Operator	
Cylinder	Cylinder Pressure	Valve Location	Current Measure	Stem Baseline	Rotator Baseline	Wear	
1		Pushrod Side					
		Exhaust Manifold					
2		Pushrod Side					
		Exhaust Manifold					
3		Pushrod Side					
		Exhaust Manifold					
4		Pushrod Side				Mark Mark Mark Mark Mark Mark Mark Mark	
		Exhaust Manifold					
5		Pushrod Side					
		Exhaust Manifold					
6		Pushrod Side					
		Exhaust Manifold					

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## **Reference Material**

SMCS Code: 1000; 4450

The following literature can be obtained through any Caterpillar dealer.

#### Lubricants

- Data Sheet, PEHP0002, "Multipurpose Lithium Complex Grease with Molybdenum (MPGM)"
- Data Sheet, PEHP0003, "Multipurpose Lithium Complex Grease (MPG)"
- Data Sheet, PEHP0017, "Special Purpose Grease (SPG) Bearing Lubricant"
- Data Sheet, PECP0004, "Natural Gas Engine Oil"
- Special Publication, PECP6026, "One Safe Source (NACD)"
- Special Publication, PECP6027, "One Safe Source (COSA)"
- Special Publication, PECP6028, "One Safe Source"

- Special Publication, PEDP7036, "S·O·S Fluid Analysis"
- Special Publication, SEBD0640, "Oil and Your Engine"
- Special Publication, PEWP9733, "Caterpillar Fluids Selector Dial"
- Special Publication, PEHP6001, "How To Take A Good Oil Sample"

#### **Fuels**

- Data Sheet, LEKQ9360, "Internal Combustion Engine Fuel Gases"
- Data Sheet, LEKQ2364, "US Stationary Engine Regulations/Spark Ignited Emissions"
- Data Sheet, LEKQ5404, "Fuels Specifications Changes"
- Application and Installation Guide, LEKQ7256, "Fuels, Fuel Systems"
- Application and Installation Guide, LEKQ7260, "Low Energy Fuels"

 Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations"

#### Coolants

- Data Sheet, PEHP7057, "Coolant Analysis"
- Special Publication, PEDP7036, "S·O·S Fluid Analysis"
- Special Publication, SEBD0518, "Know Your Cooling System"
- Special Publication, SEBD0970, "Coolant and Your Engine"
- Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations"

#### **Miscellaneous**

- Service Manual, RENR5965, "G3304 & G3306 Engines"
- Specifications, SENR7938, "G3304 & G3306 Engines"
- Systems Operation/Testing and Adjusting, SENR7939, "G3304 & G3306 Engines"
- Disassembly and Assembly, RENR5965, "G3304 & G3306 Engines"
- Schematic, RENR5962, "G3304 & G3306 Engines"
- Application and Installation Guide, LEKQ7250, "Air Intake"
- Service Manual, REG1139F, "Service Manual Contents Microfiche"
- Engine Performance, LEBQ4197, "G3300 Gas"
- Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations"
- Software Program, LEKQ6378, "Methane Number Program"
- Specifications, SENR3130, "Torque Specifications"
- Special Instruction, GMG00694, "Analyzing Cylinder Condition By Measuring Air Flow"
- Special Instruction, SEHS7332, "Do Not Operate Tag"

- Special Instruction, SEHS7633, "Battery Test Procedure"
- Special Instruction, SEHS7768, "Use of the 6V-2150 Starting/Chargineg Analyzer"
- Special Instruction, SEHS8622, "Using the FT-1984 Air-To-Air Aftercooler Leak Test Group"
- Special Instruction, SEHS8712, "Using the 8T-2700 Blowby/Airflow Indicator Group"
- Special Instruction, SEHS9031, "Storage Procedure for Caterpillar Products"
- Special Instruction, SEHS9298, "Installation and Maintenance of Gaseous Fuel Filters"
- Special Instruction, REHS0371, "Installation and Initial Start-Up Procedure for G3300 and G3400 Engines"
- Special Publication, NEHS0526, "Service Technician Application Guide"
- Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide"
- Special Publication, SEBF8029, "Index to Guidelines for Reusable Parts and Salvage Operations"
- Special Publication, SEBF8062, "Procedure to Inspect and Clean Air Filters"

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## Additional Reference Material

**SMCS Code:** 1000; 4450

The "Engine Fluids Data Book" can be obtained from the following locations: local technological society, local library, and local college. If necessary, consult EMA at the following address:

Engine Manufacturers Association Two North LaSalle Street, Suite 2200 Chicago, Illinois, USA 60602 E-mail: ema@enginemanufacturers.org (312) 827-8700 Facsimile: (312) 827-8737

The "Society of Automotive Engineers (SAE) Specifications" can be found in your SAE handbook. This publication can also be obtained from the following locations: local technological society, local library, and local college. If necessary, consult SAE at the following address:

SAE International 400 Commonwealth Drive Warrendale, PA, USA 15096-0001 Telephone: (724) 776-4841

The "American Petroleum Institute Publication No. 1509" can be obtained from the following locations: local technological society, local library, and local college. If necessary, consult API at the following address:

American Petroleum Institute 1220 L St. N.W. Washington, DC, USA 20005 Telephone: (202) 682-8000

The International Organization for Standardization (ISO) offers information and customer service regarding international standards and standardizing activities. ISO can also supply information on the following subjects that are not controlled by ISO: national standards, regional standards, regulations, certification, and related activities. Consult the member of ISO in your country.

International Organization for Standardization (ISO)
1, rue de Varembé
Case postale 56
CH-1211 Genève 20
Switzerland

Telephone: +41 22 749 01 11 Facsimile: +41 22 733 34 30 E-mail: central@iso.ch Web site: http://www.iso.ch

European classifications are established by the Counseil International Des Machines a Combustion (CIMAC) (International Council on Combustion Engines).

CIMAC Central Secretariat Lyoner Strasse 18 60528 Frankfurt Germany Telephone: +49 69 6603 1567 Facsimile: +49 69 6603 1566 i00382622

## **Warranty Information**

SMCS Code: 1000

### **Engine Protection Plans**

## Extended Warranties and Service Contracts

A wide variety of protection plans are available for Caterpillar Engines. Consult your Caterpillar dealer for detailed information on the specific programs and coverages that are available.

Consult your Caterpillar dealer for information on a plan that is tailored in order to fit your requirements.



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## **Product and Dealer Information**

Parts:

Service:

Note: For product identification plate locations, see the section "Product Identification Information" in the Operation and Maintenance Manual. **Delivery Date: Product Information** Model: \_ Product Identification Number: \_\_ Engine Serial Number: \_\_\_ Transmission Serial Number: Generator Serial Number: Attachment Serial Numbers: \_\_\_\_\_ Attachment Information: Customer Equipment Number: Dealer Equipment Number: **Dealer Information** Name: Branch: Address: Dealer Contact Phone Number Hours Sales:

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