M0097687 (en-us)
August 2018

Operation and Maintenance Manual

C9.3B Industrial Engine

NGL 1-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, including human factors that can affect safety. 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 verify that you are authorized to perform this work, and 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.

⚠ WARNING

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.

A non-exhaustive list of 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. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

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. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Foreword

California Proposition 65 Warning

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

WARNING – This product can expose you to chemicals including ethylene glycol, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to:

www.P65Warnings.ca.gov

Do not ingest this chemical. Wash hands after handling to avoid incidental ingestion.

WARNING – This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to:

www.P65Warnings.ca.gov

Wash hands after handling components that may contain lead.

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 Cat 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 Cat 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 fuel consumption, service hours and/or calendar time maintenance intervals. Items in the maintenance schedule are referenced to detailed instructions that follow.

Use fuel consumption or 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 be performed at the appropriate intervals as indicated in the Maintenance Interval Schedule. The actual operating environment of the engine also governs the Maintenance Interval Schedule. Therefore, under severe, dusty, wet, or freezing cold operating conditions, more frequent lubrication, and maintenance than is specified in the Maintenance Interval 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 accepted as proof of maintenance or repair. Your authorized Cat dealer can assist you in adjusting your maintenance schedule to meet the needs of your operating environment.

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 Cat dealer. Your Cat dealer offers various options regarding overhaul programs. If you experience a major engine failure, there are also numerous after failure overhaul options available from your Cat dealer. Consult with your dealer for information regarding these options.

Safety Section

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Safety Messages

SMCS Code: 1000; 7405

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

Ensure that all 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. Use a cloth, water, and soap to clean the safety messages. Do not use solvents, gasoline, or other harsh chemicals. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the safety messages. The safety messages that are loosened could drop off the engine.

Replace any safety message that is 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. Your Caterpillar dealer can provide new safety messages.

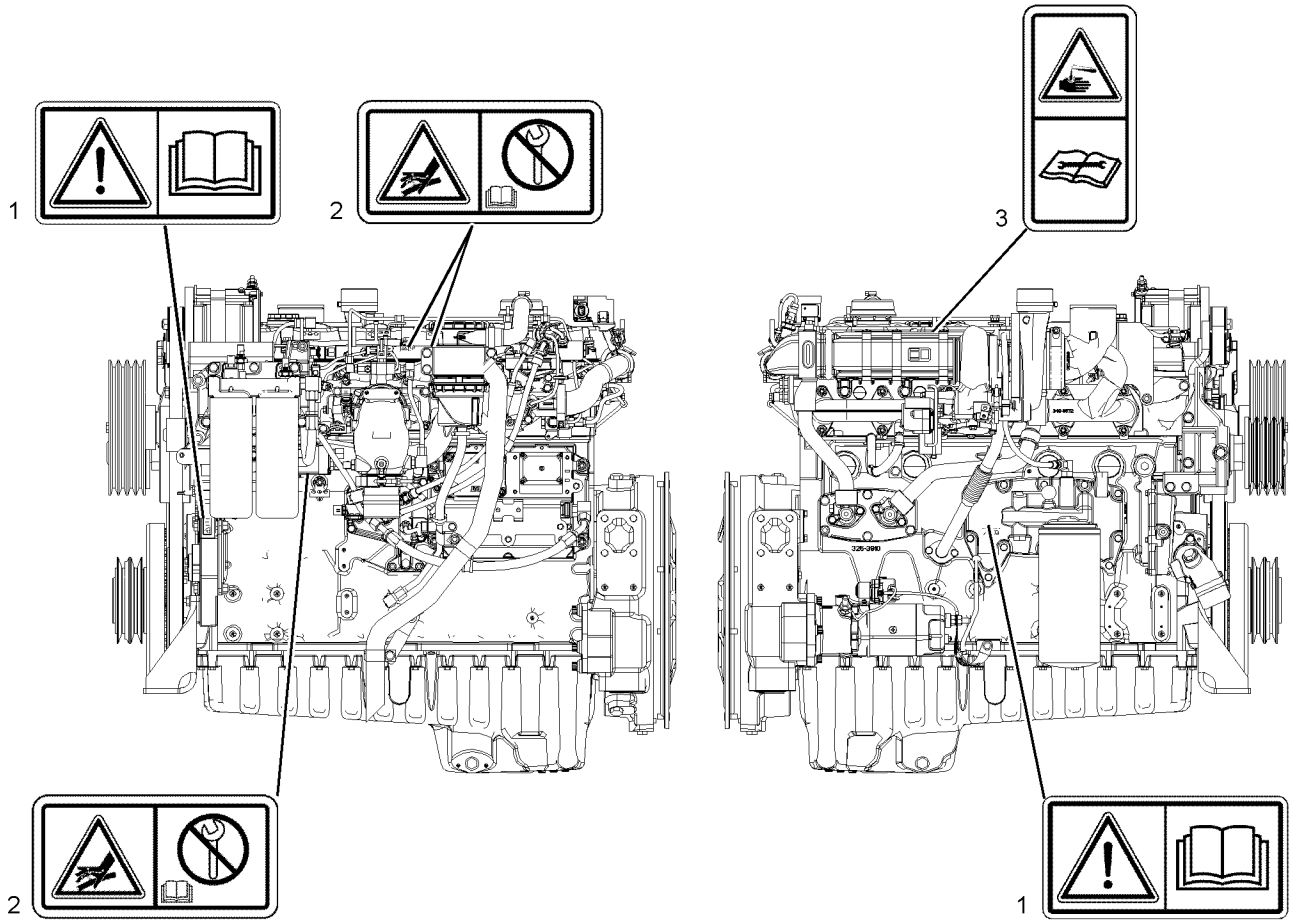

Illustration 1 g02199153

View of the left side and view of the right side of a C9.3B Industrial Engine

Universal Warning (1)

Illustration 2 g01370904

One safety message is on the left side of the front housing. One safety message is on the base for the oil filter, on the right side of the engine.

⚠ WARNING

Do not operate or work on this equipment 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.

High Pressure (2)

Illustration 3 g01381180

One safety message for high pressure (2) is on the bottom of the fuel pump. Two messages are on the fuel rail.

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

Sulfuric Acid Burn (3)

Illustration 4 g01382725

The safety message for sulfuric acid burn (3) is on top of the exhaust cooler.

⚠ WARNING

Sulfuric Acid Burn Hazard may cause serious personal injury or death.

The exhaust gas cooler may contain a small amount of sulfuric acid. The use of fuel with sulfur levels greater than 15 ppm may increase the amount of sulfuric acid formed. The sulfuric acid may spill from the cooler during service of the engine. The sulfuric acid will burn the eyes, skin and clothing on contact. Always wear the appropriate personal protective equipment (PPE) that is noted on a material safety data sheet (MSDS) for sulfuric acid. Always follow the directions for first aid that are noted on a material safety data sheet (MSDS) for sulfuric acid.

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Additional Messages

SMCS Code: 1000; 7405

There are several specific messages on this engine. The exact location of the messages and the description of the information are reviewed in this section. Become familiar with all messages.

Make sure that all the messages are legible. Clean the messages or replace the messages if you cannot read the words. Replace the illustrations if the illustrations are not legible. When you clean the messages, use a cloth, water, and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the messages. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the messages. Loose adhesive will allow the messages to fall.

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

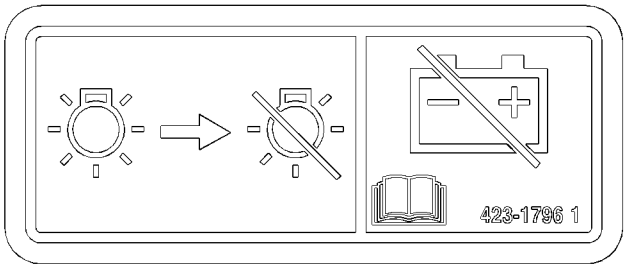

Illustration 5 g03422039

Purge notice message

This notice is located next to the battery disconnect switch.

NOTICE
Do not turn the battery disconnect switch off until the indicator lamp has turned off.

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General Hazard Information

SMCS Code: 1000; 4450; 7405

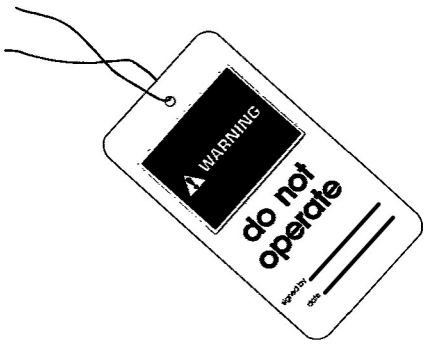

Illustration 6 g03838041

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

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

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.

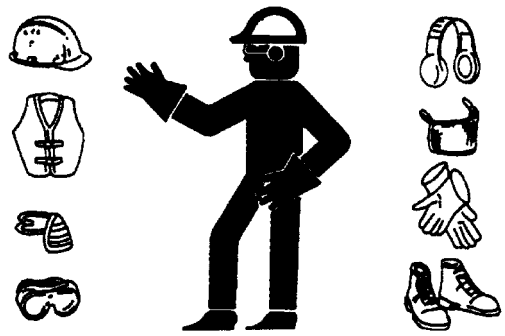

Illustration 7 g00702020

- 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.
- The protective locks or the controls are in the applied position.
- 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.
- When starting a new engine, make provisions to stop the engine if an overspeed occurs. If an engine has not been started since service has been performed, make provisions to stop the engine if an overspeed occurs. Shutting down the engine may be accomplished by shutting off the fuel supply and/or the air supply to the engine.
- Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.
- Start the engine with the operator controls. Never short across the starting motor terminals or the batteries. This method of starting the engine could bypass the engine neutral start system and/or the electrical system could be damaged.

Pressurized Air and Water

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

The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the air nozzle is deadheaded and used with effective chip guarding (if applicable) and personal protective equipment. The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

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

Avoid direct spraying of water on electrical connectors, connections, and components. When using air for cleaning, allow the machine to cool to reduce the possibility of fine debris igniting when redeposited on hot surfaces.

Fluid Penetration

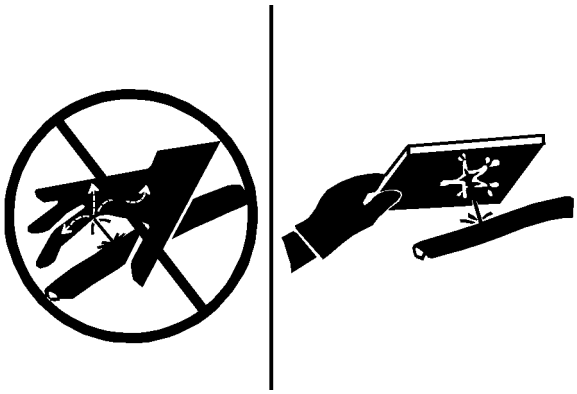

Illustration 8 g00687600

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

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, “Cat Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Cat Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Static Electricity Hazard when Fueling with Ultra-low Sulfur Diesel Fuel

The removal of sulfur and other compounds in ultra-low sulfur diesel fuel (ULSD fuel) decreases the conductivity of ULSD and increases the ability of ULSD to store static charge. Refineries may have treated the fuel with a static dissipating additive. Many factors can reduce the effectiveness of the additive over time. Static charges can build up in ULSD fuel while the fuel is flowing through fuel delivery systems. Static electricity discharge when combustible vapors are present could result in a fire or explosion. Ensure that the entire system used to refuel your machine (fuel supply tank, transfer pump, transfer hose, nozzle, and others) is properly grounded and bonded. Consult with your fuel or fuel system supplier to ensure that the delivery system complies with fueling standards for proper grounding and bonding.

⚠ WARNING

Avoid static electricity risk when fueling. Ultra-low sulfur diesel fuel (ULSD fuel) poses a greater static ignition hazard than earlier diesel formulations with a higher sulfur contents. Avoid death or serious injury from fire or explosion. Consult with your fuel or fuel system supplier to ensure the delivery system is in compliance with fueling standards for proper grounding and bonding practices.

Lines, Tubes, and Hoses

Do not bend or strike high-pressure lines. Do not install lines, tubes, or hoses that are damaged.

Repair any fuel lines, oil lines, tubes, or hoses that are loose or damaged. Leaks can cause fires.

Inspect all lines, tubes, and hoses carefully. Do not use bare hands to check for leaks. Always use a board or cardboard for checking engine components for leaks. 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
- Wire that is exposed in reinforced hose
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

Ensure that all of the clamps, the guards, and the heat shields are installed correctly. Correct installation of these components will help to prevent these effects: vibration, rubbing against other parts and excessive heat during operation.

Inhalation

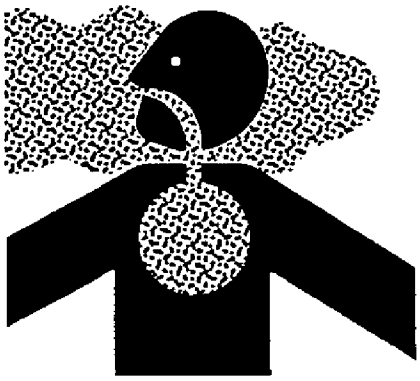

Illustration 9 g02159053

Exhaust

Use caution. Exhaust fumes can be hazardous to your health. If you operate the equipment in an enclosed area, adequate ventilation is necessary.

Asbestos Information

Cat equipment and replacement parts that are shipped from Caterpillar are asbestos free. Caterpillar recommends the use of only genuine Cat 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 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.

Softwrap

Keep the engine room ventilation operating at full capacity. Wear a particulate respirator that has been approved by the National Institute of Occupational Safety and Health (NIOSH). Wear appropriate protective clothing in order to minimize direct contact. Use good hygiene practices and wash hands thoroughly after handling Softwrap material. Do not smoke until washing hands thoroughly after handling Softwrap material. Clean up debris with a vacuum or by wet sweeping. Do not use pressurized air to clean up debris.

Reference: The applicable material safety data sheets can be found at the following web site by searching using part number or the name:

https://catmsds.cat.com/MSDSSearch/servlet/cat.cis.ecs.msdsSearch.controller.UserIdentificationDisplayServlet

Dispose of Waste Properly

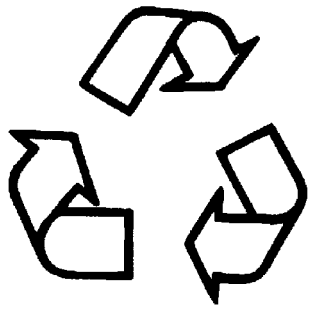

Illustration 10 g00706404

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.

i07254650

Fire Prevention and Explosion Prevention

SMCS Code: 1000; 4450; 7405

Illustration 11 g00704000

Use of personal protection equipment (PPE) may be needed.

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

Always perform a Walk-Around Inspection, which may help you identify a fire hazard. Do not operate a product when a fire hazard exists. Contact your Cat dealer for service.

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 15 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 Cat 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.

All fluids that are captured in the fluid spill containment basin should be cleaned up immediately. Failure to clean up spilled fluids can cause a fire. Fire may cause personal injury and property damage.

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 a line, a tube, or a seal failure. Exhaust shields must be installed correctly.

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

Wiring must be kept in good condition. Properly route and attach all electrical wires. 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. Properly route all hoses. The lines and hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

Properly install all oil filters and fuel filters. The filter housings must be tightened to the proper torque.

Illustration 12 g00704059

Use caution when you are refueling an engine. Do not smoke while you are refueling an engine. Do not refuel an engine near open flames or sparks. Always stop the engine before refueling.

Avoid static electricity risk when fueling. Ultra Low Sulfur Diesel (ULSD) poses a greater static ignition hazard than earlier diesel formulations with a higher Sulfur content. Avoid death or serious injury from fire or explosion. Consult with your fuel or fuel system supplier to ensure that the delivery system is in compliance with fueling standards for proper grounding and bonding practices.

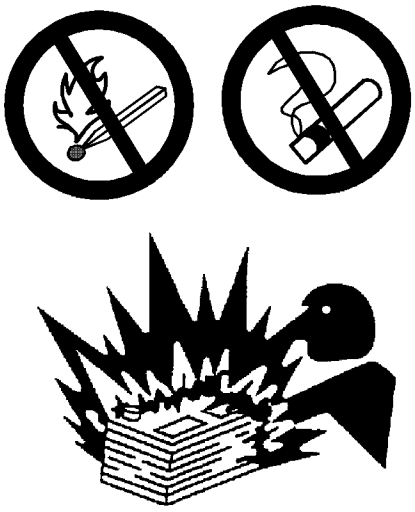

Illustration 13 g02298225

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. Charging a frozen battery may result in 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.

Ether

Ether is flammable and poisonous.

Use ether in ventilated areas. Do not smoke while you are replacing an ether cylinder or while you are using an ether spray.

Do not store ether cylinders in living areas or in the engine compartment. Do not store ether cylinders in direct sunlight or in temperatures above 49 °C (120 °F). Keep ether cylinders away from open flames or sparks.

Dispose of used ether cylinders properly. Do not puncture an ether cylinder. Keep ether cylinders away from unauthorized personnel.

Do not spray ether into an engine if the engine is equipped with a thermal starting aid for cold weather starting.

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 Cat 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 parts 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 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.

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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.

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 this Operation and Maintenance Manual, “Engine Starting” topic (Operation Section). Knowledge of the correct procedure will help to prevent major damage to the engine components. Knowledge of 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 gauge and the oil temperature gauge during the heater operation.

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

i06299648

Engine Stopping

SMCS Code: 1000

Do not stop the engine immediately after the machine has been operated under load. Stopping the engine immediately can cause overheating and accelerated wear of engine components.

After the machine is parked and the parking brake is engaged, allow the engine to run at low idle for 5 minutes before shutdown. Running the engine allows hot areas of the engine to cool gradually.

i02469632

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.

To help prevent sparks from igniting combustible gases that are produced by some batteries, the negative “−” jump start cable should be connected last from the external power source to the negative “−” terminal of the starting motor. If the starting motor is not equipped with a negative “−” terminal, connect the jump start cable to the engine block.

Check the electrical wires daily for wires that are loose or frayed. Tighten all loose electrical wires before the engine is started. Repair all frayed electrical wires before the engine is started. Refer to the “Engine Starting” section of this Operation and Maintenance Manual for specific starting instructions.

Grounding Practices

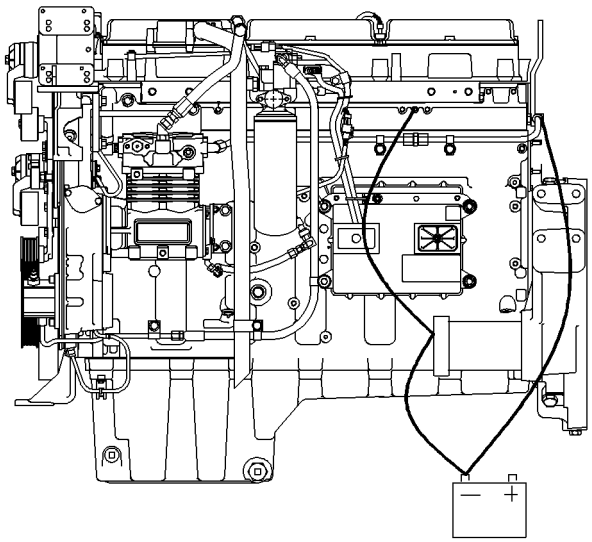

Illustration 14 g00771448

Typical example

Grounding Stud To Battery Ground

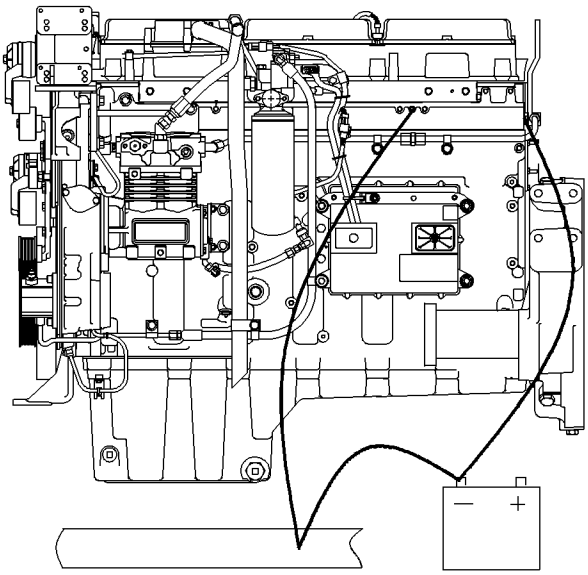

Illustration 15 g00771487

Typical example

Alternate Grounding Stud To Battery Ground

Proper grounding for the engine electrical system 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 bearing journal surfaces, and to aluminum components.

Engines that are installed without engine-to-frame ground straps can be damaged by electrical discharge.

To ensure that the engine and the engine electrical systems function properly, an engine-to-frame ground strap with a direct path to the battery must be used. This path may be provided by way of a starting motor ground, a starting motor ground to the frame, or a direct engine ground to the frame.

All grounds should be tight and free of corrosion. The engine alternator must be grounded to the negative "-" battery terminal with a wire that is adequate to handle the full charging current of the alternator.

i04021529

Engine Electronics

SMCS Code: 1000; 1900

⚠ WARNING

Tampering with the electronic system installation or the OEM wiring installation can be dangerous and could result in personal injury or death and/or engine damage.

The Electronic Control Module (ECM) provides a comprehensive, programmable engine monitoring system for this engine. The ECM monitors specific engine operating parameters in order to detect abnormal conditions that may develop. The ECM will generate an event code if a specific engine parameter exceeds an acceptable range that is defined by the engine monitoring system. The ECM will react with an action that is dependent on the severity of the condition. For information on event codes, refer to this Operation and Maintenance Manual, "Event Codes" topic (Operation Section) The following actions may be initiated by the ECM. These actions are dependent on the severity of the condition:

- Illumination of a warning lamp or warning alarm
- Engine derate
- Engine protection shutdown

The Engine Monitoring package can vary for different engine models and different engine applications. However, the monitoring system and the engine monitoring control will be similar for all engines.

Note: Many of the engine control systems and display modules that are available for Caterpillar Engines will work in unison with the Engine Monitoring System. Together, the two controls will provide the engine monitoring function for the specific engine application. Refer to the Troubleshooting Manual for more information.

