CATERPILLAR®

SEBU8087-09
July 2007

Operation and Maintenance Manual

C13 and C15 On-highway Engines

S3C1-Up (Engine)
LEE1-Up (Engine)
SDP1-Up (Engine)
B5R1-Up (Engine)

Important Safety Information

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

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

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

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

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

⚠ 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.

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

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

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

⚠ WARNING

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

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

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Foreword

Literature Information

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

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

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

Safety

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

Operation

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

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

Maintenance

The maintenance section is a guide to engine care. The illustrated step-by-step instructions are grouped by distance (odometer), 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, distance (odometer), service hours, or calendar time, whichever occurs first, in order to determine the maintenance intervals. 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 extremely 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 preventative maintenance management program. If the preventative maintenance program is followed, a periodic tune-up is not required. The implementation of a preventative maintenance program should minimize operating costs through cost avoidances resulting from reductions in unscheduled downtime and failures.

Maintenance Intervals

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

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

Overhaul

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

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.

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

Certified Engine Maintenance

Proper maintenance and repair is essential to keep the engine and machine systems operating correctly. As the on-highway truck diesel engine owner, you are responsible for the performance of the required maintenance listed in the Owner Manual, Operation and Maintenance Manual, and Service Manual.

It is prohibited for any person engaged in the business of repairing, servicing, selling, leasing, or trading engines or machines to remove, alter or render inoperative any emission related device or element of design installed on or in an engine or machine that is in compliance with the regulations (40 CFR Part 89). Certain elements of the machine and engine such as the exhaust system, fuel system, electrical system, intake air system and cooling system may be emission related and should not be altered unless approved by Caterpillar.

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. Please become familiar with all safety messages.

Ensure that all of the safety messages are legible. Clean the safety messages or replace the safety messages if the words cannot be read or if the illustrations are not visible. 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 of 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.

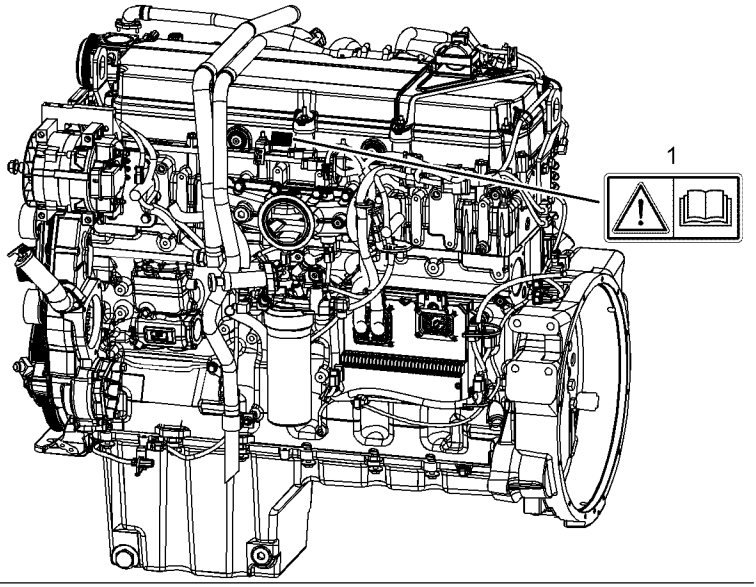

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Illustration 1

Left side of the C13 Engine

(1) The universal safety message is located on the middle of the valve cover base.