Product Information Section

General Information

i07501731

Model View Illustrations

SMCS Code: 1000

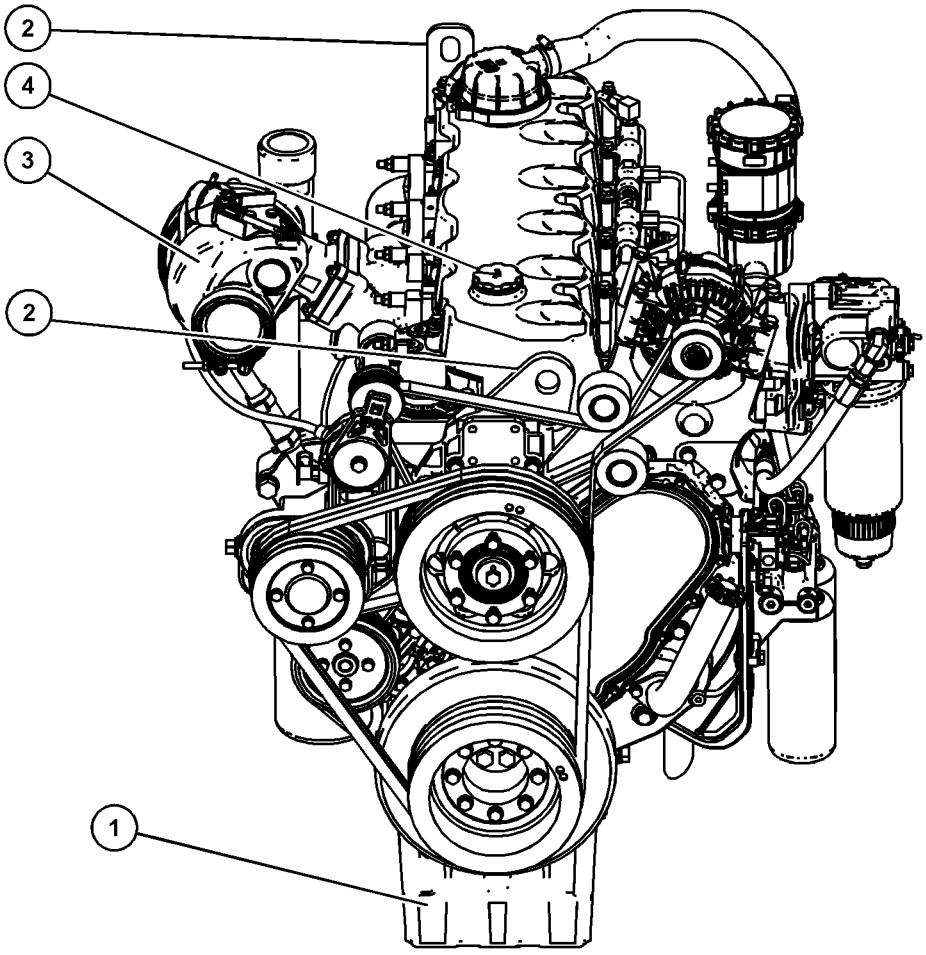

Illustration 16 g06200473

View of the top of a typical C9.3B Engine

(1) Oil pan
(2) Lifting eyes
(3) Turbocharger
(4) Oil cap

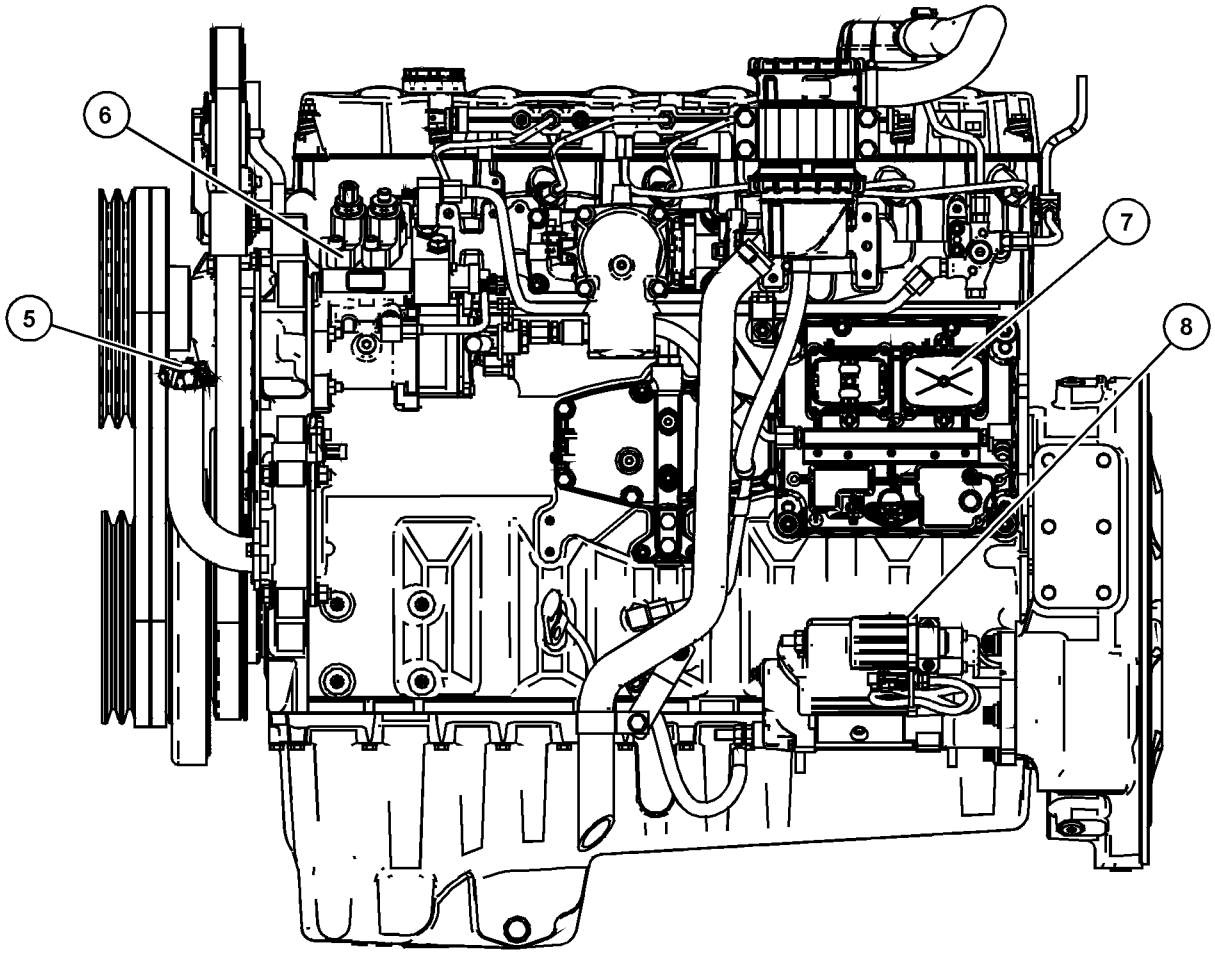

Illustration 17 g06204459

View of the left side of a typical 9.3B Engine

(5) Oil filler tube
(6) Fuel Injection pump
(7) Electronic Control module (ECM)
(8) Starting motor

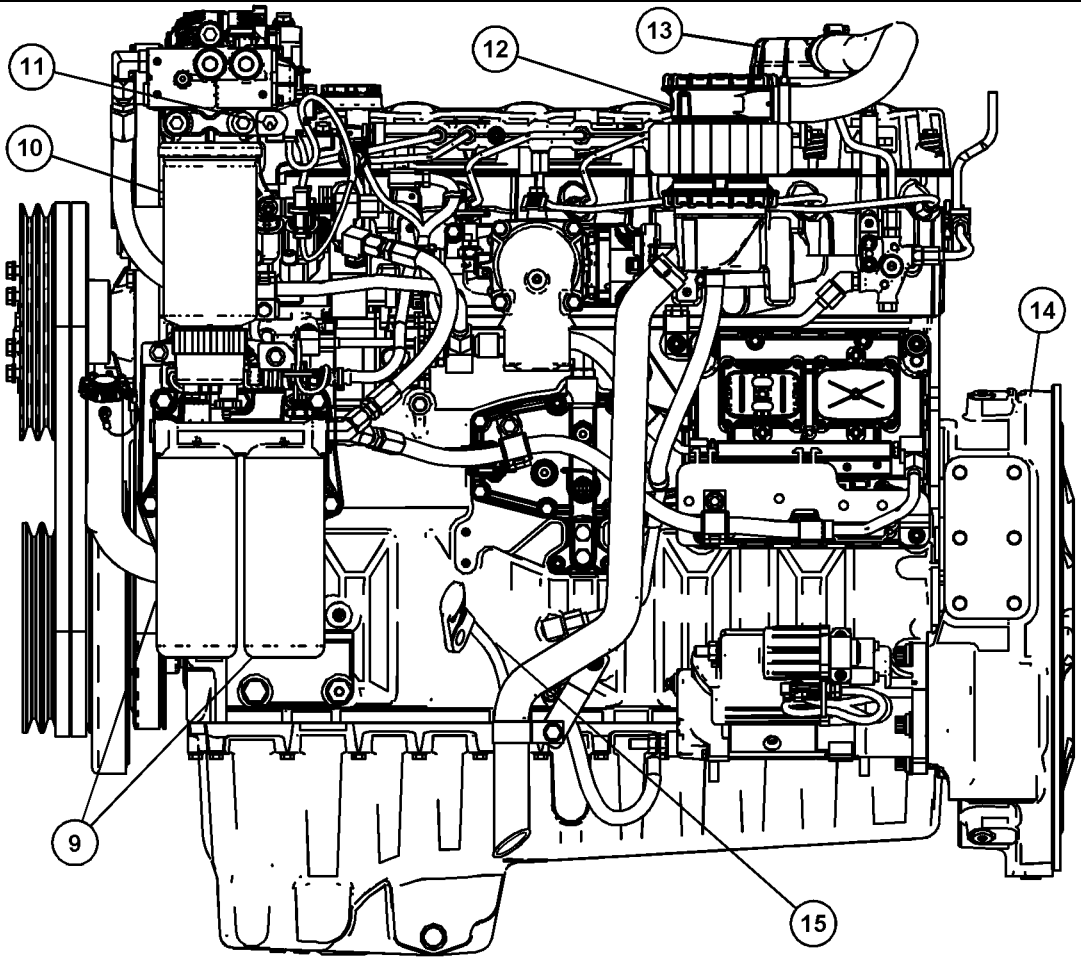

Illustration 18 g06204604

View of the left side of a typical 9.3B Engine

(9) Secondary fuel filters
(10) Primary fuel filter/ water separator
(11) Fuel pump switch assembly
(12) Crankcase ventilation filter (if equipped)
(13) Crankcase breather
(14) Flywheel housing
(15) Oil dipstick

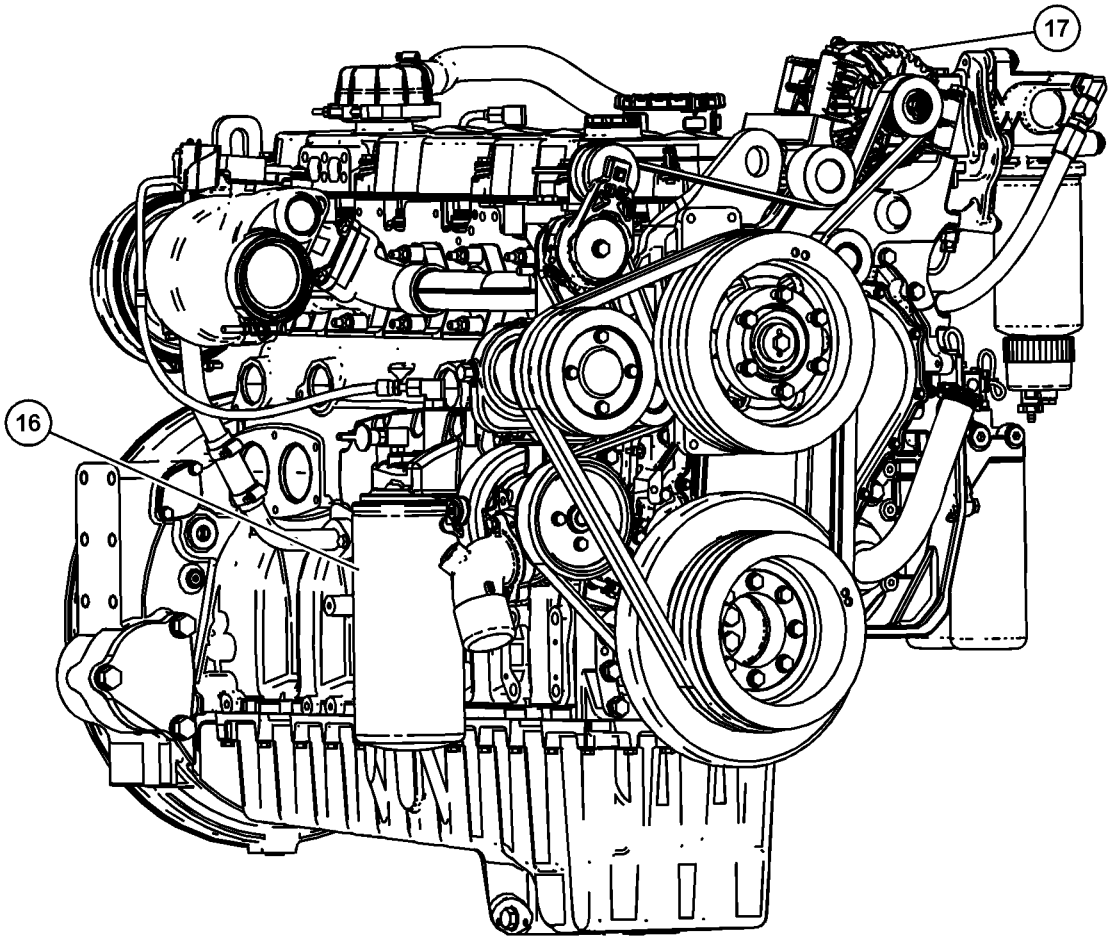

Illustration 19 g06204634

View of the front right side of a typical 9.3B Engine

(16) Oil filter (17) Alternator

i07501705

Product Description

SMCS Code: 1000; 4450; 4491

The Caterpillar C9.3B Industrial Engine has the following characteristics:

- Four-stroke cycle
- High-pressure common rail fuel system
- Turbocharged

Engine Specifications

Note: The front end of the engine is opposite the flywheel end of the engine. The left and the right sides of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.

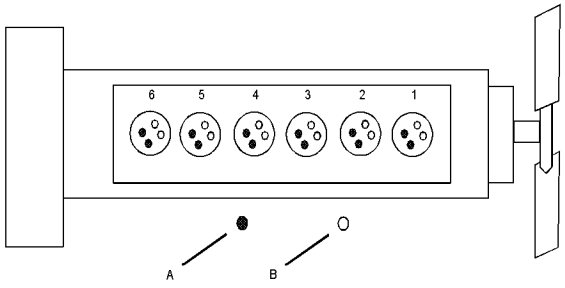

Illustration 20 g01387009

Cylinder and valve location

(A) Exhaust valve
(B) Inlet valve

Table 1

C-9.3B Engine Specifications	
Arrangement and Cylinders	In-Line six cylinder
Bore	115.0 mm (4.53 inch)
Stroke	149.0 mm (5.87 inch)
Aspiration	ATAAC(1)
	SCAC (2)
Displacement	9.3 L (568 in^3)
Firing Order	1-5-3-6-2-4
Rotation (flywheel end)	Counterclockwise

(1) Air-to-air aftercooled
(2) Separate circuit after cooling

Electronic Engine Features

The Caterpillar C9.3B Engine is designed for electronic controls. The integral on board computer controls the operation of the engine. Current operating conditions are monitored. The Electronic Control Module (ECM) controls the response of the engine to these conditions and to the demands of the operator. These conditions and operator demands determine the precise control of fuel injection by the ECM. The electronic engine control system provides the following features:

- Engine speed governor
- Automatic air/fuel ratio control
- Torque rise shaping
- Injection timing control
- System diagnostics

Additional Features

The following features provide increased engine fuel economy and serviceability:

- Cold starting capability
- Tampering detection
- Diagnostics

Common Rail Fuel Injection System

The common rail fuel injection system performs the following functions:

- Pump the fuel.
- Meter the fuel.
- Time the fuel injection.

The fuel pump pressurizes the fuel, and pumps the fuel to the common fuel rail. The common rail fuel injectors inject the fuel into the cylinders at a precise time. The fuel is injected into the cylinders with the appropriate volume. Electronic sensors on the engine determine time and volume of fuel injection.

Engine Service Life

Engine efficiency and maximum utilization of engine performance depend on the adherence to proper operation and maintenance recommendations. In addition, use recommended fuels, coolants, and lubricants. Use the Operation and Maintenance Manual as a guide for required engine maintenance.

Expected engine life is predicted by the average power that is demanded. The average power that is demanded is based on fuel consumption of the engine over a time. Reduced hours of operation at full throttle and/or operating at reduced throttle settings result in a lower average power demand. Reduced hours of operation will increase the length of operating time before an engine overhaul is required. For more information, refer to the Operation and Maintenance Manual, “Overhaul Considerations” topic (Maintenance Section).

Aftermarket Products and Caterpillar Engines

NOTICE
In order to maximize fuel system life and prevent premature wear out from abrasive particles in the fuel, a four micron[c] absolute high efficiency fuel filter is required for all Caterpillar common rail fuel systems. Caterpillar High Efficiency Fuel Filters meet these requirements. Consult your Caterpillar dealer for the proper part numbers.

When auxiliary devices, accessories, or consumables made by other manufacturers are used on Caterpillar products, the Caterpillar warranty is not affected simply because of such use.

However, failures that result from the installation or use of devices, accessories, or consumables from other manufacturers are NOT Caterpillar defects. Therefore, the defects are NOT covered under the Caterpillar warranty.

Product Identification Information

i07501710

Plate Locations and Film Locations

SMCS Code: 1000; 4450

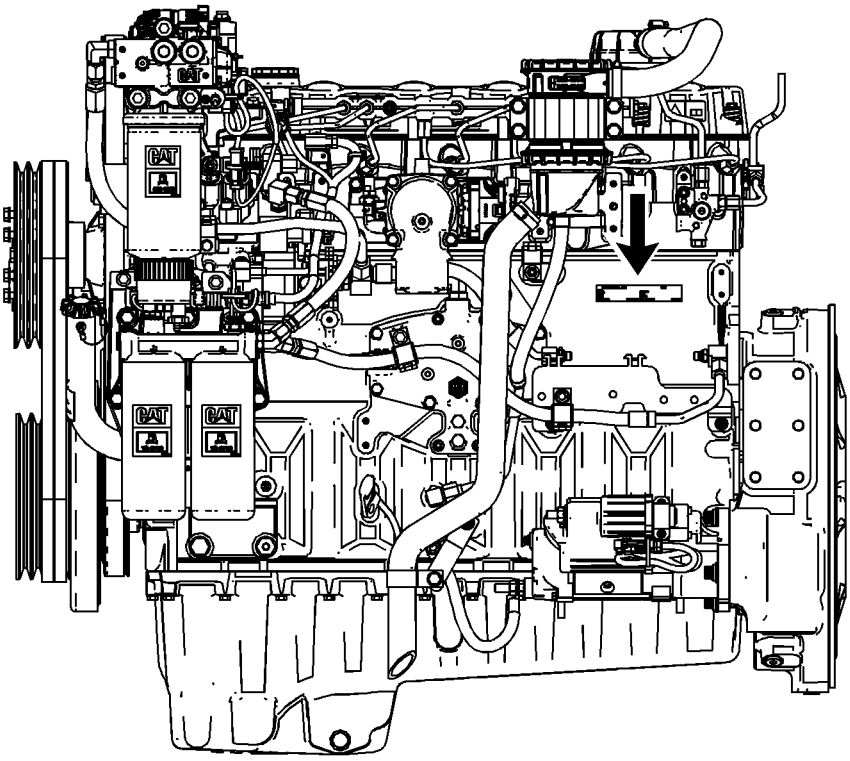

Illustration 21 g06205197

View of the left side of a C9.3B Industrial Engine

The serial number plate is on the right side of the cylinder block. The engine control module will obstruct the view of the serial number plate.

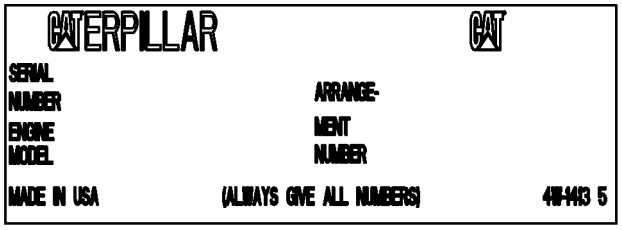

Illustration 22 g06199254

Serial number plate

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

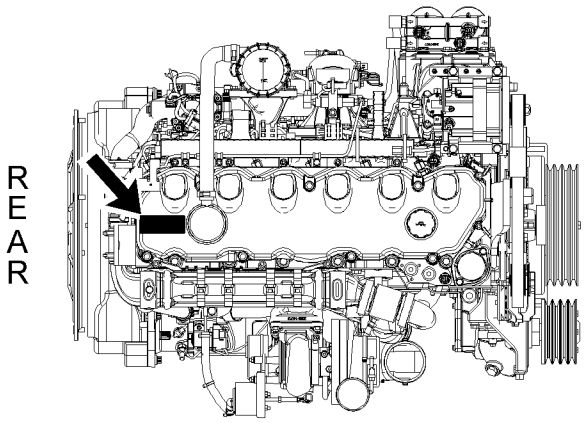

Illustration 23 g02201394

View of the top of a C9.3B Industrial Engine

The engine information plate is located toward the rear of the valve cover. The engine information plate may be read from the right side of the engine.

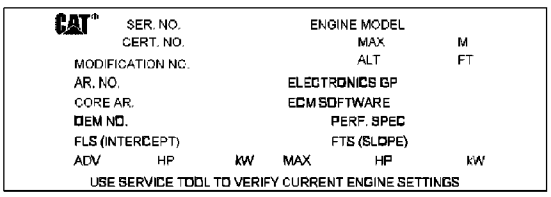

Illustration 24 g01347963

Engine information plate

The following information is on the information plate: engine serial number, engine model, engine arrangement number, maximum altitude of the engine that is necessary to achieve the rated power, horsepower, high idle, full load rpm, fuel settings, and other information

i04128675

Reference Information

SMCS Code: 1000; 4450

Information for the following items may be needed to order parts. Locate the information for your engine. Record the information on the appropriate space. Make a copy of this list for a record. Retain the information for future reference.

Record for Reference

Table 2

System or Component	Information
Chassis serial number	
Engine model	
Engine serial number	
Engine arrangement number	
Modification number	
Engine low idle rpm	
Engine full load rpm	
Performance specification number	
Engine horsepower	
Primary fuel filter part number	
Water separator element part number	
Secondary fuel filter element part number	
Lubrication oil filter element part number	
Auxiliary oil filter element part number	
Supplemental coolant additive maintenance element part number (if equipped)	
Total lubrication system capacity	

(continued)

(Table 2, contd)

Total cooling system capacity	
Engine air cleaner element part number	
Fan drive belt part number	
Alternator belt part number	

Operation Section

Lifting and Storage

i07501715

Product Lifting

SMCS Code: 7000; 7002

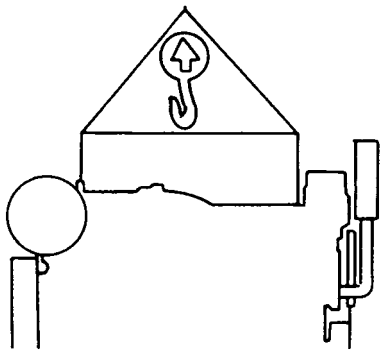

Illustration 25 g00103219

NOTICE
Always inspect lifting eyebolts and all other lifting equipment for damage before performing any lifting.

Never bend the eyebolts or the brackets. Never perform product lifting if components are damaged. 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 removing a component at an angle is necessary, 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 the fixtures 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

To lift engines, use the load rings provided on the front and rear mounting brackets, with a certified spreader bar.

Refer to the Special Publication, NENG2500, “Cat Dealer Service Tool Catalog” for the latest in lifting devise part numbers. Follow the safety instructions for the selected tool to ensure a safe lift. For most packages, the recommended spreader bar is 6V-6146 set at 142 cm (56 inch) with the lift hook locations set at about 3/4 of the way toward the front stop (closest to the front engine lift eye).

Remove any ATAAC lines, air cleaners, or other attachments that would otherwise interfere with the lift chains or other lifting devises.

The engine package center of gravity will change depending on the engine attachments. Adjust the spreader bar and chains as necessary to maintain a lift within 5 degrees of horizontal in all directions.

Remove the front load ring before returning the engine to service, to prevent the last load ring from rubbing on the fan belt.

Engine and Installed Radiator Only

The engine lifting eyes are rated to lift an engine with attached radiator, assuming a less than 5 degree tilt angle can be maintained. Be sure to use an appropriate spreader set so that lifting chains are perpendicular to the engine.

Radiator Only

Detach the radiator, and mounting bracket at the engine front support. Add eyebolts or lifting brackets to the threaded holes marked for lifting.

i07501717

Product Storage

SMCS Code: 7002

Storage (Less Than One Year)

If an engine is not used, oil can run off the following parts that normally receive lubrication: cylinder walls, piston rings, main bearings, connecting rod bearings, crankshaft, and gears.

This lack of lubricant allows corrosion to begin to appear on the metal. This condition is worse in areas of high humidity.

When the engine is started again, metal to metal contact will cause wear before the surfaces receive oil. To minimize this wear, use the starter to turn the engine with the throttle in the FUEL OFF position. When oil pressure is shown on the pressure gauge, start the engine.

1. Clean the engine of any dirt, rust, grease, and oil. Inspect the exterior. Paint areas that contain paint damage with a good quality paint.

2. Remove dirt from the air cleaners. Check all seals, gaskets, and the filter element for damage.

3. Apply lubricant to all points in this Operation and Maintenance Manual, “Maintenance Interval Schedule”.

4. Drain the crankcase oil. Replace the crankcase oil and change the oil filters. For the proper procedure, refer to this Operation and Maintenance Manual.

5. If the engine is equipped with an air starting motor, fill the reservoir with the following mixture: 50 percent volatile corrosion inhibitor oil (<nomen>VCI oil</nomen>) and 50 percent engine oil.

6. Add VCI oil to the crankcase oil. The volume of VCI oil in the crankcase oil should be 3 to 4 percent.

Note: If the engine crankcase is full, drain enough engine oil so the mixture can be added.

7. Remove the air filter elements. Turn the engine at cranking speed with the throttle control in FUEL OFF position. Use a sprayer to add a mixture of 50 percent VCI oil and 50 percent engine oil into the air inlet or turbocharger inlet.

Note: The mixture of VCI oil can be added to the inlet by removing the plug for checking turbocharger boost pressure. The minimum application rate for the VCI oil mixture is 5.5 mL per L (3 oz per 1000 cu in) of engine displacement.

8. Use a sprayer to apply a mixture of 50 percent VCI oil and 50 percent crankcase oil into the exhaust openings. The minimum application rate for the oil mixture is 5.5 mL per L (3 oz per 1000 cu in) of engine displacement. Seal the exhaust pipe and seal any drain holes in the muffler.

9. Remove the fuel from the secondary fuel filter housing. Alternately, empty and reinstall the spin-on fuel filter element to remove any dirt and water. Drain any sleeve metering fuel pump.

Clean the primary fuel filter. Fill with calibration fluid or kerosene. Install the primary fuel filter and operate the priming pump. This procedure will send clean oil to the secondary filter and the engine.

Open the fuel tank drain valve to drain any water and dirt from the fuel tank. Apply a spray of calibration fluid or kerosene at the rate of 30 mL per 30 L (1 oz per 7.50 gal US) of fuel tank capacity to prevent rust in the fuel tank. Add 0.15 mL per L (.02 oz per 1 gal US) of commercial biocide such as Biobor JF to the fuel.

Apply a small amount of oil to the threads on the fuel tank filler neck and install the cap. Seal all openings to the tank to prevent evaporation of the fuel and as a preservative.

10. Remove the fuel nozzles or spark plugs. Apply 30 mL (1 oz) of the mixture of oils (50 percent VCI oil and 50 percent engine oil) into each cylinder.

Use a bar or a turning tool to turn over the engine slowly. This procedure puts the oil on the cylinder walls. Install all fuel nozzles or spark plugs and tighten to the correct torque.

11. Spray a thin amount of a mixture of 50 percent VCI oil and 50 percent engine oil onto the following components: flywheel, ring gear teeth, and starter pinion. Install the covers to prevent evaporation of the vapors from the VCI oil.

12. Apply a heavy amount of Cat Multipurpose Grease (MPGM) to all outside parts that move, such as rod threads, ball joints, linkage.

Note: Install all covers. Ensure that tape has been installed over all openings, air inlets, exhaust openings, the flywheel housing, the crankcase breathers, the dipstick tubes.

Ensure that all covers are airtight and weatherproof. Use a waterproof weather resistant tape such as Kendall No. 231 or an equivalent. Do not use duct tape. Duct tape will only seal for a short time.

13. Under most conditions, removing the batteries is the best procedure. As an alternative, place the batteries in storage. As needed, periodically charge the batteries while the batteries are in storage.

If the batteries are not removed, wash the tops of the batteries until the tops are clean. Apply an electrical charge to the batteries to obtain a specific gravity of 1.225.

Disconnect the battery terminals. Place a plastic cover over the batteries.

Note: For additional information, refer to Special Instruction, SEHS7633, “Battery Test Procedure”.

14. Loosen all belts.

15. Place a waterproof cover over the engine. Ensure that the engine cover is secure. The cover should be loose enough to allow air to circulate around the engine to prevent damage from condensation.

16. Attach a tag with the storage date to the engine.

17. Remove the waterproof cover at 2-month or 3-month intervals to check the engine for corrosion. If the engine has signs of corrosion, repeat the protection procedure.

Coolant System

Completely fill the cooling system before storage.

Refer to this Operation and Maintenance Manual, “Fluid Recommendations” for more information about coolants.

Removal from Storage

1. Remove all outside protective covers.

2. Change the oil and filters.

3. Check the condition of the fan and alternator belts. Replace the belts, if necessary. Refer to this Operation and Maintenance Manual, “Belts - Inspect/Adjust/Replace” for the correct procedure.

4. Replace the fuel filter elements.

5. Remove the plastic covers from the air cleaner elements.

6. Use a bar or a turning tool to turn the engine in the normal direction of rotation. The procedure ensures that no hydraulic locks or resistance exist.

7. Before starting the engine, remove the valve cover or covers. Put a large amount of engine oil on the camshaft, cam followers, and valve mechanism to prevent damage to the mechanism.

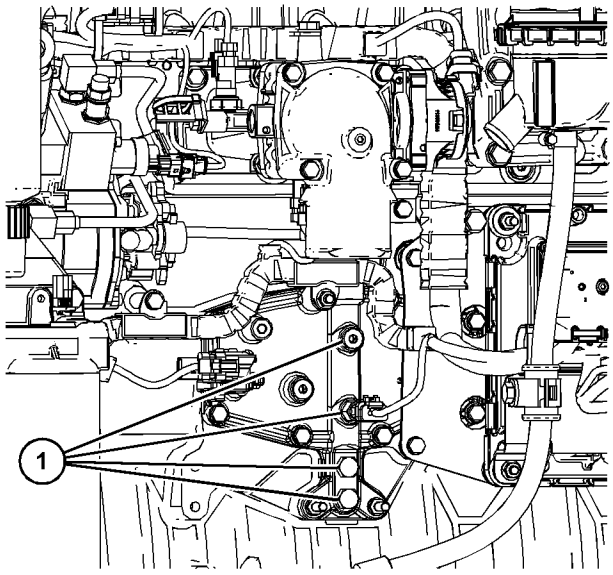

Illustration 26 g06260878

(1) Plugs for oil system

8. If an engine is stored for more than 1 year, Caterpillar recommends pre-lubrication of the engine to avoid dry starting. Use a suitable pump to put engine oil into the engine oil system.

The pump will need to create a minimum pressure within the engine of 0.25 bar (3.60 psi). This pressure is needed for 15 seconds to lubricate the internal surfaces.

Remove one of the plugs (1) shown in illustration 26 to connect to the engine oil system. The connection required is 9/16 in x 18 tpi. Ensure that the correct oil specifications used. Refer to this Operation and Maintenance Manual, Fluid Recommendations for more information. After the engine internal surfaces have been lubricated, remove connector, and install plug (1). Tighten plug to a torque of 60 N·m (530 lb in). Caterpillar recommends performing the procedure in a minimum ambient temperature of 0° C (32° F).

9. Check the condition of all rubber hoses. Replace any worn hoses. Replace any damaged hoses.

10. Before start-up, test the cooling system for a 3 percent to a 6 percent concentration of coolant conditioner. Add liquid coolant conditioner or a coolant conditioner element, if equipped.

Test the coolant mixture for proper nitrite level. If necessary, adjust the coolant mixture.

Prime the engine with clean diesel fuel before starting.

11. Ensure that the cooling system is clean. Ensure that the system is full. Ensure that the system has the correct amount of supplemental cooling system conditioner.

12. On the first day of operation, check the entire engine several times for leaks and correct operation.

13. If the engine was removed from storage in which temperatures of less than -12°C (10°F) were encountered, refer to Service Manual, SEBU5898, “Cold Weather Recommendations Operation and Maintenance”.

Features and Controls

i07501791

Battery Disconnect Switch (If Equipped)

SMCS Code: 1411

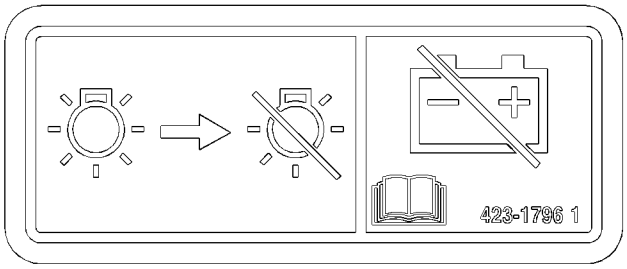

Illustration 27 g03422039

NOTICE
Do not turn the battery disconnect switch off until the indicator lamp has turned off.

NOTICE
Never move the battery disconnect switch to the OFF position while the engine is operating. Serious damage to the electrical system could result.

Battery Disconnect Switch – The battery disconnect switch can be used to disconnect the battery from the engines electrical system. The key must be inserted into the battery disconnect switch before the battery disconnect switch can be turned.

ON – To activate the electrical system, insert the disconnect switch key and turn the battery disconnect switch clockwise. The battery disconnect switch must be turned to the ON position before you start the engine.

OFF – To deactivate the electrical system, turn the battery disconnect switch counterclockwise to the OFF position.

The battery disconnect switch and the engine start switch perform different functions. The entire electrical system is disabled when you turn the battery disconnect switch to the OFF position. The battery remains connected to the electrical system when you turn the engine start switch to the OFF position.

Turn the battery disconnect switch to the OFF position and remove the key when you service the electrical system or any other engine components.

Turn the battery disconnect switch to the OFF position and remove the disconnect switch key after you operate the engine. Turning the battery disconnect switch to OFF will prevent the battery from being discharged. The following problems can cause battery discharge:

- short circuits
- current draw via some components
- vandalism

i07504953

Monitoring System

SMCS Code: 1900; 7400; 7450; 7451

The Monitoring System is designed to alert the operator to an immediate problem with any of the engine systems that are monitored. The Monitoring System is also designed to alert the operator to an impending problem with any of the engine systems that are monitored.

Indicators and Gauges

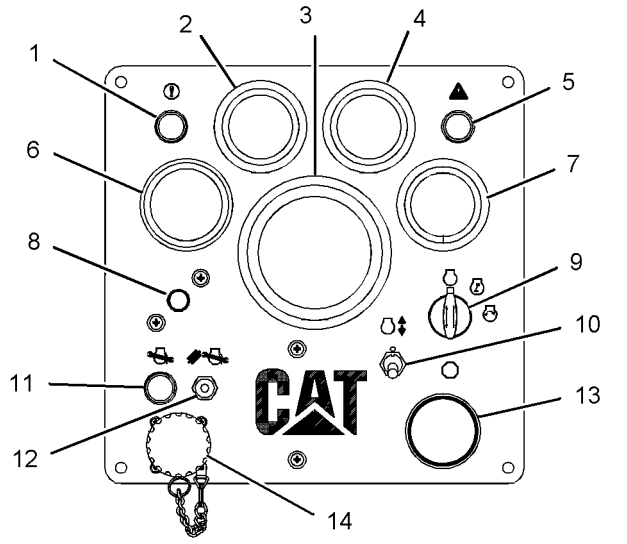

Illustration 28 g01063079
Gauge cluster and indicators

Diagnostic Lamp (1) – The diagnostic lamp is used to indicate the existence of a fault by flashing.

Engine Oil Pressure (2) – The oil pressure should be greatest 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 is stable.

A lower oil pressure is normal at low idle. If the load is stable and the gauge reading changes, perform the following procedure:

1. Remove the load.

2. Reduce engine speed to low idle.

3. Check and maintain the oil level.

Tachometer (3) – This gauge indicates engine speed (rpm). When the throttle control lever is moved to the full throttle position without load, the engine is running at high idle. The engine is running at the full load rpm when the throttle control lever is at the full throttle position with maximum rated load.

NOTICE
To help prevent engine damage, never exceed the high idle rpm. Overspeeding can result in serious damage to the engine. The engine can be operated at high idle without damage, but should never be allowed to exceed high idle rpm.

Note: The high idle rpm and the full load rpm are stamped on the Information Plate.

Coolant Temperature (4) – When the coolant temperature is above the normal operating value, the coolant temperature gauge will be in the red zone. Refer to the Messenger display for any additional information that may be available.

Warning Lamp (5) – There is a general fault in the engine. Refer to the Messenger display for any additional information that may be available.

Fuel Pressure (6) – This gauge indicates fuel pressure to the fuel injection pump from the fuel filter. A decrease in fuel pressure usually indicates a dirty fuel filter or a plugged fuel filter. As the fuel filter becomes plugged, there will be a noticeable reduction in the performance of the engine.

System Voltage (7) – This gauge indicates the voltage of the electrical system.

Circuit Breaker (8) – Reset the circuit breaker if a circuit breaker trips. Press the button to reset the circuit breaker. If the electrical system is working properly, the button will remain pressed. If the button does not remain pressed or if the circuit breaker trips soon after being reset, check the appropriate electrical circuit. Repair the electrical circuit, if necessary.

Start Switch (9) – The start switch has three positions: OFF, RUN, and START. When the start switch is turned clockwise to the RUN position, the lamps will flash for 5 seconds during the system test. The lamps will then shut off. In the RUN position, the ECM and electronic systems are powered up.

Idle Speed Switch (10) – When the switch is in the up position, the engine speed increases to HIGH IDLE. When the switch is in the down position, the engine speed decreases to LOW IDLE.

Maintenance Lamp (11) – The ECM records data that is related to equipment maintenance. The ECM will activate the maintenance indicator lamp when scheduled maintenance is due. The maintenance indicator lamp can be reset by actuating the maintenance clear switch. The maintenance interval may be based on operating hours or fuel consumption. The ECM provides information that pertains to maintenance intervals and the last maintenance that was performed.

Maintenance Clear Switch (12) – The maintenance clear switch is required to reset the maintenance lamp after maintenance on the engine is performed.

Shutdown Switch (13) – Use the engine shutdown switch to stop the engine. Push the shutdown switch to put the switch in the OFF position. This will stop the engine. After the engine stops, turn the knob clockwise. This will reset the engine shutdown switch to the ON position.

Service Tool Connector (14) – For more information regarding the use of Caterpillar Electronic Technician (ET) and the PC requirements for Cat ET, refer to the documentation that accompanies your Cat ET software.

Caterpillar Messenger Display

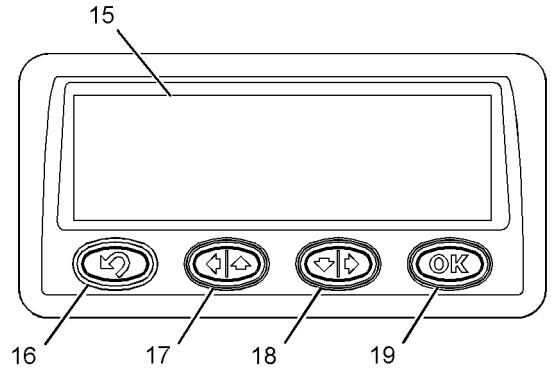

Illustration 29 g01063102

Digital display area (15) – The Messenger system shows information on the digital display area.

Previous button (16) – Use the previous button to return to information that was previously shown on the digital display area.

“Scroll up/scroll left button” (17) – This button is used to scroll up through information that is shown on the display area. The button can also be used to scroll to the left through information that is shown on the display area.

“Scroll down/scroll right button” (18) – This button is used to scroll down through information that is shown on the display area. The button can also be used to scroll to the right through information that is shown on the display area.

OK button (19) – This button may be used to confirm the selections that were selected with the “scroll up/ scroll left” button, and with the “scroll down/scroll right” button.

Performance Monitor Screen

The following options are available through the performance monitor screen:

Engine Speed – When you scroll to this option, the performance monitor screen will show the engine RPM.

Engine Coolant Temperature – When you scroll to this option, the performance monitor screen will show the engine coolant temperature in degrees fahrenheit or in degrees celsius.

Fuel Level – When you scroll to this option, the performance monitor screen will show the amount of fuel that remains in the fuel tank as a percentage of a full tank.

Display Screen for Totals

The following information is available through the display:

Service Hours – When you scroll to this option, the display shows the total amount of service hours that the engine has accumulated.

Total Time – When you scroll to this option, the display shows the total hours for the engine ECM.

Total Fuel – When you scroll to this option, the display shows the total amount of fuel that has been consumed.

Display Screen for Settings

The following options are available through the payload display:

Language – Select this option to change the language that is shown on the display.

Units – Select this option to choose the desired system of measurement. The choices are metric or English.

Adjust Contrast – Select this option to adjust the contrast of the display so that visibility will be improved.

Adjust the Backlight – Select this option to adjust the backlighting of the display so that visibility will be improved.

Equipment ID – Select this option to view the product identification number.

Product Identification – Select this option to view the product identification number.

Service Display

The following options are password protection. You must enter a password to change the settings.

View – Select this option to view events that have been logged by the monitoring system. If you use an authorized password, you can clear individual events.

Clear All Diagnostics – If you use an authorized password, you can select this option to clear all logged events.

SYSTEM PARAMETERS

MONITORING SYSTEM

- **Battery Voltage** When you scroll to this option, the battery voltage is displayed.
- **Fuel Level** When you scroll to this option, the fuel level is displayed.
- **Status of the Alternator** When you scroll to this option, the status of the alternator is displayed.
- **Engine Speed** When you scroll to this option, the engine RPM is displayed.
- **Desired Engine Speed** When you scroll to this option, the desired engine speed is displayed. This parameter is used by the Automatic Retarder Control to prevent the engine from overspeeding. If you have an approved password, you can change this parameter.
- **Throttle Position** When you scroll to this option, the throttle position is displayed.
- **Coolant Temperature** When you scroll to this option, the coolant temperature is displayed.
- **Coolant Flow** When you scroll to this option, the amount of coolant flow is displayed.
- **Boost Pressure** When you scroll to this option, the boost pressure is displayed.
- **Atmospheric Pressure** When you scroll to this option, the atmospheric pressure is displayed.
- **Turbocharger Inlet Pressure** When you scroll to this option, the turbocharger inlet pressure is displayed.
- **Oil Pressure** When you scroll to this option, the absolute engine oil pressure is displayed.
- **Oil Pressure** When you scroll to this option, the engine oil pressure gauge is displayed.
- **Fuel Temperature** When you scroll to this option, the fuel temperature is displayed.

SYSTEMS TESTS

“SYSTEM SELF TEST”

If you select this option, the monitoring system will initiate the self test. The self test is similar to the functional test that occurs when you turn the start switch from the OFF position to the ON position.

INFORMATION on MONITORING and ENGINE SYSTEMS

MONITORING SYSTEM

- **Software Part Number** When you scroll to this option, the software part number is displayed.
- **ECM Part Number** When you scroll to this option, the ECM part number is displayed.
- **“Software Release Date”** When you scroll to this option, the release date of the software is displayed.
- **“Software Description”** When you scroll to this option, the description of the software is displayed.

ENGINE

- **ECM Serial Number** When you scroll to this option, the ECM serial number is displayed.
- **Software Part Number** When you scroll to this option, the software part number is displayed.
- **“Software Release Date”** When you scroll to this option, the release date of the software is displayed.
- **“Software Description”** When you scroll to this option, the description of the software is displayed.

- **Engine Serial Number** When you scroll to this option, the engine serial number is displayed.

TATTLETALE

- **"Full Tattletale Readout"** When this option is selected, all displays and gauges will display the maximum values that have been reached during operation.
- **Engine Coolant Temperature** When this option is selected, all indicators will display the maximum values that have been reached during operation. The engine coolant temperature gauge will also show the maximum value that was reached during operation.
- **Tachometer** When this option is selected, all indicators will display the maximum values that have been reached during operation. The tachometer will also show the maximum value that was reached during operation.
- **Fuel Level** When this option is selected, all indicators will display the maximum values that were reached during operation. The fuel level gauge will also show the minimum value that was reached during operation.
- **Clear** If you have an approved password, you can clear the maximum values that have been stored by the monitoring system.

Engine Diagnostics

i03840813

i01563934

Self-Diagnostics

SMCS Code: 1000; 1900; 1901; 1902

Caterpillar Electronic Engines have the capability to perform a self-diagnostics test. When the system detects an active problem, the “DIAGNOSTIC” lamp is activated. Diagnostic codes will be stored in permanent memory in the Electronic Control Module (ECM). The diagnostic codes can be retrieved by using the following components:

- Caterpillar electronic service tools
- “DIAGNOSTIC” lamp

Note: The “DIAGNOSTIC” lamp must be installed by the OEM or by the customer.

Some installations have electronic displays that provide direct readouts of the engine diagnostic codes. Refer to the manual that is provided by the OEM for more information on retrieving engine diagnostic codes.

Active codes represent problems that currently exist. These problems should be investigated first. If a code is active, the “DIAGNOSTIC” lamp will flash the flash code at five second intervals.

Logged codes represent the following items:

- Intermittent problems
- Recorded events
- Performance history

The problems may have been repaired since the logging of the code. These codes do not indicate that a repair is needed. The codes are guides or signals when a situation exists. Codes may be helpful to troubleshoot problems.

When the problems have been corrected, the corresponding logged fault codes should be cleared.

Fault Logging

SMCS Code: 1000; 1900; 1901; 1902

The system provides the capability of Fault Logging. When the Electronic Control Module (ECM) generates an active diagnostic code, the code will be logged in the memory of the ECM. The codes that have been logged in the memory of the ECM can be retrieved with Caterpillar electronic service tools. The codes that have been logged can be cleared with Caterpillar electronic service tools. The codes that have been logged in the memory of the ECM will be automatically cleared from the memory after 100 hours. The following faults cannot be cleared from the memory of the ECM without using a factory password: overspeed, low engine oil pressure and high engine coolant temperature.

Engine Starting

i02354640

Before Starting Engine

SMCS Code: 1000; 1400; 1450

Perform the required daily maintenance and other periodic maintenance before the engine is started. Inspect the engine compartment. This inspection can help prevent major repairs at a later date.

- For the maximum service life of the engine, make a thorough inspection before starting the engine. Look for the following items: oil leaks, coolant leaks, loose bolts and trash buildup. Remove trash buildup and arrange for repairs, as needed.
- Inspect the cooling system hoses for cracks and for loose clamps.
- Inspect the alternator and accessory drive belts for cracks, breaks, and other damage.
- Inspect the wiring for loose connections and for worn wires or frayed wires.
- Check the fuel supply. Drain water from the water separator (if equipped). Open the fuel supply valve.

NOTICE
All valves in the fuel return line must be open before and during engine operation to help prevent high fuel pressure. High fuel pressure may cause filter housing failure or other damage.

If the engine has not been run for several weeks, fuel may have drained from the fuel system. Air may have entered the filter housing. Also, when fuel filters have been changed, some air space will be left in the housing. In these instances, prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime” for more information on priming the fuel system.

⚠ 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.

- 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 the areas around the rotating parts are clear.
- All of the guards must be put in place. Check for damaged guards or for missing guards. Repair any damaged guards. Replace damaged guards and/or missing guards.
- Disconnect any battery chargers that are not protected against the high current drain that is created when the electric starting motor (if equipped) is engaged. Check electrical cables and check the battery for poor connections and for corrosion.
- Reset any of the shutoff components or alarm components.
- Check the engine lubrication oil level. Maintain the oil level between the “ADD” mark and the “FULL” mark on the oil level gauge.
- Check the coolant level. 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 in the sight glass.
- Observe the air cleaner service indicator. Service the air cleaner when the red target locks in the visible position.
- Disengage any driven equipment. Remove any electrical loads.

i04132731

Cold Weather Starting

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

Startability will be improved at temperatures below 10°C (50°F) from the use of a cylinder block coolant heater or from other means that are used to heat the crankcase oil. Some engine applications use a jacket water heater to improve startability. Use of a jacket water heater will help reduce white smoke and misfire during start-up in cold weather.

Note: If the engine has not been run for several weeks, fuel may have drained. Air may have moved into the filter housing. Also, when fuel filters have been changed, some air will be left in the filter housing. Refer to the Operation and Maintenance Manual, “Fuel System - Prime” (Maintenance Section) for more information on priming the fuel system.

Ether Injection System (If Equipped)

The ether injection system is controlled by the ECM. The ECM monitors the coolant temperature, intake air temperature, ambient air temperature, and barometric pressure to determine when ether injection is needed. At sea level, ether will be used if any of the temperatures fails to exceed 0° C (32° F). This temperature is subject to an increase as barometric pressure increases.

⚠ WARNING

Personal injury or property damage can result from alcohol or starting fluids.

Alcohol or starting fluids are highly flammable and toxic and if improperly stored could result in injury or property damage.

Follow the procedure in this Operation and Maintenance Manual, “Starting the Engine”.

i07504962

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.

Starting the Engine

Refer to the Owner's Manual of the OEM for your type of controls. Use the following procedure to start the engine.

1. Place the transmission in NEUTRAL. Disengage the flywheel clutch to allow the engine to start faster, and to reduce the draining of the battery.

2. Turn the ignition switch to the ON position.

During the key on, the diagnostic lamp, and warning lamp will be checked for proper bulb operation. If any of the lamps do not illuminate, replace the bulb.

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. Push the start button or turn the ignition switch to the START position to crank the engine.

Do not push down or hold the throttle down while the engine is cranked. The system will automatically provide the correct amount of fuel that is needed to start the engine.

4. If the engine fails to start within 30 seconds, release the start button, or the ignition switch. Wait for 2 minutes to allow the starting motor to cool before attempting to start the engine again.

NOTICE
Oil pressure should rise within 15 seconds after the engine starts. Do not increase engine rpm until the oil pressure gauge indicates normal. If oil pressure is not indicated on the gauge within 15 seconds, DO NOT operate the engine. STOP the engine, investigate and correct the cause.

5. Allow the engine to idle for approximately 3 minutes. Idle the engine until the water temperature gauge has begun to rise. Check all gauges during the warmup period.

Note: Oil pressures and fuel pressures should be in the normal range on the instrument panel. Engines that are equipped with “WARNING” lamps do not have an operating range. The “WARNING and DIAGNOSTIC” lamp (if equipped) will flash while the engine is cranking. The lamp should turn off after proper engine oil pressure or fuel pressure is achieved. Do not apply a load to the engine or increase engine rpm until the oil pressure gauge indicates at least normal pressure. Inspect the engine for leaks and/or unusual noises.

If the engine is operated with a low load, the engine will reach normal operating temperature sooner than idling the engine with no load. When the engine is idled in cold weather, increase the engine rpm to approximately 1000 to 1200 rpm to warm up the engine more quickly. Do not exceed the recommended rpm to increase the speed of the warmup. Limit unnecessary idle time to 10 minutes.

Starting Problems

An occasional starting problem may be caused by one of the following items:

- Low battery charge
- Lack of fuel
- Problem with the wiring harness

If the engine fuel system has been run dry, fill the fuel tank and prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime” topic (Maintenance Section).

If the other problems are suspected, perform the appropriate procedure to start the engine.

Problems with the Wiring Harness

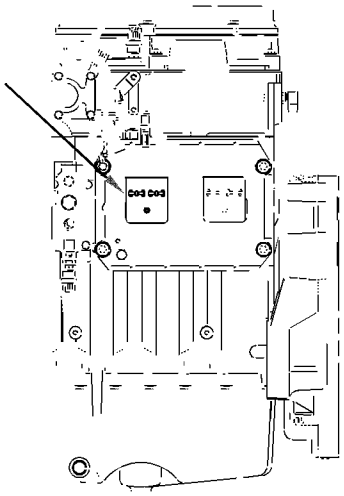

Illustration 30 g01248812
ECM Connector J2/P2

Locate the ECM. Check the connector to ensure that the connector is secure. Lightly pull each of the wires in the chassis harness.

1. Pull each wire with approximately 4.5 kg (10 lb) of force. The wire should remain in the connector.

2. If a wire is loose, push the wire back into the connector. Pull the wire again to ensure that the wire is secure.

3. Start the engine. If the engine does not start, consult the nearest Caterpillar dealer for assistance.

i06983895

Starting with Jump Start Cables
(Do Not Use This Procedure in Hazardous Locations that have Explosive Atmospheres)

SMCS Code: 1000; 1401; 1402; 1900

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

First, determine the reason that starting the engine from an external electrical source is necessary. Refer to Troubleshooting, M0076536, “C9.3B Engines”.

Many batteries which are considered unusable are still rechargeable. After jump starting, the alternator may not be able to 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 generator set 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.

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

2. 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.
4. 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.

i07501724

After Starting Engine

SMCS Code: 1000

Note: In temperatures from 0 to 60°C (32 to 140°F), the warmup time is approximately 3 minutes. In temperatures below 0°C (32°F), extra warmup time may be required.

When the engine is idling during warmup, observe the following conditions:

- Check for fluid or air leaks at idle rpm and at one-half full rpm (no load on the engine) before operating the engine under load. Operating the engine at idle and at one-half full rpm with no load is not possible in some applications.
- Operate the engine at low idle until all systems achieve operating temperatures. Check all gauges during the warmup period.

Note: Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

Extended Idle at Cold Ambient Temperature

The engine may automatically change speeds when the engine is idling in cold ambient temperatures (typically less than 0° C (32° F) for extended periods. The purpose of the automatic speed change is to keep the engine coolant warm. The engine speed may rise to 1600 rpm for as long as 20 minutes.

Engine Operation

i06545704

Engine Operation

SMCS Code: 1000

Proper operation and maintenance are key factors in obtaining the maximum life and economy of the engine. If the directions in the Operation and Maintenance Manual are followed, costs can be minimized and engine service life can be maximized.

The time that is needed for the engine to reach normal operating temperature can be less than the time needed for a walk-around inspection of the engine.

After the engine is started and after the engine reaches normal operating temperature, the engine can be operated at the rated rpm. The engine will reach normal operating temperature faster when the engine is at rated speed. The engine will reach normal operating temperature faster when the engine is at low-power demand. This procedure is more effective than idling the engine at no load. The engine should reach operating temperature in a few minutes.

Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

Engines rated for constant speed use are allowed to complete a starting sequence, an operation at a single constant speed, and a shutdown sequence. Every time the engine is run, each of these operations should occur only once. The starting sequence and shutdown sequence can include a short period of operation at the low idle speed for purposes of warming up and cooling down the engine or driven equipment. The emissions type approval is not valid for operation of a constant speed engine in a manner different from that described above.

i04038637

Engaging the Driven Equipment

SMCS Code: 1000

1. Operate the engine at one-half of the rated rpm, when possible.
2. Engage the driven equipment without a load on the equipment, when possible.

   Interrupted starts put excessive stress on the drive train. Interrupted starts also waste fuel. To get the driven equipment in motion, engage the clutch smoothly with no load on the equipment. This method should produce a start that is smooth and easy. The engine rpm should not increase and the clutch should not slip.
3. Ensure that the ranges of the gauges are normal when the engine is operating at one-half of the rated rpm. Ensure that all gauges operate properly.
4. Increase the engine rpm to the rated rpm. Always increase the engine rpm to the rated rpm before the load is applied.
5. Apply the load. Begin operating the engine at low load. Check the gauges and equipment for proper operation. After normal oil pressure is reached and the temperature gauge begins to move, the engine may be operated at full load. Check the gauges and equipment frequently when the engine is operated under load.

   Extended operation at low idle or at reduced load may cause increased oil consumption and carbon buildup in the cylinders. This carbon buildup results in a loss of power and/or poor performance.

i01136207

Fuel Conservation Practices

SMCS Code: 1000; 1250

The efficiency of the engine can affect the fuel economy. Caterpillar's design and technology in manufacturing provides maximum fuel efficiency in all applications. Follow the recommended procedures in order to attain optimum performance for the life of the engine.

- Avoid spilling fuel.

Fuel expands when the fuel is warmed up. The fuel may overflow from the fuel tank. Inspect fuel lines for leaks. Repair the fuel lines, as needed.

- Be aware of the properties of the different fuels. Use only the recommended fuels.
- Avoid unnecessary idling.

Shut off the engine rather than idle for long periods of time.

- Observe the service indicator frequently. Keep the air cleaner elements clean.

- Ensure that the turbochargers are operating correctly so that the proper air/fuel ratio is maintained. Clean exhaust indicates proper functioning.
- Maintain a good electrical system.

One faulty battery cell will overwork the alternator. This will consume excess power and excess fuel.

- Ensure that the belts are properly adjusted. The belts should be in good condition.
- Ensure that all of the connections of the hoses are tight. The connections should not leak.
- Ensure that the driven equipment is in good working order.
- Cold engines consume excess fuel. Utilize heat from the jacket water system and the exhaust system, when possible. Keep cooling system components clean and keep cooling system components in good repair. Never operate the engine without water temperature regulators. All of these items will help maintain operating temperatures.

Cold Weather Operation

i03729720

Radiator Restrictions

SMCS Code: 1353; 1396

Caterpillar discourages the use of airflow restriction devices that are mounted in front of radiators. Airflow restriction can cause the following conditions:

- High exhaust temperatures
- Power loss
- Excessive fan usage
- Reduction in fuel economy

If an airflow restriction device must be used, the device should have a permanent opening directly in line with the fan hub. The device must have a minimum opening dimension of at least 770 cm^2 (120 in^2).

A centered opening that is directly in line with the fan hub is specified in order to prevent an interrupted airflow on the fan blades. Interrupted airflow on the fan blades could cause a fan failure.

Caterpillar recommends a warning device for the inlet manifold temperature and/or the installation of an inlet air temperature gauge. The warning device for the inlet manifold temperature should be set at 90° C (194° F). The inlet manifold air temperature should not exceed 75 °C (167 °F). Temperatures that exceed this limit can cause power loss and potential engine damage.

i05264084

Fuel and the Effect from Cold Weather

SMCS Code: 1000; 1250; 1280

The following fuels are the grades that are available for Cat engines:

- No. 1
- No. 2
- Blend of No. 1 and No. 2

No. 2 diesel fuel is the most commonly used fuel. Either No. 1 diesel fuel or a blend of No. 1 and No. 2 is best suited for cold-weather operation.

Quantities of No. 1 diesel fuel are limited. No. 1 diesel fuels are usually available during the months of the winter in the colder climates. During cold-weather operation, if No. 1 diesel fuel is not available, use No. 2 diesel fuel, if necessary.

There are three major differences between No. 1 and No. 2 diesel fuel. No. 1 diesel fuel has the following properties:

- Lower cloud point
- Lower pour point
- Lower rating of kJ (BTU) per unit volume of fuel

When No. 1 diesel fuel is used, a decrease in power and in fuel efficiency may be noticed. Other operating effects should not be experienced.

The cloud point is the temperature when a cloud of wax crystals begins to form in the fuel. These crystals can cause the fuel filters to plug. The pour point is the temperature when diesel fuel will thicken. The diesel fuel becomes more resistant to flow through fuel pumps and through fuel lines.

Be aware of these values when diesel fuel is purchased. Anticipate the average ambient temperature of the area. Engines that are fueled in one climate may not operate well if the engines are moved to another climate. Problems can result due to changes in temperature.

Before troubleshooting for low power or for poor performance in the winter, check the type of fuel that is being used.

When No. 2 diesel fuel is used the following components provide a means of minimizing problems in cold weather:

- Starting aids
- Engine oil pan heaters
- Engine coolant heaters
- Fuel heaters
- Fuel line insulation

For more information on cold-weather operation, see Special Publication, SEBU5898, “Cold Weather Recommendations”.

i03728501

Fuel Related Components in Cold Weather

SMCS Code: 1000; 1250; 1280

Fuel Tanks

Condensation can form in partially filled fuel tanks. Top off the fuel tanks after operating the engine.

Fuel tanks should contain some provision for draining water and sediment from the bottom of the tanks. Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe.

Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Drain the water and sediment from any fuel storage tank at the following intervals:

- Weekly
- Oil changes
- Refueling of the fuel tank

This will help prevent water and/or sediment from being pumped from the fuel storage tank and into the engine fuel tank.

Fuel Heaters

Fuel heaters help to prevent fuel filters from plugging in cold weather due to waxing. A fuel heater should be installed in order for the fuel to be heated before the fuel enters the primary fuel filter.

Select a fuel heater that is mechanically simple, yet adequate for the application. The fuel heater should also help to prevent overheating of the fuel. High fuel temperatures reduce engine performance and the availability of engine power. Choose a fuel heater with a large heating surface. The fuel heater should be practical in size. Small heaters can be too hot due to the limited surface area.

Disconnect the fuel heater in warm weather.

Note: Fuel heaters that are controlled by the water temperature regulator or self-regulating fuel heaters should be used with this engine. Fuel heaters that are not controlled by the water temperature regulator can heat the fuel in excess of 65° C (149° F). A loss of engine power can occur if the fuel supply temperature exceeds 37° C (100° F).

Note: Heat exchanger type fuel heaters should have a bypass provision in order to prevent overheating of the fuel in warm weather operation.

For further information on fuel heaters, consult your Caterpillar dealer.

Engine Stopping

i07501737

Stopping the Engine

SMCS Code: 1000

NOTICE
Stopping the engine immediately after working under load can result in overheating, and accelerated wear of the engine components.

Refer to the following stopping procedure to allow the engine to cool, and to prevent excessive temperatures in the turbocharger center housing.

Positions of the engine key switch are indicated by a film that surrounds the engine key switch.

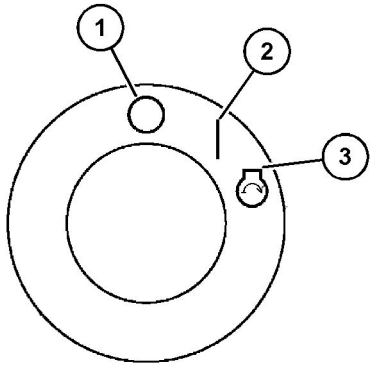

Illustration 31 g06340185

Type 1 engine key switch positions

(1) OFF
(2) ON
(3) START

1. Before shutting down, run the engine for 5 minutes at low idle. Idling the engine allows hot areas of the engine to cool gradually.

2. Turn the engine key switch to OFF position (1) and remove the key.

i05812522

Manual Stop Procedure

SMCS Code: 1000; 7418

NOTICE
Stopping the engine immediately after it has been working under load can result in overheating and accelerated wear of the engine components.

If the engine has been operating at high rpm and/or high loads, run at low idle for at least three minutes to reduce and stabilize internal engine temperature before stopping the engine.

Avoiding hot engine shutdowns will maximize turbocharger shaft and bearing life.

Note: Individual applications have different control systems. Ensure that the shutoff procedures are understood. Use the following general guidelines in order to stop the engine.

1. Remove the load from the engine so that the engine has no more than 30% power.

2. Run the engine at the programmed low idle speed for at least 3 minutes.

3. After the cool down period, turn the start switch to the OFF position.

i01465494

After Stopping Engine

SMCS Code: 1000

Note: Before you check the engine oil, do not operate the engine for at least 10 minutes in order to allow the engine oil to return to the oil pan.

- Check the crankcase oil level. Maintain the oil level between the “ADD” mark and the “FULL” mark on the oil level gauge.
- If necessary, perform minor adjustments. Repair any leaks and tighten any loose bolts.
- Note the service hour meter reading. Perform the maintenance that is in the Operation and Maintenance Manual, “Maintenance Interval Schedule”.
- Fill the fuel tank in order to help prevent accumulation of moisture in the fuel. Do not overfill the fuel tank.

NOTICE
Only use antifreeze/coolant mixtures recommended in the Coolant Specifications that are in the Operation and Maintenance 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 proper antifreeze protection. 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. This maintenance is outlined in the instructions from the OEM.

Maintenance Section

Refill Capacities

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Refill Capacities

SMCS Code: 1000; 1348; 1395; 7560

Refer to this Operation and Maintenance Manual, “Fluid Recommendations” for information about the fluids which are acceptable for this engine.

Refer to Special Publication, SEBU6251, “Caterpillar Commercial Engine Fluids Recommendations” for additional information.

Lubricant Refill Capacities

The refill capacities for the engine crankcase reflect the approximate capacity of the crankcase or sump plus standard oil filters. Auxiliary oil filter systems will require more oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.

Table 3

C9.3B Industrial Engine Approximate Refill Capacities		
System	**Liters**	**Quarts**
Oil Sump(1)	32	33.8

(1) These values are approximate capacities for the crankcase oil sump which include the standard oil filters that are installed at the factory. Engines with auxiliary oil filters will require more oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.

Coolant Refill Capacities

To maintain the cooling system, the total cooling system capacity must be known. The capacity of the total cooling system will vary. The capacity will depend on the size of the radiator (capacity). Table 4 should be completed by the customer for the maintenance of the cooling system.

Table 4

Approximate Capacity of the Cooling System		
Compartment or System	Liters	Quarts
Total Cooling System(1)		

(continued)

(Table 4, contd)

(1) The total cooling system capacity includes the following components: the engine block, the radiator, and all coolant hoses and lines.

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Fluid Recommendations

SMCS Code: 1280; 1348; 1395; 7560

Refer to this Operation and Maintenance Manual, “Severe Service Application” for information about operating an engine in a severe service application.

Note: The interval for changing the coolant varies depending on the type of coolant being replaced. Refer to this article, “Coolant Recommendations”, for the intervals for changing the coolant.

Diesel Engine Oil

For more information, refer to Special Publication, SEBU6251, “Cat Commercial Diesel Engine Fluids Recommendations”.

Cat Diesel Engine Oil (Cat DEO)

Cat oils have been developed and tested in order to provide the full performance and service life that has been designed and built into Cat engines. Cat oils are currently used to fill Cat Diesel Engines at the factory. These oils are offered by Cat dealers for continued use when the engine oil is changed. Consult your Cat dealer for more information on these oils.

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

Table 5

Cat Lubricants		Viscosity Grade
Diesel Engine Oil-Ultra Low Sulfur	Cat DEO-ULS	SAE 15W-40
		SAE 10W-30
	Cat DEO-ULS SYN	SAE 5W-40
	Cat Cold Weather DEO-ULS	SAE 0W-40
Diesel Engine Oil	Cat DEO	SAE 15W-40
		SAE 10W-30
	Cat DEO SYN	SAE 5W-40

Note: Cat DEO and Cat DEO-ULS multigrade oils are the preferred oils for use in this Cat Diesel Engine.

Commercial Oil

Note: Non-Cat commercial oils are second choice oils for your engine.

NOTICE
Caterpillar does not warrant the quality or performance of non-Cat fluids.

The three current Caterpillar ECF specifications are: Cat ECF-1-a, Cat ECF-2 and Cat ECF-3. Each higher Cat ECF specification provides increased performance over lower Cat ECF specifications.

A commercial oil must meet the following standards to be considered an equivalent of a Cat Diesel Engine Oil:

Table 6

Cat Engine Crankcase Fluids (ECF) Definitions	
Cat Performance Requirement	Cat ECF Specifications Requirements
Cat ECF-3	API CJ-4 Oil Category performance requirements
Cat ECF-2	API CI-4 / CI-4 PLUS Oil Category performance requirements
	Passing standard Cat C13 engine test per API requirements
	Oils of sulfated ash > 1.50 percent are not allowed
Cat ECF-1-a	API CH-4 Oil Category performance requirements
	For oils that are between 1.30 percent and 1.50 percent sulfated ash, passing one additional Cat 1P SCOTE test (“ASTM D6681”) is required
	Oils of sulfated ash > 1.50 percent are not allowed

In selecting oil for any engine application, both of the following must be satisfied: the oil viscosity and the category of oil performance or the specification for oil performance . Using only one of these parameters will not sufficiently define oil for an engine application.

The proper SAE viscosity grade of oil is determined by the following temperatures: minimum ambient temperature during cold engine start-up and maximum ambient temperature during engine operation.

Refer to Table 7 (minimum temperature) in order to determine the required oil viscosity for starting a cold engine.

Refer to Table 7 (maximum temperature) in order to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

Note: Generally, use the highest oil viscosity that is available to meet the requirement for the temperature at start-up.

Table 7

Lubricant Viscosities for Ambient Temperatures for Cat Diesel Engines					
Oil Type and Performance Requirements	**Viscosity Grade**	**°C**		**°F**	
		Min	**Max**	**Min**	**Max**
Cat ECF-1-a Cat ECF-2 Cat ECF-3	SAE 0W-30	−40	30	−40	86
Cat Cold Weather DEO-ULS Cat ECF-1-a Cat ECF-2 Cat ECF-3	SAE 0W-40	−40	40	−40	104
Cat DEO-ULS Cat ECF-1-a Cat ECF-2 Cat ECF-3	SAE 5W-30	−30	30	−22	86
Cat DEO-ULS SYN Cat DEO Cat ECF-1-a Cat ECF-2 Cat ECF-3	SAE 5W-40	−30	50	−22	122
Cat ECF-1-a Cat ECF-2 Cat ECF-3	SAE 10W-30	−18	40	0	104
Cat DEO-ULS Cat DEO	SAE 10W-40	−18	50	0	122
	SAE 15W-40	−9.5	50	15	122

Note: A cold soaked start occurs when the engine has not been operated recently, allowing the oil to become more viscous due to cooler ambient temperatures. Supplemental heat is recommended for cold soaked starts below the minimum ambient temperature. Supplemental heat may be necessary for cold soaked starts that are above the minimum temperature depending on factors such as parasitic load.

Total Base Number (TBN) and Fuel Sulfur Levels

The use of Cat S·O·S Services oil analysis is recommended strongly for determining oil life.

The minimum required Total Base Number (TBN) for oil depends on the fuel sulfur level. The TBN for new oil is typically determined by the “ASTM D2896” procedure. For direct injection engines that use distillate fuel, the following guidelines apply:

Table 8

TBN recommendations for applications in Cat engines (1)		
Fuel Sulfur Level percent (ppm)	Cat Engine Oils	TBN of Commercial Engine Oils
≤0.05 percent (≤500 ppm)	Cat DEO-ULS Cat DEO	Min 7
0. 1- 0.05 percent (1000-500 ppm)	Cat DEO-ULS Cat DEO	Min 7
Above 0.1 percent (above 1000 ppm)(2)	Cat DEO(3)	Min 10

(1) When using fuel with 0.10% sulfur (1000 ppm) or higher, refer to this Operation and Maintenance Manual, “Severe Service Application” for more information.
(2) For fuels of sulfur levels that exceed 1.0 percent (10,000 ppm), refer to TBN and engine oil guidelines given in this section.
(3) Cat DEO-ULS may be used if an oil analysis program is followed. Base the oil change interval on the analysis.

S·O·S Services Oil Analysis

Caterpillar has developed a maintenance tool that evaluates oil degradation. the maintenance management also detects the early signs of wear on internal components. The Caterpillar tool for oil analysis is called S·O·S oil analysis and the tool is part of the S·O·S Services program. S·O·S oil analysis divides oil analysis into four categories:

- Component wear rate
- Oil condition
- Oil contamination
- Identification of oil

These four types of analysis are used to monitor the condition of your equipment. The four types of analysis will also help you identify potential problems. A properly administered S·O·S oil analysis program will reduce repair costs and the program will lessen the impact of downtime.

The S·O·S Oil Analysis program uses a wide range of tests to determine the condition of the oil and the crankcase. Guidelines that are based on experience and a correlation to failures have been established for these tests. Exceeding one or more of these guidelines could indicate serious fluid degradation or a pending component failure. A trained person at your Cat dealership should make the final analysis.

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 Special Publication, SEBU6251, “Cat Commercial Diesel Engine Fluids Recommendations” in order to obtain additional information about S·O·S Services oil analysis. You can also contact your local Cat dealer.

Fuel

Note: Caterpillar strongly recommends the filtration of fuel through a fuel filter with a rating of four microns(c) absolute or less. This filtration should be located on the device that dispenses the fuel to the fuel tank for the engine. This filtration should also be located on the device that dispenses fuel from the bulk storage tank. Series filtration is recommended.

NOTICE
In order to meet expected fuel system component life, 4 micron(c) absolute or less secondary fuel filtration is required for all Cat Diesel Engines that are equipped with unit injected fuel systems. All current Cat Diesel Engines are factory equipped with Cat Advanced Efficiency 4 micron(c) absolute fuel filters.

Caterpillar does not warrant the quality or performance of non-Cat fluids and filters.

Diesel engines can burn a wide variety of fuels. These fuels are divided into two general groups. The two groups are called the preferred fuels and the permissible fuels.

Note: The permissible fuels are some crude oils, some blends of crude oil with distillate fuel, some biodiesel, and some marine diesel fuel. These fuels are not suitable for use in all engine applications. The acceptability of these fuels for use is determined on an individual basis. A complete fuel analysis is required.

For more information, refer to Special Publication, SEBU6251, “Cat Commercial Diesel Engine Fluids Recommendations” or consult your Cat dealer for further information.

Diesel Distillate Fuel

Diesel engines may burn a wide variety of fuels. These fuels are divided into two general groups. The two groups are called the preferred fuels and the permissible fuels.

The preferred fuels provide maximum engine service life and performance. The preferred fuels are distillate fuels. These fuels are commonly called diesel fuel, furnace oil, gas oil, or kerosene. These fuels must meet the “Cat Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines” found in this Special Publication, “Distillate Diesel Fuel” article.

Note: The permissible fuels are some crude oils, some blends of crude oil with distillate fuel, some biodiesel, and some marine diesel fuel. **These fuels are not suitable for use in all engine applications.** The acceptability of these fuels for use is determined on a case by case basis. A complete fuel analysis is required. Consult your Cat dealer for further information.

NOTICE
The footnotes are a key part of the “Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines” Table. Read ALL of the footnotes.

Table 9

Caterpillar Specification for Distillate Fuel for Nonroad Diesel Engines			
Specifications	**Requirements**	**ASTM Test**	**ISO Test**
Aromatics	35% maximum	“D1319”	“ISO 3837”
Ash	0.01% maximum (weight)	“D482”	“ISO 6245”
Carbon Residue on 10% Bottoms	0.35% maximum (weight)	“D524”	“ISO 4262”
Cetane Number (1)	40 minimum (DI engines)	“D613” or “D6890”	“ISO 5165”
	35 minimum (PC engines)		
Cloud Point	The cloud point must not exceed the lowest expected ambient temperature.	“D2500”	“ISO 3015”
Copper Strip Corrosion	No. 3 maximum	“D130”	“ISO 2160”
Distillation	10% at 282 °C (540 °F) maximum	“D86”	“ISO 3405”
	90% at 360 °C (680 °F) maximum		
Flash Point	legal limit	“D93”	“ISO 2719”

(continued)

(Table 9, contd)

Caterpillar Specification for Distillate Fuel for Nonroad Diesel Engines			
Specifications	**Requirements**	**ASTM Test**	**ISO Test**
Thermal Stability	Minimum of 80% reflectance after aging for 180 minutes at 150 °C (302 °F)	“D6468”	No equivalent test
API Gravity (2)	30 minimum	“D287”	No equivalent test
	45 maximum		
Pour Point	6 °C (10 °F) minimum below ambient temperature	“D97”	“ISO 3016”
Sulfur	(3)(4)(5)	“D5453” or “D2622”	ISO 20846 or ISO 20884
Kinematic Viscosity	1.4 cSt minimum and 20.0 cSt maximum as delivered to the fuel injection pumps	-	-
	1.4 cSt minimum and 4.5 cSt maximum as delivered to the rotary fuel injection pumps		
Water and Sediment	0.05% maximum	“D1796” or “D2709”	“ISO 3734”
Water	0.05% maximum	“D6304”	No equivalent test
Sediment	0.05% maximum (weight)	“D473”	“ISO 3735”
Gums and Resins (6)	10 mg per 100 mL maximum	“D381”	“ISO 6246”
Lubricity	0.52 mm (0.0205 inch) maximum at 60 °C (140 °F)	“D6079”	No equivalent test

(1) Alternatively, to ensure a minimum cetane number of 35 (PC engines), and 40 (DI engines), distillate diesel fuel should have a minimum cetane index of 37.5 (PC engines), and 44.2 (DI engines) when the “ASTM D4737-96a” test method is used. A fuel with a higher cetane number may be required for operation at a higher altitude or in cold weather.

(2) Via standards tables, the equivalent kg/m^3 (kilograms per cubic meter) using the “ASTM D287” test method temperature of 15.56° C (60° F) for the minimum API gravity of 30 is 875.7 kg/m^3, and for the maximum API gravity of 45 is 801.3 kg/m^3.

(3) ULSD 0.0015% (<15 ppm S) is required by law for Tier 4 engines and engines with aftertreatment devices.

(continued)

(Table 9, contd)

(4) Certain Cat fuel systems and engine components can operate on fuel with a maximum sulfur content of 3%. Contact your Cat dealer for guidance about appropriate maintenance intervals and fluids for engines operating on fuel with sulfur levels between 0.1% and 3%.

(5) An engine which operates on fuel with 0.1% (1000 ppm) of sulfur or more is operating in a severe service application. Refer to this Operation and Maintenance Manual, “Severe Service Application” for information about operating an engine in a severe service application.

(6) Follow the test conditions and procedures for gasoline (motor).

Biodiesel

A biodiesel blend of up to 20 percent may be used in the engine when the fuel blend meets the recommendations in table 10 and meets the recommendations in Special Publication, SEBU6251, “Biodiesel”.

Note: A complete Cat S·O·S Services oil analysis program is **recommended strongly** when using biodiesel blends above 5 percent.

Table 10

Biodiesel Blends for Cat Commercial Diesel Engines		
Biodiesel blend stock	Final blend	Distillate diesel fuel used for blend
Caterpillar biodiesel specification, “ASTM D6751” or “EN14214”	B20: “ASTM D7467” and “API” gravity 30-45	Caterpillar distillate diesel fuel specification, “ASTM D975” or “EN590”

Fuel Additives

Cat Diesel Fuel Conditioner

Cat Diesel Fuel Conditioner is a proprietary formulation that has been extensively tested for use with distillate diesel fuels for use in Cat Diesel Engines. Cat Diesel Fuel Conditioner is a high performance diesel fuel conditioner for use with lower quality fuels that do not meet the minimum requirements of any of the following:

- “Caterpillar Specification for Distillate Diesel Fuel”
- National Conference on Weights and Measures (NCWM) Premium Diesel definition (refer to the 2004 or newer National Institute of Standards & Technology (NIST) Handbook).
- EN590 (non-arctic)
- ASTM D975

Cat Diesel Fuel Conditioner is the only fuel conditioner/additive available to the end user that is tested and approved by Caterpillar for use in Cat Diesel Engines.

Refer to Special Publication, SEBU6251, “Cat Commercial Diesel Engine Fluids Recommendations” for information about the use of Cat Diesel Fuel Conditioner.

Cat Diesel Fuel System Cleaner

Note: Cat Diesel Fuel System Cleaner is the only fuel system cleaner available to the end user that is tested and approved by Caterpillar for use in Cat Diesel Engines.

Cat Diesel Fuel System Cleaner is a proven high performance detergent product designed specifically for cleaning deposits that form in the fuel system. Deposits in the fuel system reduce system performance and can increase fuel consumption. Cat Diesel Fuel System Cleaner addresses the deposits formed due to the use of degraded diesel fuel, poor quality diesel fuel, and diesel fuel containing high quantities of high molecular weight compounds. Cat Diesel Fuel System Cleaner addresses deposits formed due to the use of biodiesel, biodiesel blends, and biodiesel that does not meet the appropriate quality specifications. Continued use of Cat Diesel Fuel System Cleaner is proven to inhibit the growth of new deposits.

Caterpillar strongly recommends that Cat Diesel Fuel System Cleaner be used with biodiesel and biodiesel blends. Cat Diesel Fuel System Cleaner is suitable for use with biodiesel/biodiesel blends that meet Caterpillar biodiesel recommendations and requirements. Not all fuel cleaners are suitable for use with biodiesel/biodiesel blends. Read and follow all applicable label usage instructions. Also, refer to Special Publication, SEBU6251, “Cat Commercial Diesel Engine Fluids Recommendations” “Distillate Diesel Fuel”, article and also refer to the “Biodiesel” article, which includes Caterpillar biodiesel recommendations and requirements.

Aftermarket Fuel Additives

There are many different types of fuel additives that are available to use. Caterpillar does not generally recommend the use of fuel additives.

In special circumstances, Caterpillar recognizes the need for fuel additives. Use fuel additives with caution. The additive may not be compatible with the fuel. Some additives may precipitate. This action causes deposits in the fuel system. The deposits may cause seizure. Some additives may plug fuel filters. Some additives may be corrosive, and some additives may be harmful to the elastomers in the fuel system. Some additives may damage emission control systems. Some additives may raise fuel sulfur levels above the maximum levels that are allowed by the following agencies: EPA and other regulatory agencies. Contact your fuel supplier for those circumstances when fuel additives are required. Your fuel supplier can make recommendations for additives to use and for the proper level of treatment.

Note: For best results, your fuel supplier should treat the fuel when additives are needed.

Cooling System

Note: Refer to Special Publication , SEBU6251, “Cat Commercial Diesel Engine Fluids Recommendations” for complete information about the proper fluids for use in the cooling system.

⚠ WARNING

The cooling system operates under pressure which is controlled by the radiator pressure cap. Removing the cap while the system is hot may allow the escape of hot coolant and steam, causing serious burns.

Before you remove the radiator cap, allow the system to cool. Use a thick cloth and turn the radiator cap slowly to the first stop to allow pressure to escape before fully removing the cap.

Avoid contact with coolant.

NOTICE
Never add coolant to an overheated engine. Engine damage could result. Allow the engine to cool first.

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

Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without water temperature regulators. Removing the regulators allows some coolant to bypass the radiator, potentially causing overheating.

Coolant Recommendations

Note: A Cat Diesel Engine equipped with air-to-air aftercooling (ATAAC) requires a minimum of 30 percent glycol to help prevent water pump cavitation.

Table 11

Coolant Recommendations for use in Cat Diesel Engines			
Recommendations	**Product**	**Service Hours (1)(2)(3)**	**Required Maintenance**
Preferred	Cat ELC (Cat Extended Life Coolant)	12000 hours or 6 years	Add Cat ELC Extender at 6000 service hours or one half of service life
	Cat ELI (Cat Extended Life Inhibitor)	12000 hours or 6 years	Add Cat ELC Extender at 6000 service hours or one half of service life
Min requirements	Cat EC-1 specification and “ASTM D6210” and Organic Additive Technology (OAT) based on a combination of a monocarboxylic acid and a dicarboxylic acid Phosphate, borate, and silicate free Tolyltriazole: minimum typical concnetration of 900 ppm Nitrite: minimum typical concentration of 500 ppm in new coolants	6000 hours or 6 years	Add Extender at 3000 service hours or one half of service life
Acceptable	Cat DEAC (Cat Diesel Engine Antifreeze/Coolant)	3000 hours or 3 years	SCA (Supplemental coolant additive) at maintenance intervals
Min requirements for fully formulated Heavy Duty Commercial coolants	“ASTM D6210” and Nitrite (as NO2) concentration: Minimum of 1200 ppm (70 grains/US gal) and maximum of 2400 ppm (140 grains/US gal) Silicon concentration: minimum of 100 ppm and maximum of 275 ppm	3000 hours or 2 years	SCA at maintenance intervals
Min requirements for Commercial coolants requiring SCA precharge	“ASTM D4985” and(1) Nitrite (as NO2) concentration: Minimum of 1200 ppm (70 grains/US gal) and maximum of 2400 ppm (140 grains/US gal) Silicon concentration: minimum of 100 ppm and maximum of 275 ppm	3000 hours or 1 year	SCA at initial fill and SCA at maintenance intervals

(1) New Coolants at 50 volume percent diluted. Coolants that are prediluted at the coolant manufacturer must be diluted with water that meets Reagent 4 “ASTM D1193” requirements.
(2) Maintain the in-service coolant at the given limits.
(3) When referring to the service hours, use the interval that occurs first. These coolant change intervals are only achievable with annual S·O·S Services Level 2 coolant sampling analysis.

Table 12

Special Requirements	
Cat C7-C32 Marine Engines with heat exchangers	Minimum of 30% glycol is required. 50% Glycol is recommended. Water alone or water with SCA or with ELI is NOT allowed.
Cat diesel engines equipped with air-to-air aftercooling (ATAAC)	

NOTICE
Use Only Approved SCAs and Extenders

Conventional coolants require the maintenance addition of SCA throughout the expected life of the coolants. Do NOT use an SCA with a coolant unless approved specifically by the coolant supplier. The coolant manufacturer is responsible for ensuring compatibility and acceptable performance.

To help ensure expected performance, EC-1 coolants require the one time maintenance addition of an extender at coolant service mid-life. Do not use an extender with a coolant unless the extender has been approved specifically for use by the coolant manufacturer. The coolant manufacturer is responsible for ensuring compatibility and acceptable performance.

Failure to follow these recommendations can result in shortened cooling system component life.

Cat ELC can be recycled into conventional coolants.

For more information, refer to Special Publication, SEBU6251, “Cat Commercial Diesel Engine Fluids Recommendations”.

S·O·S Services Coolant Analysis

Testing the engine coolant is important to ensure that the engine is protected from internal cavitation and corrosion. The analysis also tests the ability of the coolant to protect the engine from boiling and freezing. S·O·S coolant analysis can be done at your Cat dealer. Cat S·O·S coolant analysis is the best way to monitor the condition of your coolant and your cooling system. S·O·S coolant analysis is a program that is based on periodic samples.

Table 13

Recommended Interval		
Type of Coolant	**Level 1**	**Level 2**
Cat DEAC Conventional Heavy-Duty Coolants	Every 250 hours	Yearly(1)
Cat ELC Cat ELI Commercial EC-1 Coolants	Optional	Yearly(1)

(1) The Level 2 Coolant Analysis should be performed sooner if a problem is suspected or identified.

Note: Check the SCA (Supplemental Coolant Additive) of the conventional coolant at every oil change or at every 250 hours. Perform this check at the interval that occurs first.

S·O·S Services Coolant Analysis (Level 1)

A coolant analysis (Level 1) is a test of the properties of the coolant.

The following properties of the coolant are tested:

- Glycol concentration for freeze protection and boil protection
- Ability to protect from erosion and corrosion
- pH
- Conductivity
- Visual analysis
- Odor analysis

The results are reported, and appropriate recommendations are made.

S·O·S Services Coolant Analysis (Level 2)

A coolant analysis (Level 2) is a comprehensive chemical evaluation of the coolant. This analysis is also a check of the overall condition of the cooling system.

The S·O·S coolant analysis (Level 2) has the following features:

- Full coolant analysis (Level 1)
- Identification of metal corrosion and of contaminants
- Identification of buildup of the impurities that cause corrosion
- Identification of buildup of the impurities that cause scaling
- Determination of the possibility of electrolysis within the cooling system of the engine

The results are reported, and appropriate recommendations are made.

For more information on S·O·S coolant analysis, consult your Cat dealer.

Greases

If it is necessary to choose a single grease, always choose a grease that meets or exceeds the requirements of the most demanding application. Remember that the products which barely meet the minimum performance requirements can be expected to barely produce the minimum lives of your parts. False economy is being used if a grease is purchased with the lowest cost as the only consideration. Instead, use the grease that yields the lowest total operating cost. The cost should be based on an analysis that includes the costs of parts, labor, downtime, and the cost of the amount of grease that is required.

For more information, refer to Special Publication, SEBU6251, “Cat Commercial Diesel Engine Fluids Recommendations”.

Maintenance Recommendations

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System Pressure Release

SMCS Code: 1250; 1300; 1350; 5050

Coolant System

⚠ WARNING

Pressurized system: Hot coolant can cause serious burn. To open cap, stop engine, wait until radiator is cool. Then loosen cap slowly to relieve the pressure.

To relieve the pressure from the coolant system, turn off the engine. Allow the cooling system pressure cap to cool. Remove the cooling system pressure cap slowly in order to relieve pressure.

Fuel System

To relieve the pressure from the fuel system, turn off the engine.

High Pressure Fuel Lines (If Equipped)

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

The high pressure fuel lines are the fuel lines that are between the high pressure fuel pump and the high pressure fuel manifold and the fuel lines that are between the fuel manifold and cylinder head. These fuel lines are different from fuel lines on other fuel systems.

This is because of the following differences:

- The high pressure fuel lines are constantly charged with high pressure.
- The internal pressures of the high pressure fuel lines are higher than other types of fuel system.

Before any service or repair is performed on the engine fuel lines, perform the following tasks:

1. Stop the engine.

2. Wait for ten minutes.

Do not loosen the high pressure fuel lines in order to remove air pressure from the fuel system.

Engine Oil

To relieve pressure from the lubricating system, turn off the engine.

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Welding on Engines with Electronic Controls

SMCS Code: 1000

NOTICE
Because the strength of the frame may decrease, some manufacturers do not recommend welding onto a chassis frame or rail. Consult the OEM of the equipment or your Cat dealer regarding welding on a chassis frame or rail.

Proper welding procedures are necessary to avoid damage to the engine Electronic Control Module (ECM), sensors, and associated components. When possible, remove the component from the unit and then weld the component. If removal of the component is not possible, the following procedure must be followed when you weld on a unit that is equipped with a Caterpillar Electronic Engine. The following procedure is considered to be the safest procedure to weld on a component. This procedure should provide a minimum risk of damage to electronic components.

NOTICE
Do not ground the welder to electrical components such as the ECM or sensors. Improper grounding can cause damage to the drive train, the bearings, hydraulic components, electrical components, and other components.

Do not ground the welder across the centerline of the package. Improper grounding could cause damage to the bearings, the crankshaft, the rotor shaft, and other components.

Clamp the ground cable from the welder to the component that will be welded. Place the clamp as close as possible to the weld. This will help reduce the possibility of damage.

Note: Perform the welding in areas that are free from explosive hazards.

1. Stop the engine. Turn the switched power to the OFF position.

2. Disconnect the negative battery cable from the battery. If a battery disconnect switch is provided, open the switch.

3. Disconnect the J1/P1 and J2/P2 connectors from the ECM and. Disconnect the wiring from the CEM. Move the harnesses to a position that will not allow the harnesses to contact with any of the ECM, CEM, or pins accidentally.

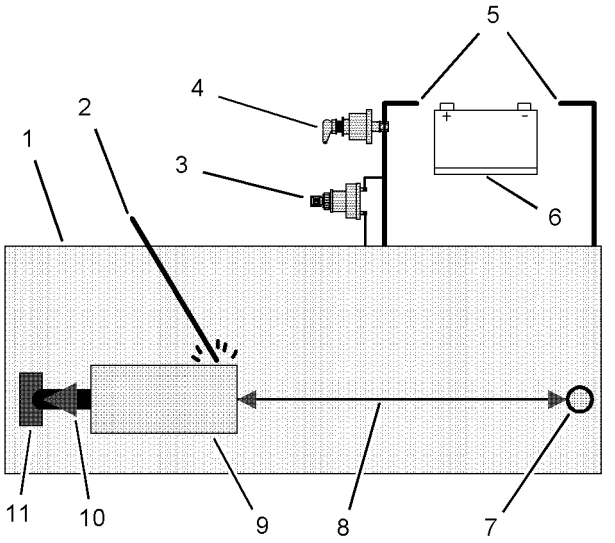

Illustration 32 g01075639

Use the example above. The current flow from the welder to the ground clamp of the welder will not damage any associated components.

(1) Engine
(2) Welding electrode
(3) Keyswitch in the OFF position
(4) Battery disconnect switch in the open position
(5) Disconnected battery cables
(6) Battery
(7) Electrical/Electronic component
(8) Minimum distance between the component that is being welded and any electrical/electronic component
(9) The component that is being welded
(10) Current path of the welder
(11) Ground clamp for the welder

4. Connect the welding ground cable directly to the part that will be welded. Place the ground cable as close as possible to the weld to reduce the possibility of welding current damage to bearings, hydraulic components, electrical components, and ground straps.

Note: If electrical/electronic components are used as a ground for the welder, or electrical/electronic components are located between the welder ground and the weld, current flow from the welder could severely damage the component.

5. Protect the wiring harness from welding debris and spatter.

6. Use standard welding practices to weld the materials.

i04889860

Severe Service Application

SMCS Code: 1000

An engine which operates outside of normal conditions is operating in a severe service application.

An engine that operates in a severe service application may need more frequent maintenance intervals in order to maximize the following conditions:

- Reliability
- Service life

The number of individual applications cause the impossibility of identifying all of the factors which may contribute to severe service operation. Consult your Cat dealer for the unique maintenance that may be necessary for your engine.

An application is a severe service application if any of the following conditions apply:

Severe Environmental Factors

- Frequent operation in dirty air
- Frequent operation at an altitude which is above 1525 m (5000 ft)
- Frequent operation in ambient temperatures which are above 32° C (90° F)
- Frequent operation in ambient temperatures which are below 0° C (32° F)

Severe Operating Conditions

- Frequent operation with inlet air which has a corrosive content
- Operation with inlet air which has a combustible content
- Operation which is outside of the intended application

- Operation with a plugged fuel filter
- Extended operation at low idle (more than 20% of hours)
- Frequent cold starts at temperatures below 0° C (32° F)
- Frequent dry starts (starting after more than 72 hours of shutdown)
- Frequent hot shutdowns (shutting down the engine without the minimum of 2 minutes to 5 minutes of cool down time)
- Operation above the engine rated speed
- Operation below the peak torque speed
- Operating with fuel which does not meet the standards for distillate diesel fuel as stated in Special Publication, SEBU6251, “Cat Commercial Diesel Engine Fluids Recommendations” “Distillate Diesel Fuel”
- Operating with a blend of distillate fuel which contains more than 20 percent biodiesel

Improper Maintenance Procedures (Maintenance Procedures Which May Contribute to a Severe Service Application)

- Inadequate maintenance of fuel storage tanks from causes such as excessive water, sediment, and microorganism growth.
- Extending maintenance intervals beyond the recommended intervals
- Using fluids which are not recommended in Special Publication, SEBU6251, “Cat Commercial Diesel Engine Fluids Recommendations”
- Extending maintenance intervals for changing the engine oil and engine coolant without S·O·S validation
- Extending maintenance intervals for changing air filters, oil filters, and fuel filters
- Failure to use a water separator
- Using filters which are not recommended by Special Publication, PEWJ0074, “2008 Cat Filter and Fluid Application Guide”

i07503004

Maintenance Interval Schedule

SMCS Code: 1000; 4450; 7500

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed. The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, and filters. The user is also responsible for the replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components. Use fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance. Before each consecutive interval is performed, all maintenance from the previous interval must be performed.

When Required

“ Battery - Recycle” 62
“ Battery - Replace” 62
“ Battery or Battery Cable - Disconnect” 63
“ Engine - Clean” 73
“ Engine Air Cleaner Element (Dual Element) - Inspect/Clean/Replace” 73
“ Engine Storage Procedure - Check” 79
“ Fuel System - Prime” 79
“ Fuel Tank Water and Sediment - Drain” 82
“ Radiator - Clean” 90

Daily

“ Air Tank Moisture and Sediment - Drain” 62
“ Coolant Level - Check” 69
“ Driven Equipment - Check” 73
“ Engine Air Cleaner Service Indicator - Inspect” . . 75
“ Engine Oil Level - Check” 75
“ Fuel System Primary Filter/Water Separator - Drain” 81
“ Power Take-Off Clutch - Check” 90
“Walk-Around Inspection” 91

Every 250 Service Hours

“ Engine Oil Sample - Obtain” 76
“Grounding Stud - Inspect/Clean/Tighten” 84

Initial 500 Service Hours

“ Engine Valve Lash - Check” 79

Every 500 Service Hours

“ Air Shutoff - Test” 61
“ Battery Electrolyte Level - Check” 63
“ Belts - Inspect/Adjust/Replace” 64
“ Coolant Sample (Level 1) - Obtain” 70
“ Cooling System Supplemental Coolant Additive (SCA) - Test/Add” 72
“ Engine Oil and Filter - Change” 77
“ Fuel System Primary Filter (Water Separator) Element - Replace” 80
“ Fuel System Secondary Filter - Replace” 82
“ Hoses and Clamps - Inspect/Replace” 84

Every 2000 Service Hours

“Fumes Disposal Filter Element (Emission Related Component) - Replace” 83

Every 2000 Service Hours or 1 Year

“ Coolant Sample (Level 2) - Obtain” 71

Every 2500 Service Hours

“ Compression Brake - Inspect/Adjust/Replace” . . 65
“ Engine Valve Lash - Check” 79

Every 3000 Service Hours or 3 Years

“ Coolant (DEAC) - Change” 65
“ Coolant Temperature Regulator - Replace” 71

Every 4000 Service Hours

“ Air Compressor - Check” 61

“ Engine Mounts - Inspect” 75

Every 4000 Service Hours or 2 Years

“ Starting Motor - Inspect” 91

Every 6000 Service Hours or 3 Years

“ Coolant Extender (ELC) - Add”. 69

Every 12 000 Service Hours or 6 Years

“ Coolant (ELC) - Change”. 67

Every 340 500 L (90 000 US gal) of Fuel

“ Overhaul Considerations” 87

i03966490

Air Compressor - Check
(If equipped)

SMCS Code: 1803-535

⚠ WARNING

Do not disconnect the air line from the air compressor governor without purging the air brake and the auxiliary air systems. Failure to purge the air brake and the auxiliary air systems before removing the air compressor and/or the air lines could cause personal injury.

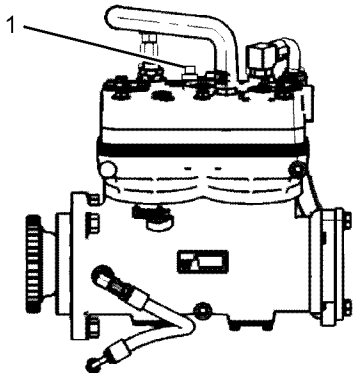

Illustration 33 g01212654

Typical example

(1) Pressure relief valve

⚠ WARNING

If the air compressor pressure relief valve that is mounted in the air compressor cylinder head is bypassing compressed air, there is a malfunction in the air system, possibly ice blockage. Under these conditions, your engine may have insufficient air for normal brake operation.

Do not operate the engine until the reason for the air bypass is identified and corrected. Failure to heed this warning could lead to property damage, personal injury, or death to the operator or bystanders.

The function of the pressure relief valve is to bypass air when there is a malfunction in the system for the air compressor.

The pressure relief valve for the air compressor releases air at 1723 kPa (250 psi). If the pressure relief valve for the air compressor exhausts, all personnel should be at a safe distance away from the air compressor. All personnel should also stay clear of the air compressor when the engine is operating and the air compressor is exposed.

Refer to the Service Manual or refer to the OEM specifications in order to find information concerning the air compressor. Consult your Caterpillar dealer for assistance.

i05427169

Air Shutoff - Test
(If Equipped)

SMCS Code: 1078-081

To ensure that the air shutoff valve always shuts down when the engine ingests gaseous fumes, perform the test below at each oil change. A test failure can indicate wear in the block off plate to valve body interface and/or the bearing system.

1. Place engine at low idle speed. Ensure all accessories that are normally used for the application are in use, like a fan, or power takeoffs.
2. Actuate the air shutoff manually. On electrical operator air shutoffs, utilize an applicable power supply or jumper cables from the battery to energize the air shut-off solenoid. Ensure that the solenoid receives only a momentary signal to prevent overheating. On hydraulic operator air shutoffs, found on some hazardous location units, actuate by pulling the emergency stop handle.
3. Ensure that air shutoff was actuated and that the engine comes to a complete stop.

Note: As every application has different parasitic loads and inertia, the duration for the problem to occur cannot be specified. However, if the engine stumbles or attempts to continue running, these symptoms may be an indication that worn components may need replacement.

If additional help is needed, contact the Dealer Solution Network.

NOTICE

Actuating the air shutoff valve may result in oil leakage past the shaft seal in some cases. Repeated actuation of the air shutoff valve during loaded operation of the engine can result in mechanical damage to the turbocharger and reduce turbocharger life.

i00847451

Air Tank Moisture and Sediment - Drain
(If Equipped)

SMCS Code: 1466-543-M&S

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

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

⚠ WARNING

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

1. Open the drain valve that is on the bottom of the air tank. Allow the moisture and sediment to drain.
2. Close the drain valve.
3. Check the air supply pressure. The air starting motor requires a minimum of 620 kPa (90 psi) of air pressure to operate properly. The maximum air pressure must not exceed 1550 kPa (225 psi). The normal air pressure will be 758 to 965 kPa (110 to 140 psi).

i02039199

Battery - Recycle

SMCS Code: 1401-535; 1401-561; 1401-005; 1401; 1401-510

Always recycle a battery. Never discard a battery. Return used batteries to one of the following locations:

- A battery supplier
- An authorized battery collection facility
- A recycling facility

i06738473

Battery - 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.

⚠ WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

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

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. Turn battery isolator switch to OFF position.
4. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the ground plane. Disconnect the cable from the NEGATIVE “-” battery terminal.
5. 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.

6. Remove the used battery.
7. Install the new battery.

Note: Before the cables are connected, ensure that the key start switch is OFF.

8. Connect the cable from the starting motor to the POSITIVE “+” battery terminal.
9. Connect the cable from the ground plane to the NEGATIVE “-” battery terminal.

i07419560

Battery Electrolyte Level - Check

SMCS Code: 1401-535-FLV

When the engine has not run for long or short periods of time, the batteries may not fully recharge. Ensure a full charge to help prevent the battery from freezing.

In warmer climates, check the electrolyte level more frequently.

Ensure that the electrolyte level is 13 mm (0.5 inch) above the top of the separators.

⚠ 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 245-5829 Coolant Battery Tester Refractometer.
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 the 1U-9921 Battery Service Tool to clean the battery terminals. Use a wire brush to clean 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 fit improperly. Coat the clamps and the terminals with the Loctite® product listed below, petroleum jelly or MPGM.

   - For Americas North - Loctite LB8632
   - For Europe and Africa, Middle East, CIS (AMEC) - Loctite LB8104
   - For Asia Pacific - Loctite LB8801
   - For Americas South - Loctite LB Superlube

   For ordering the products listed above, go to the following address.

   http://www.loctite.com/en/meta/meta-nav/location-selector.html

i02039603

Battery or Battery Cable - Disconnect

SMCS Code: 1401; 1402-029

⚠ WARNING

The connection of battery cables to a battery and the disconnection of battery cables from a battery may cause an explosion which may result in injury or death. The connection and the disconnection of other electrical equipment may also cause an explosion which may result in injury or death. The procedures for the connection and the disconnection of battery cables and other electrical equipment should only be performed in a nonexplosive atmosphere.

⚠ WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.

2. Disconnect the negative battery terminal at the battery that goes to the start switch. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, the negative side of two batteries must be disconnected.

3. Tape the leads in order to help prevent accidental starting.

4. Proceed with necessary system repairs. Reverse the steps in order to reconnect all of the cables.

i06927283

Belts - Inspect/Adjust/Replace

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

Inspection

Belt tension should be checked initially between the first 20 to 40 hours of engine operation.

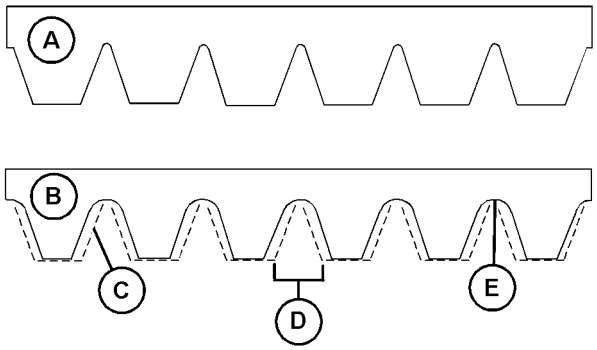

Illustration 34 g06114636

Inspect the condition of the serpentine belt. Over time the belt ribs will lose material (C). The space between the ribs will increase (D). The loss of material will cause the pulley sheave to contact the belt valley. This will lead to belt slippage and accelerated wear (E). Replace the belt if the belt is worn or frayed.

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

If the belts are too loose, vibration causes unnecessary wear on the belts and pulleys. Loose belts may slip enough to cause overheating.

If the belts are too tight, unnecessary stresses are placed on the pulley bearings and on the belts. This may shorten the service life of the components.

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

To check the belt tension, apply 110 N (25 lb ft) of force midway between the pulleys. A correctly adjusted belt will deflect 9 mm (0.35 inch) to 15 mm (0.59 inch).

Alternator Belt

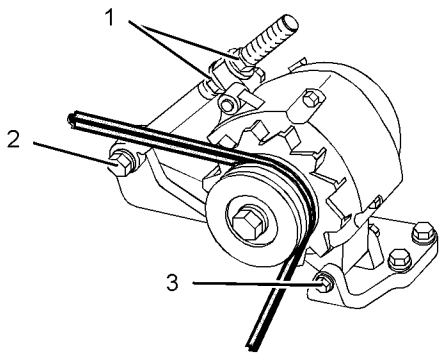

Illustration 35 g01154344

Typical alternator mounting

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

1. Slightly loosen mounting bolt (2) and mounting bolt (3). Slightly loosen adjusting nut (1).

2. Move the pulley to adjust the belt tension.

3. Tighten the following: adjusting nuts (1), mounting bolt, (2) and mounting bolt (3). Refer to the Specifications, SENR3130 for the proper torques.

4. Install the belt guard. Refer to the Specifications, SENR3130 for the proper torques.

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

Drive Belt for the Air Compressor (If Equipped)

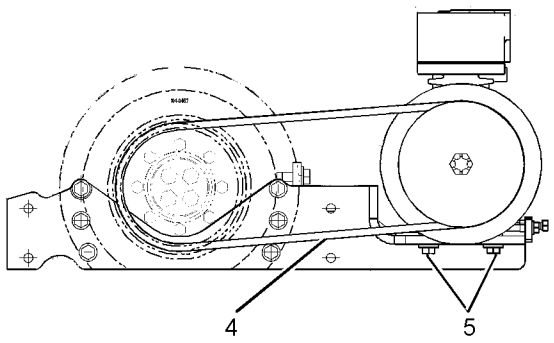

Illustration 36 g01389673

(4) Drive belt for the air compressor
(5) Mounting bolts

Loosen the four mounting bolts from the bracket that holds the air compressor.

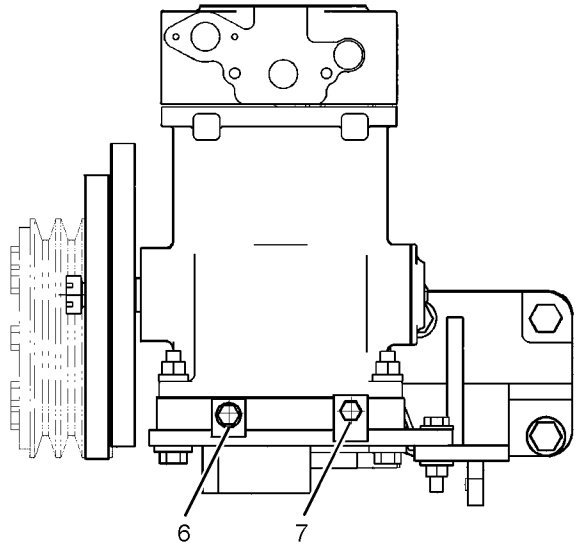

Illustration 37 g01389675

Side view of the air compressor and pulley

(6) Bolt
(7) Adjusting bolt

Loosen bolt 6. Loosen bolt 7. Slide the air compressor closer to the pulley. Remove the old belt. Install a new belt.

Slide the air compressor into position. Tighten bolt 7. Refer to Specification, SENR3130, “Torque Specifications” for the correct torque.

Tension the belt.

Tighten the four mounting bolts (5). Refer to Specification, SENR3130, “Torque Specifications” for the correct torque.

i03965390

Compression Brake - Inspect/ Adjust/Replace

SMCS Code: 1129-040; 1129-025; 1129-510

Contact your Cat dealer for the proper procedure.

i03841934

Coolant (DEAC) - Change

SMCS Code: 1350-070; 1395-044

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

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

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

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

Drain

⚠ 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 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.
2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove one of the drain plugs.

Note: If equipped, be sure to drain the heater and any related supply and return lines.

Allow the coolant to drain.

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

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

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

Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

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 15 L (4 US gal) of the cooling system capacity. Install the cooling system filler cap.
4. Start and run the engine at low idle for a minimum of 30 minutes. The coolant temperature should be at least 82 °C (180 °F).

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.

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 drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. If equipped, be sure to flush the heater and any related supply and return lines. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

Cooling Systems with Heavy Deposits or Plugging

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

1. Flush the cooling system with clean water in order to remove any debris.

Note: If equipped, be sure to flush the heater and any related supply and return lines.

2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

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.
4. Start and run the engine at low idle for a minimum of 90 minutes. The coolant temperature should be at least 82 °C (180 °F).

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.

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 drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

Fill

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

1. Fill the cooling system with an antifreeze/coolant solution. Refer to the Operation and Maintenance Manual, “Refill Capacitites and Recommendations” topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.

2. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.

3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).

4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain 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.

i03842431

Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

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

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

Note: When the cooling system is cleaned, only clean water is needed when the ELC is drained and replaced.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

Drain

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 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.
2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove the cooling system drain plugs.

   Allow the coolant to drain.

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

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

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

Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

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 clean water. Install the cooling system filler cap.
4. Start and run the engine at low idle until the temperature reaches 49 to 66 °C (120 to 150 °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 drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

Fill

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

1. Fill the cooling system with Extended Life Coolant (ELC). Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.
2. Start and run the engine at low idle. Increase the engine rpm to high idle. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).
4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain 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.

i04745732

Coolant Extender (ELC) - Add

SMCS Code: 1352-544-NL

Cat ELC (Extended Life Coolant) does not require the frequent additions of any supplemental cooling additives which are associated with the present conventional coolants. The Cat ELC Extender will only be added one time.

NOTICE
Use only Cat Extended Life Coolant (ELC) Extender with Cat ELC.

Do NOT use conventional supplemental coolant additive (SCA) with Cat ELC. Mixing Cat ELC with conventional coolants and/or conventional SCA reduces the Cat ELC service life.

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

⚠ WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove cooling system pressure cap slowly to relieve pressure only when engine is stopped and cooling system pressure cap is cool enough to touch with your bare hand.

Do not attempt to tighten hose connections when the coolant is hot, the hose can come off causing burns.

Cooling System Coolant Additive contains alkali. Avoid contact with skin and eyes.

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, “Cat Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Cat Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

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

2. If necessary, drain enough coolant from the cooling system in order to add the Cat ELC Extender.

3. Add Cat ELC Extender according to the requirements for the cooling system capacity. Refer to this Operation and Maintenance Manual, “Refill Capacities” or to this Operation and Maintenance Manual, “Fluid Recommendations” for more information.

4. Clean the cooling system filler cap. Inspect the gaskets on the cooling system filler cap. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.

i03842450

Coolant Level - Check

SMCS Code: 1395-082

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

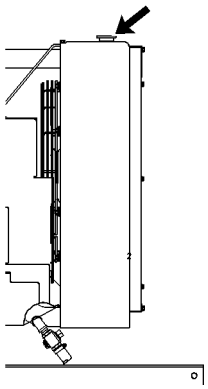

Illustration 38 g00285520
Cooling system filler cap

⚠ 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.

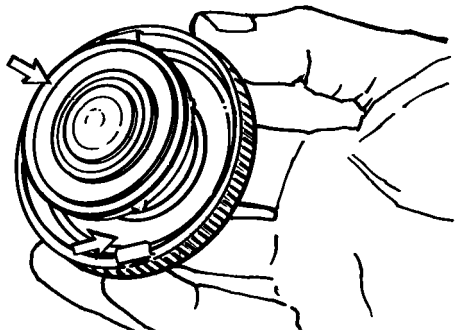

Illustration 39 g00103639
Typical filler cap gaskets

3. 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.

i04956993

Coolant Sample (Level 1) - Obtain

SMCS Code: 1350-008; 1395-008; 1395-554; 7542

Note: Obtaining a Coolant Sample (Level 1) is optional if the cooling system is filled with Cat ELC (Extended Life Coolant). Cooling systems filled with Cat ELC should have a Coolant Sample (Level 2) that is obtained at the recommended interval as stated in the maintenance interval schedule.

Note: Obtain a Coolant Sample (Level 1) if the cooling system is filled with any other coolant instead of Cat ELC including the following coolants:

- Commercial long life coolants that meet the Caterpillar Engine Coolant Specification -1 (Caterpillar EC-1)
- Cat DEAC (Diesel Engine Antifreeze/Coolant)
- Commercial heavy-duty coolant/antifreeze

Table 14

Recommended Interval		
Type of Coolant	Level 1	Level 2
Cat DEAC	Every 250 service hours	2000 Hours or Every year(1)
Conventional heavy duty-coolant		
Cat ELC or conventional EC-1 coolant	Optional	2000 Hours or Every year(1)

(1) The Level 2 Coolant Analysis should be performed sooner if a problem is suspected or identified.

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, 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 this Operation and Maintenance Manual, “Fluid Recommendations” or consult your Caterpillar dealer.

i05378320

Coolant Sample (Level 2) - Obtain

SMCS Code: 1350-008; 1395-008; 1395-554; 7542

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

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, “Cat Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Cat Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

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

Submit the sample for Level 2 analysis.

For additional information about coolant analysis, see Special Publication, SEBU7003, “Cat 3600 Series and C280 Series Diesel Engine Fluids Recommendations” or consult your Cat dealer.

i04139169

Coolant Temperature Regulator - Replace

SMCS Code: 1355-510

Replace the water temperature regulator before the water temperature regulator fails. Replacing the water temperature regulator is a recommended preventive maintenance practice. Replacing the water temperature regulator reduces the chances for unscheduled downtime. Refer to this Operation and Maintenance Manual, “Maintenance Interval Schedule” for the proper maintenance interval.

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

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

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner.

NOTICE
Failure to replace your water temperature regulator on a regularly scheduled basis could cause severe engine damage.

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

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

Do not use liquid gasket material on the gasket or cylinder head surface.

Refer to two articles in the Disassembly and Assembly Manual, “Water Temperature Regulators - Remove and Water Temperature Regulators - Install” for the replacement procedure of the water temperature regulator, or consult your Caterpillar dealer.

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

i07232094

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.

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.

This maintenance procedure is required for conventional coolants such as DEAC.**Do not perform this maintenance for cooling systems that are filled with Cat Extended Life Coolant (Cat ELC) or Cat Extended Life Inhibitor (Cat ELI).**

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

NOTICE
Do NOT mix brands or types of SCA. Do NOT mix SCAs and extenders.

Failure to follow the recommendations can result in shortened cooling system component life.

NOTICE
Use Only Approved SCAs. Conventional coolants require the maintenance addition of SCA throughout their expected life. Do NOT use an SCA with a coolant unless specifically approved by the coolant supplier for use with their coolant. It is the responsibility of the coolant manufacturer to ensure compatibility and acceptable performance.

Failure to follow the recommendations can result in shortened cooling system component life.

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, “Cat Dealer Service Tool Catalog” and to Special Publication, GECJ0003, “Cat Shop Supplies and Tools” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to applicable regulations and mandates.

Note: Caterpillar recommends that an S·O·S Coolant Analysis (Level 1) is performed to check the concentration of SCA.

Maintain the Proper Concentration of SCA in the Coolant

⚠ 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.

2. Test the concentration of the SCA with a 286-2578 Nitrite Test Strip or review the results of the S·O·S Coolant Analysis (Level 1).

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

4. Add the amount of SCA required to maintain a concentration of 3 percent to 6 percent SCA in the coolant.

5. Clean the cooling system filler cap. Install the cooling system filler cap.

For further information, refer to Special Publication, SEBU6251, “Cat Commercial Diesel Engine Fluids Recommendations”.

For information on Cat coolant conditioner for aluminum components, refer to Special Instruction, REHS7296, “Instructions for Use of Cat Coolant Conditioner for Aluminum Components”.

i00174798

Driven Equipment - Check

SMCS Code: 3279-535

Refer to the OEM specifications for more information on the following maintenance recommendations for the driven equipment:

- Inspection
- Adjustment
- Lubrication
- Other maintenance recommendations

Perform any maintenance for the driven equipment which is recommended by the OEM.

i06103535

Engine - Clean

SMCS Code: 1000-070

⚠ WARNING

Personal injury or death can result from high voltage.

Moisture can create paths of electrical conductivity.

Make sure that the electrical system is OFF. Lock out the starting controls and tag the controls “DO NOT OPERATE” .

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.

Periodic cleaning of the engine is recommended. 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

Note: Caution must be used in order to prevent electrical components from being damaged by excessive water when you clean the engine. Avoid electrical components such as the alternator, the starter, and the ECM.

i07229047

Engine Air Cleaner Element (Dual Element) - Inspect/Clean/Replace

SMCS Code: 1051; 1054-510; 1054-040; 1054-070

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

Note: The air filter system may not have been provided by Caterpillar. The procedure that follows is for a typical air filter system. Refer to the OEM information for the correct procedure.

If the air cleaner element becomes plugged, the air can split the material of the air cleaner element. Unfiltered air will drastically accelerate internal engine wear. Refer to the OEM information for the correct air cleaner elements for your application.

- Check the precleaner (if equipped) and the dust bowl daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.
- Operating in dirty conditions may require more frequent service of the air cleaner element.
- The air cleaner element should be replaced at least one time per year.

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

Dual Element Air Cleaners

The dual element air cleaner contains a primary air cleaner element and a secondary air cleaner element.

Do not replace the air cleaner filter elements in a dirty environment, as dirt can enter the air system when the elements are removed.

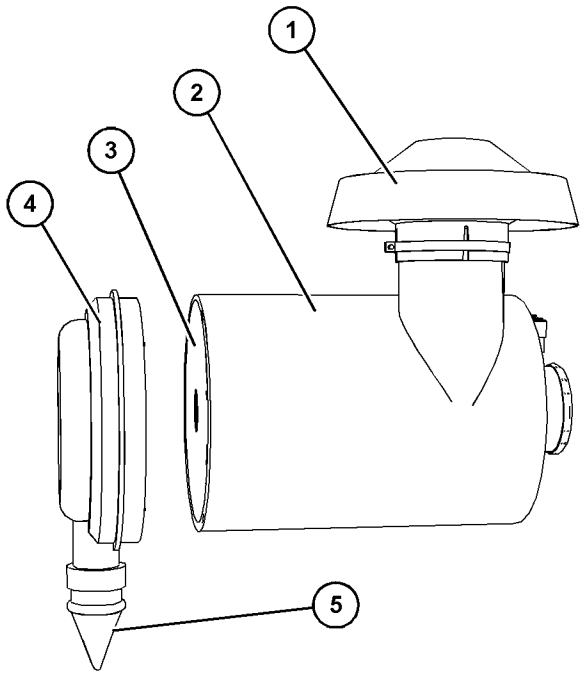

Illustration 40 g06217098
Typical example

1. Ensure that the outer body of the air cleaner to be serviced is clean and free from dirt.
2. Inspect the top cover (1) and if necessary remove top cover to clean cover. Ensure that dirt cannot enter the air cleaner system with top cover removed. If necessary, clean top cover and install.
3. Remove end cover (4) from air cleaner body (2). If necessary, clean end cover and ensure that the valve (5) is clean and free from dirt. Check the valve (5) for wear or damage, replace if necessary.
4. Remove primary air filter element (3) and remove the secondary air filter element (Not Shown). Discard all old air filter elements.
5. Install new secondary air filter element (Not Shown) and install new primary air filter element (3).

6. Install end cover (4) to air cleaner body (2) and secure end cover. If necessary, reset the air service indicator, refer to this Operation and Maintenance Manual, Engine Air Cleaner Service Indicator - Inspect for more information.

i06103548

Engine Air Cleaner Service Indicator - Inspect
(If Equipped)

SMCS Code: 7452-040

Some engines may be equipped with a different service indicator.

Some engines are equipped with a differential gauge for inlet air pressure. The differential gauge for inlet air pressure displays the difference in the pressure that is measured before and after the air cleaner element. As the air cleaner element becomes dirty, the pressure differential rises. If your engine is equipped with a different type of service indicator, follow the OEM recommendations in order to service the air cleaner service indicator.

The service indicator may be mounted on the clean side of the air cleaner housing or in a remote location.

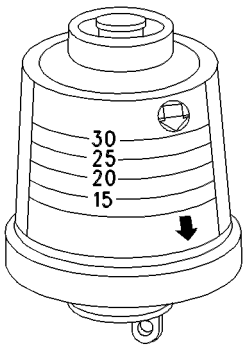

Illustration 41 g00103777

Typical service indicator

Observe the service indicator. The air cleaner element should be cleaned or the air cleaner element should be replaced when one of the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.

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 service indicator core when the engine is run at full load speed. The core should latch approximately at the greatest vacuum that is attained.

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

If necessary, replace the service indicator more 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).

i02436689

Engine Mounts - Inspect

SMCS Code: 1152; 1152-040

Inspect the engine mounts for deterioration and for proper bolt torque. Engine vibration can be caused by the following conditions:

- Improper mounting of the engine
- Deterioration of the engine mounts
- Loose mounting bolts

Any engine mount that shows deterioration should be replaced. Refer to the Specifications Manual, SENR3130, “Torque Specifications”. Refer to your Caterpillar dealer for more information.

i04369322

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

WARNING

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

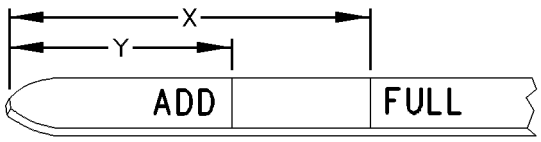

Illustration 42 g00110310

(Y) "ADD" mark
(X) "FULL" mark

NOTICE
Perform this maintenance with the engine stopped.

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, "Cat Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Cat Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

1. Maintain the oil level between "ADD" mark (Y) and "FULL" mark (X) on the oil level gauge. Do not fill the crankcase above "FULL" mark (X).

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. Remove the oil filler cap and add oil, if necessary. For information about choosing the correct oil for the engine, refer to one of the following articles: Operation and Maintenance Manual, "Refill Capacities and Recommendations" or Operation and Maintenance Manual, "Fluid Recommendations". Do not fill the crankcase above "FULL" mark (X) on the oil level gauge. Clean the oil filler cap. Install the oil filler cap.
3. 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 sample. This information will help to provide the most accurate oil analysis.

i04237495

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. S·O·S oil analysis provides infrared analysis, which is required for determining nitration and oxidation levels.

Obtain the Sample and the Analysis

⚠ WARNING

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

Before you take the oil sample, complete the Label, PEEP5031 for identification of the sample. In order to help obtain the most accurate analysis, provide the following information:

- Engine model
- Service hours on the engine
- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

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

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

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

The 169-8373 Fluid Sampling Bottle is recommended for use with the sampling valve. The fluid sampling bottle includes the parts that are needed for obtaining oil samples. Instructions are also provided.

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

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

For instructions, see Special Publication, PEGJ0047, “How To Take A Good S·O·S Oil Sample”. Consult your Cat dealer for complete information and assistance in establishing an S·O·S program for your engine.

i06985757

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.

Selection of Oil Change Interval

Refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” for further information about oils that may be used in Caterpillar engines.

Refer to this Operation and Maintenance Manual, “Severe Service Application - Check” to determine if oil change interval should be reduced from the normal change interval. If operating in any of the conditions or environments outlined in the Severe Service Application, use S·O·S Services oil analysis to determine the best oil change interval. If S·O·S Services oil analysis S is not being used, oil change interval should be reduced to 250 hrs.

Table 15

Oil Change Interval for C9.3B Industrial Engine [1]		
Multigrade Oil Type	**Operating Conditions**	
	Normal	**Severe Service Application**
Cat DEO or Cat DEO-ULS Preferred	500 hr	250 hr
Oil meeting the requirements of the Cat ECF-3 Specification or the API CK-4 classification 8 minimum TBN Preferred	500 hr	250 hr
Oil meeting the requirements of the ACEA C9/ E6 Specification TBN below 10.4	500 hr	250 hr

[1] The standard oil change interval in this engine is 500 hours, if the operating conditions and recommended oil types that are listed in this table are met. If the type of oil, the quality of the oil and the operating conditions fails to meet certain standards, the oil change intervals must be decreased to 250 hours. Refer to Special Publication, PEHJ0192, “Optimizing Oil Change Intervals” to determine whether the oil change interval should be reduced to 250 hours.

Drain the Engine Oil

After the engine has been run at the normal operating temperature, stop the engine. Attach a “DO NOT OPERATE” or a similar warning tag to the ignition keyswitch before the engine is serviced.

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, “Cat Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Cat Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

1. Remove the oil drain plug to allow the oil to drain.

2. After the oil has drained, the oil drain plug should be cleaned and installed.

Replace the Oil Filter

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.

Illustration 43 g00103713
Typical filter mounting base and filter gasket

1. Remove the oil filter with a 185-3630 Strap Wrench.

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

3. 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 or engine damage.

4. 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

1. 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) for more information.

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

NOTICE
To help prevent crankshaft or bearing damage, crank engine to fill all filters before starting. Do not crank engine for more than 30 seconds.

2. Start the engine and run the engine at “LOW IDLE” for 2 minutes. Perform this procedure to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.
3. Stop the engine and allow the oil to drain back to the sump for a minimum of 10 minutes.
4. Remove the oil level gauge to check the oil level. Maintain the oil level between the “ADD” and “FULL” marks on the “ENGINE STOPPED” side of the oil level gauge.

i02703023

Engine Storage Procedure - Check

SMCS Code: 1000-535

Caterpillar recommends storage procedures and start-up procedures for all engines that are stored for more than 1 month. These procedures provide maximum protection to internal engine components. Refer to Special Instruction, SEHS9031, “Storage Procedure For Caterpillar Products” for information on these procedures.

An extension of the oil change interval to 12 months is permitted if you follow the required procedures for storage and start-up. This extension is permitted if the following intervals in the Operation and Maintenance Manual, “Maintenance Interval Schedule” have not been reached:

- Operating hours
- Fuel consumption

i07504990

Engine Valve Lash - Check

SMCS Code: 1105-535

Note: Procedures for adjusting the valve lash can be found in Systems Operation/Testing and Adjusting, “Valve Lash Adjustment”. Consult your Cat dealer for assistance.

⚠ WARNING

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

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

The initial valve lash adjustment on new engines, rebuilt engines, or remanufactured engines is recommended at the first scheduled oil change. The adjustment is necessary due to the initial wear and seating of the valve train components. This maintenance is recommended as part of a lubrication and preventive maintenance schedule to help provide maximum engine life.

i04036726

Fuel System - Prime

SMCS Code: 1250-548; 1258-548

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

Key-on Priming (if equipped)

1. Turn the engine start switch to the ON position. Leave the engine start switch in the ON position for 2 minutes.
2. Verify that the water separator is full of fuel.
3. If the water separator is not full of fuel, turn the engine start switch OFF and then turn the engine start switch ON. Turning the switch OFF, then ON will cycle the fuel priming pump again.

4. When the water separator is full of fuel, attempt to start the engine. If the engine starts and the engine runs rough or the engine misfires, operate at low idle until the engine is running smoothly. If the engine cannot be started, or if the engine continues to misfire or smoke, repeat Step 1.

Manual Switch Priming (if equipped)

The manual switch is located on the primary filter base/electric priming pump assembly.

1. Hold the manual switch in the up position until fuel has filled the water separator.
2. Continue to hold the switch for 30 seconds after the water separator is full.
3. Attempt to start the engine. If engine starts and runs rough or misfires, operate at low idle until the engine is running smoothly. If the engine cannot be started, continue to prime the fuel system for 30 more seconds.

i02349031

Fuel System Primary Filter (Water Separator) Element - Replace

SMCS Code: 1260-510-FQ; 1263-510-FQ

⚠ WARNING

Personal injury or death may result from failure to adhere to the following procedures.

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

Clean up all leaked or spilled fuel. Do not smoke while working on the fuel system.

Turn the disconnect switch OFF or disconnect the battery when changing fuel filters.

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

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 Dealer Service Tool Catalog” guide for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Turn the start switch to the OFF position or disconnect the battery (starting motor) when maintenance is performed on a fuel filter.
2. Shut off the fuel supply.

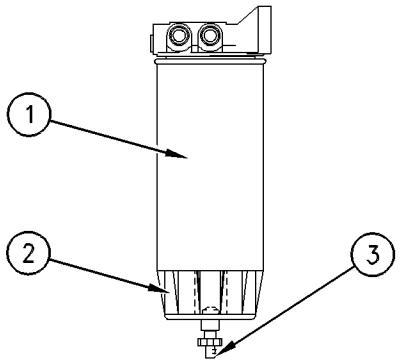

Illustration 44 g00104012

(1) filter body
(2) bowl
(3) drain valve

Note: Refer to this Operation and Maintenance Manual, “General Hazard Information” that pertains to containing fluid spillage.

3. Turn drain valve (3) counterclockwise in order to open. The drain valve is located on the bottom of the water separator.
4. Drain the water and sediment into a suitable container. Dispose of the drained fluids and used filters according to local regulations.
5. Close the drain valve.
6. Hold the bottom of the filter while you loosen the bowl. Remove the bowl.
7. Turn the filter counterclockwise in order to loosen the filter. If the filter will not turn, use a strap wrench to loosen the filter.

8. Remove the filter and discard the filter. Clean the bottom of the filter mounting base. Make sure that all of the old filter seal is removed from the bottom groove of the opening in the base.

9. Clean the water separator bowl and clean the groove for the seal. Inspect the seal. If the seal is worn or damaged, replace the seal.

10. Lubricate the seal with clean diesel fuel or lubricate the seal with clean motor oil. Place the seal in the groove on the water separator bowl.

11. Install the water separator bowl onto the new fuel filter by hand. Tighten the bowl assembly to 15 15 N·m (11 lb ft).

12. Apply clean diesel fuel to the seal of the new filter.

13. Install the new filter onto the base. Tighten the filter by hand until the seal contacts the filter base. Additionally tighten the filter by 1/3 to 1/2 rotation.

14. Open the fuel shutoff valve.

15. Reconnect the battery, if necessary.

16. Purge the air from the fuel system. See this Operation and Maintenance Manual, “Fuel System - Prime” for further instructions.

17. Stop the engine and check for leaks.

Note: The secondary fuel filter should also be replaced at this time. See this Operation and Maintenance Manual, “Fuel System Secondary Filter - Replace” for further information.

i04370506

Fuel System Primary Filter/ Water Separator - Drain

SMCS Code: 1260-543; 1263-543

⚠ WARNING

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

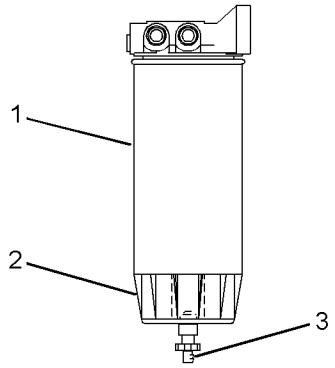

Illustration 45 g01453091

Typical primary fuel filter/water separator

(1) Primary fuel filter element
(2) Collection bowl for the water separator
(3) Drain for the water separator

The bowl should be monitored daily for signs of water. If water is present, drain the water from the bowl.

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, “Cat Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Cat Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

1. Open the drain. The drain is a self-ventilated drain. Catch the draining water in a suitable container. Dispose of the water properly.

2. Close the drain.

NOTICE
The water separator is under suction during normal engine operation. Ensure that the drain valve is tightened securely to help prevent air from entering the fuel system.

i04036723

Fuel System Secondary Filter - Replace

SMCS Code: 1261-510-SE

⚠ WARNING

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

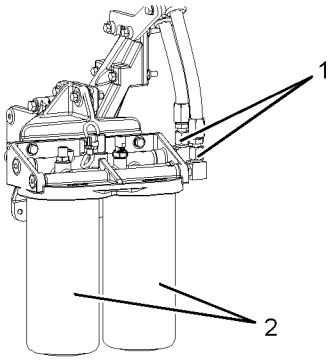

Illustration 46 g02145531

(1) Fuel supply connections
(2) Fuel filters

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over any disconnected fuel system components.

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

1. It may be necessary to relieve residual fuel pressure from the fuel system before removing the fuel filter.

   Loosen one of the fuel supply connections (1) in order to purge any residual pressure.

NOTICE
Do not loosen fuel lines or fittings at the fuel manifold or ECM. The engine components may be damaged.

2. Remove the used fuel filter.
3. Clean the gasket sealing surface of the fuel filter base. Ensure that all of the old gasket is removed.
4. Apply clean diesel fuel to the new fuel filter gasket.

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

5. Install the new fuel filter. Spin the fuel filter onto the fuel filter base until the gasket contacts the base. Use the rotation index marks on the filters as a guide for proper tightening. Tighten the filter for an additional 3/4 turn by hand. Do not overtighten the filter.

i06104305

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

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, “Cat Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Cat Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive wear to the fuel system. Condensation occurs during the heating and cooling of fuel. The condensation occurs as the fuel passes through the fuel system and the fuel returns to the fuel tank. This causes water to accumulate in fuel tanks. Draining the fuel tank regularly and obtaining fuel from reliable sources can help to eliminate water in the fuel. The fuel tank utilizes a fuel tank vent to prevent an air lock or vacuum. Ensure that the vent is free of debris and not damaged.

Drain the Water and the Sediment

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

Prepare to catch water and sediment in an appropriate container. Connect a hose (if necessary) to the valve prior to opening the valve.

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

Note: Failure to close the drain properly could result in fuel leakage, which could have detrimental results to performance.

Check the fuel daily. Drain the water and sediment from the fuel tank after operating the engine. Drain the water and sediment from the fuel tank after the fuel tank has been filled. Allow 5 to 10 minutes before performing this procedure.

Fill the fuel tank after operating the engine in order to drive out moist air. This procedure will help prevent condensation. Do not fill the tank to the top. The fuel expands as the fuel gets warm. The tank may overflow.

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

Fuel Storage Tanks

Drain the water and the sediment from the fuel storage tank during the following conditions:

- Weekly
- Refill of the tank

This procedure will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank. A four micron(c) absolute filter for the breather vent on the fuel tank is also recommended.

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

i07286945

Fumes Disposal Filter Element (Emission Related Component) - Replace

SMCS Code: 1074-510

The filter for the open crankcase ventilation system (OCV) may be located toward the front or toward the rear of the left side of the engine. A filter that has been used may contain a small amount of engine oil.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the machine. 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 in Caterpillar machines.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Failure to perform this maintenance procedure at less than 1500 service hours will not void the emissions-related warranty.

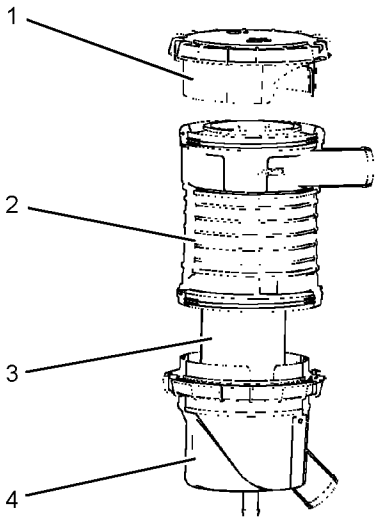

Illustration 47 g02021434

(1) Cap
(2) Housing for the filter element
(3) Filter element
(4) Cup

Remove either the cap or the cup from the housing for the OCV filter. Remove the OCV filter. The filter may not be used again. Dispose of the filter. Place a new OCV filter inside the filter housing. If the cap was removed, replace the cap. If the cup was removed, replace the cup. Tighten hand tight.

Note: Caterpillar will not be held liable for an engine that does not comply with EPA emissions standards due to modification of the OCV filter or due to the use of a filter that is not approved by Caterpillar.

i03965989

Grounding Stud - Inspect/ Clean/Tighten

SMCS Code: 7423-070; 7423-079; 7423-040

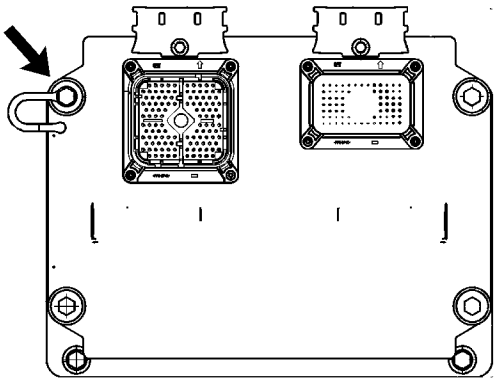

Illustration 48 g01376112

The grounding stud is located on the upper left corner of the engine control module.

Inspect the OEM harness for good connections. Inspect the condition of the OEM harness.

The grounding stud must have a wire ground to the battery. Tighten the grounding stud at every oil change. Ground wires and straps should be combined at engine grounds. All grounds should be tight and free of corrosion.

- Clean the grounding stud and the terminals for the ground strap with a clean cloth.
- If the connections are corroded, clean the connections with a solution of baking soda and water.
- Keep the grounding stud and the strap clean and coated with MPGM grease or petroleum jelly.

i06825542

Hoses and Clamps - Inspect/ Replace

SMCS Code: 7554-040; 7554-510

Hoses and clamps must be inspected periodically and replaced at the recommended interval to ensure safe and continuous operation of the engine. Failure to replace a fuel hose at the recommended change interval may result in a hazardous situation. Take proper safety precautions before inspecting or replacing hoses and clamps.

Note: Always use a board or cardboard when the engine components are checked for leaks. Leaking fluid that is under pressure can cause serious injury or possible death. Leaks that are the size of a pin hole are included. Refer to Operation and Maintenance Manual, “General Hazard Information” for more information.

Note: Ensure that the hose is compatible with the application.

Inspect Tubes, Hoses, Bellows, and Clamps

Inspect all tubes and hoses for leaks that are caused by the following conditions. Replace any tube or hose which exhibits any of the following conditions. Failure to replace a tube or hose which exhibits any of the following conditions may result in a hazardous situation.

- Hoses which are cracked
- Hoses which are soft
- 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
- Exhaust bellows for leaks or damage
- Hoses which exhibit signs of leakage which are not the result of loose couplings or clamps

Inspect all clamps for the following conditions. Replace any clamp which exhibits signs of any of the following conditions.

- Cracking
- Looseness
- Damage

Inspect all couplings for leaks. Replace any coupling which exhibits signs of leaks.

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

Due to extreme temperature changes, the hose will heat set. Heat setting causes hose clamps to loosen which can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Replace hoses that are cracked or soft. Replace hoses that show signs of leakage. Replace hoses that show signs of damage. Replace hose clamps that are cracked or damaged. Tighten or replace hose clamps which are loose.

Replace the Hoses and the Clamps

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, “Cat Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Cat Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Cooling System

⚠ 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.

⚠ 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. Stop the engine.
2. Allow the engine to cool.
3. Before servicing a coolant hose, slowly loosen the filler cap for the cooling system to relieve any pressure.
4. Remove the filler cap for the cooling system.

5. Drain the coolant from the cooling system to a level that is below the hose that is being replaced. Drain the coolant into a suitable clean container. The coolant can be reused.

6. Remove the hose clamps.

7. Disconnect the old hose.

8. Replace the old hose with a new hose.

9. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications” “Hose Clamps” for information about selecting and installing the proper hose clamps.

10. Refill the cooling system.

11. Clean the coolant filler cap. Inspect the gaskets on the filler cap. Inspect the gasket seat. Inspect the vacuum valve and seat for debris or damage. Replace the filler cap if the gaskets are damaged. Install the filler cap.

12. Start the engine. Inspect the cooling system for leaks.

Fuel System

⚠ 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.

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

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.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over any disconnected fuel system components.

Note: High-pressure fuel lines may be installed between the high-pressure fuel pump and the fuel injectors. High-pressure fuel lines are constantly charged with high pressure. Do not check the high-pressure fuel lines with the engine or the starting motor in operation. Wait for 10 minutes after the engine stops before you perform any service or repair on high-pressure fuel lines. Waiting for 10 minutes will allow the pressure to be purged.

1. Drain the fuel from the fuel system to a level that is below the hose that is being replaced.

2. Remove the hose clamps.

3. Disconnect the old hose.

Note: When servicing fuel system, use cap/s or cover/s as required to protect the system and maintain fuel system cleanliness.

4. Replace the old hose with a new hose.

5. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications” “Hose Clamps” for information about selecting and installing the proper hose clamps.

6. Carefully inspect the engine for any spilled fuel. Make sure that no fuel remains on or close to the engine.

Note: Fuel must be added to the fuel system ahead of the fuel filter.

7. Refill the fuel system. Refer to this Operation and Maintenance Manual, “Fuel System - Prime” for information about priming the engine with fuel.

8. Start the engine. Inspect the fuel system for leaks.

Lubrication System

⚠ WARNING

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

1. Drain the oil from the lubrication system to a level that is below the hose that is being replaced.

2. Remove the hose clamps.

3. Disconnect the old hose.

4. Replace the old hose with a new hose.

5. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications” “Hose Clamps” for information about selecting and installing the proper hose clamps.

6. Refill the lubrication system. Refer to this Operation and Maintenance Manual, “Engine Oil Level - Check” to ensure that the lubrication system is filled with the proper amount of engine oil.

7. Start the engine. Inspect the lubrication system for leaks.

Air System

1. Remove the hose clamps.

2. Disconnect the old hose.

3. Replace the old hose with a new hose.

4. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications” “Hose Clamps” for information about selecting and installing the proper hose clamps.

Note: The bellows and the V-clamps that are used on the exhaust bellows should never be reused.

5. Start the engine. Inspect the air lines for leaks.

i04631403

Overhaul Considerations

SMCS Code: 7595-043

Reduced hours of operation at full load will result in a lower average power demand and reduced fuel consumption. A decreased average power demand should increase both the engine service life and the overhaul interval.

The need for an overhaul is indicated by increased fuel consumption, increased oil consumption, excessive engine blowby, and reduced power. Arctic temperatures, extreme high temperatures, corrosive environments, or extreme dusty conditions contribute to premature wear and the need for an overhaul.

The following factors are important when a decision is being made on the proper time for an engine overhaul:

- The need for preventive maintenance
- The quality of the fuel that is being used
- The operating conditions
- The results of the S·O·S analysis

Note: The aftertreatment system can be expected to function properly for the useful life of the engine (emissions durability period), as defined by regulation, subject to prescribed maintenance requirements being followed.

Oil Consumption as an Overhaul Indicator

Oil consumption, fuel consumption, and maintenance information can be used to estimate the total operating cost for your Cat engine. Oil consumption can also be used to estimate the required capacity of a makeup oil tank that is suitable for the maintenance intervals.

Oil consumption is in proportion to the percentage of the rated engine load. As the percentage of the engine load is increased, the amount of oil that is consumed per hour also increases.

The oil consumption rate (brake-specific oil consumption) is measured in grams per kW/h (lb per bhp). The brake-specific oil consumption (BSOC) depends on the engine load. Consult your Cat dealer for assistance in determining the typical oil consumption rate for your engine.

When the oil consumption of an engine has risen to three times the original oil consumption rate due to normal wear, an engine overhaul should be scheduled. There may be a corresponding increase in blowby and a slight increase in fuel consumption.

Overhaul Options

Before Failure Overhaul

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 standards for reusable parts.
- The service life of the engine can be extended without the risk of a major catastrophe due to engine failure.
- The best cost/value relationship per hour of extended life can be attained.

After Failure Overhaul

If a major engine failure occurs and the engine must be removed, many options are available. An overhaul should be performed if the engine block or the crankshaft needs to be repaired.

If the engine block is repairable and/or the crankshaft is repairable, the overhaul cost should be between 40 percent and 50 percent of the cost of a new engine with a similar exchange core.

This lower cost can be attributed to three aspects:

- Specially designed Cat engine features
- Cat dealer exchange components
- Caterpillar remanufactured exchange components

Overhaul Recommendation

To minimize downtime, Caterpillar recommends a scheduled engine overhaul by your Cat dealer before the engine fails. A scheduled engine overhaul will provide you with the best cost/value relationship.

Note: Overhaul programs vary according to the engine application and according to the dealer that performs the overhaul. Consult your Cat dealer for specific information about the available overhaul programs and about overhaul services for extending the engine life.

If an overhaul is performed without overhaul service from your Cat dealer, be aware of the following maintenance recommendations.

Rebuild or Exchange

Cylinder Head Assembly, Cylinder Packs, Oil Pump, and Fuel Transfer Pump

These components should be inspected according to the instructions that are found in various Cat reusability publications. The Special Publication, SEBF8029 lists the reusability publications that are needed for inspecting the engine parts.

If the parts comply with the established inspection specifications that are expressed in the reusable parts guideline, the parts should be reused.

Parts that are not within the established inspection specifications should be dealt with in one of the following manners:

- Salvaging
- Repairing
- Replacing

Using out-of-spec parts can result in the following problems:

- Unscheduled downtime
- Costly repairs
- Damage to other engine parts
- Reduced engine efficiency
- Increased fuel consumption

Reduced engine efficiency and increased fuel consumption translates into higher operating costs. Therefore, Caterpillar recommends repairing out-of-spec parts or replacing out-of-spec parts.

Inspection and/or Replacement

Crankshaft Bearings, Valve Rotators, and Crankshaft Seals

The following components may not last until the second overhaul.

- Thrust bearings
- Main bearings
- Rod bearings
- Crankshaft seals

Caterpillar recommends the installation of new parts at each overhaul period.

Inspect these parts while the engine is disassembled for an overhaul.

Inspect the crankshaft for any of the following conditions:

- Deflection
- Damage to the journals
- Bearing material that has seized to the journals

Check the journal taper and the profile of the crankshaft journals. Check these components by interpreting the wear patterns on the following components:

- Rod bearing
- Main bearings

Inspect the camshaft for damage to the journals and to the lobes.

Note: If the camshaft is removed for any reason, use the magnetic particle inspection process to check for cracks in the camshaft.

Inspect the following components for signs of wear or for signs of scuffing:

- Camshaft bearings
- Camshaft followers

Caterpillar recommends replacing the crankshaft vibration damper.

Oil Cooler Core

During an overhaul, Caterpillar recommends the removal of the oil cooler core. Clean the oil cooler core. Then, pressure test the oil cooler core.

NOTICE
Do not use caustic cleaners to clean the core.

Caustic cleaners can attack the internal metals of the core and cause leakage.

Note: Use this cleaning procedure to clean the oil cooler core.

1. Remove the oil cooler core.
2. Remove any debris from the oil cooler core. To remove debris from the oil cooler core, turn the oil cooler core onto one end.
3. Flush the oil cooler core internally with cleaner in order to loosen foreign substances. Flushing the oil cooler will also help to remove oil from the oil cooler core.

Note: Caterpillar recommends the use of Hydrosolv Liquid Cleaners. Table 16 lists the Hydrosolv Liquid Cleaners that are available from your Cat dealer.

Table 16

HydrosolvLiquid Cleaners		
Part Number	**Description**	**Size**
1U-5490	Hydrosolv4165	19 L (5 US gallon)
174-6854	Hydrosolv100	19 L (5 US gallon)

4. Use steam to clean the oil cooler core. Steam-cleaning the oil cooler core removes any remaining residue from the cleaner. Flush the fins of the oil cooler core. Remove any other trapped debris.
5. Wash the oil cooler core with hot, soapy water. Rinse the oil cooler 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 oil cooler core with compressed air. Direct the air in the reverse direction of the normal flow.
7. Inspect the components in order to ensure cleanliness. The oil cooler core should be pressure tested. Repair the oil cooler core, if necessary. Install the oil cooler core.

For more information about cleaning the cores, consult your Cat dealer.

Obtain Coolant Analysis

The concentration of supplemental coolant additive (SCA) should be checked regularly with test kits or with S·O·S Coolant Analysis (Level 1). Further coolant analysis is recommended when the engine is overhauled.

For example, considerable deposits are found in the water jacket areas on the external cooling system, but the concentrations of coolant additives were carefully maintained. The coolant water probably contained minerals that were deposited on the engine over time.

A coolant analysis can be conducted in order to verify the condition of the water that is being used in the cooling system. A full water analysis can be obtained by consulting your local water utility company or an agricultural agent. Private laboratories are also available for water analysis.

Caterpillar recommends an S·O·S Coolant Analysis (Level 2).

S·O·S Coolant Analysis (Level 2)

An S·O·S Coolant Analysis (Level 2) is a comprehensive coolant analysis which completely analyzes the coolant and the effects on the cooling system. An S·O·S Coolant Analysis (Level 2) provides the following information:

- Complete S·O·S Coolant Analysis (Level 1)
- Visual inspection of properties
- Identification of metal corrosion
- Identification of contaminants
- Identification of built up impurities (corrosion and scale)

S·O·S Coolant Analysis (Level 2) provides a report of the results of both the analysis and the maintenance recommendations.

For more information about coolant analysis, see your Cat dealer.

i03901481

Power Take-Off Clutch - Check

SMCS Code: 3055-535

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”.

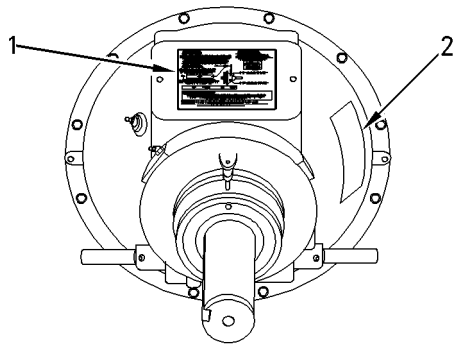

Illustration 49 g00781502

(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.

i02372787

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. 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”.

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Starting Motor - Inspect
(If Equipped)

SMCS Code: 1451-040; 1453-040

Note: The OEM may be responsible for the starting motor for this engine application. Air starting motors are recommended if an explosive atmosphere may be present. If the starting motor is supplied by an OEM, refer to the Service Manual for the starter in order to locate additional information on the checking procedure and for specifications.

⚠ WARNING

The connection of battery cables to a battery and the disconnection of battery cables from a battery may cause an explosion which may result in injury or death. The connection and the disconnection of other electrical equipment may also cause an explosion which may result in injury or death. The procedures for the connection and the disconnection of battery cables and other electrical equipment should only be performed in a nonexplosive atmosphere.

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.

Removal and Installation of the Starting Motor

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

Consult your Caterpillar dealer for assistance.

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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, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, 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 (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

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

- Ensure that the cooling lines are properly clamped and that the cooling lines are tight. 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 as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of water pumps and the installation of water pumps and/or seals, refer to the Service Manual 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 cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps or for loose fuel line tie-wraps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps. Ensure that hoses and tubes are not contacting other hoses, tubes, wiring harnesses, etc.
- Inspect the alternator belt and the accessory drive belts for cracks, breaks or other damage.

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

- Drain the water and the sediment from fuel tanks on a daily basis in order to ensure that only clean fuel enters the fuel system.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Inspect the ECM to the cylinder head ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges that are cracked. Replace any gauge that can not be calibrated.

Warranty Section

Warranty Information

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Warranty Information

SMCS Code: 1000

Engines are covered by a standard one year warranty. The coverage of individual warranties may be different due to the engine application and the geographic location.

The warranty is shipped with other loose parts, or with the Parts Manual, when the engine is shipped.

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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Emissions Warranty Information

SMCS Code: 1000

The certifying engine manufacturer warrants to the ultimate purchaser and each subsequent purchaser that:

1. New non-road diesel engines and stationary diesel engines less than 10 liters per cylinder (including Tier 1 and Tier 2 marine engines < 37 kW, but excluding locomotive and other marine engines) operated and serviced in the United States and Canada, including all parts of their emission control systems (“emission related components”), are:

a. Designed, built, and equipped so as to conform, at the time of sale, with applicable emission standards prescribed by the United States Environmental Protection Agency (EPA) by way of regulation.

b. Free from defects in materials and workmanship in emission-related components that can cause the engine to fail to conform to applicable emission standards for the warranty period.

2. New non-road diesel engines (including Tier 1 and Tier 2 marine propulsion engines < 37 kW and Tier 1 through Tier 4 marine auxiliary engines < 37 kW, but excluding locomotive and other marine engines) operated and serviced in the state of California, including all parts of their emission control systems (“emission related components”), are:

a. Designed, built, and equipped so as to conform, at the time of sale, to all applicable regulations adopted by the California Air Resources Board (ARB).

b. Free from defects in materials and workmanship which cause the failure of an emission-related component to be identical in all material respects to the component as described in the engine manufacturer's application for certification for the warranty period.

3. New non-road diesel engines installed in construction machines conforming to the South Korean regulations for construction machines manufactured after January 1, 2015, and operated and serviced in South Korea, including all parts of their emission control systems (“emission related components”), are:

a. Designed, built, and equipped so as to conform, at the time of sale, with applicable emission standards prescribed in the Enforcement Rule of the Clean Air Conservation Act promulgated by South Korea MOE.

b. Free from defects in materials and workmanship in emission-related components that can cause the engine to fail to conform to applicable emission standards for the warranty period.

The aftertreatment system can be expected to function properly for the lifetime of the engine (emissions durability period) subject to prescribed maintenance requirements being followed.

A detailed explanation of the Emission Control Warranty that is applicable to new non-road and stationary diesel engines, including the components covered and the warranty period, is found in a supplemental Special Publication. Consult your authorized Cat dealer to determine if your engine is subject to an Emission Control Warranty and to obtain a copy of the applicable Special Publication.

Reference Information Section

Engine Ratings

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Engine Rating Conditions

SMCS Code: 1000

All engine ratings are based on“SAE J1349”.

Ratings relate to the standard conditions of “AS1501”, of “ISO3046/1”, of “DIN6271”, and of “BS5514”.

The engine ratings are gross output ratings.

Gross Output Ratings – The total output capability of the engine that is equipped with standard accessories.

Standard accessories include the following components:

- Oil pumps
- Fuel pumps
- Water pumps

Subtract the power that is required to drive auxiliary components from the gross output. This will produce the net power that is available for the external load (flywheel).

i03880100

Engine Rating Definitions

SMCS Code: 1000

In selecting a rating for a specific application, the most important consideration is the time that is spent at full throttle. These rating definitions identify the percent of time at full throttle. The definitions also identify the corresponding times below rated rpm. Refer to this Operation and Maintenance Manual, “Configuration Parameters” for information about the rating for this engine.

Note: The examples of the applications are only for reference. For an exact determination of the appropriate rating, follow the OEM specifications or consult your Caterpillar dealer.

Table 17

Engine Rating Information				
Perform-ance Rating	Load Factor	Time at Rated Load(1)		Examples of Applications
		Overall	Any One Instance	
A	100%	100%	n/a	Pipe line pumping Ventilation
B	85%	75%	n/a	Irrigation pumps Drilling applications Plant air compressors
C	70%	50%	Less than1 hour	Fire pumps Chippers Rock crushers Portable air compressors
D	50%	10%	Less than 30 minutes	Snowgroomer Snowblowers Cranes Water well drills
E	35%	5%	Less than 15 minutes	Standby centrifu-gal pumps Oil well servicing

(1) Both the overall time at rated load and the time the engine is operated in any one instance must be considered.

NOTICE
Operating engines above the rating definitions can result in shorter service life before overhaul.

Customer Service

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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 Cat replacement parts are available from Cat dealers throughout the world. Cat dealer parts inventories are up-to-date. The parts stocks include all the parts that are normally needed to protect your Cat engine investment.

When you order parts, specify the following information:

- Part number
- Part name
- Quantity

If there is a question concerning the part number, provide your dealer with a complete description of the needed item.

When a Cat 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 information will help the dealer in troubleshooting the problem and solving the problem faster.

Reference Materials

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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 various other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is managed. Accurate maintenance records can help your Cat 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 repair costs
- Owner receipts
- Maintenance log

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Reference Material

SMCS Code: 1000; 4450

Additional literature regarding your product may be purchased from your local Cat dealer or by visiting publications.cat.com. Use the product name, sales model, and serial number to obtain the correct information for your product.

publications.cat.com

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Product and Dealer Information

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:	_____	_____	_____
Parts:	_____	_____	_____
Service:	_____	_____	_____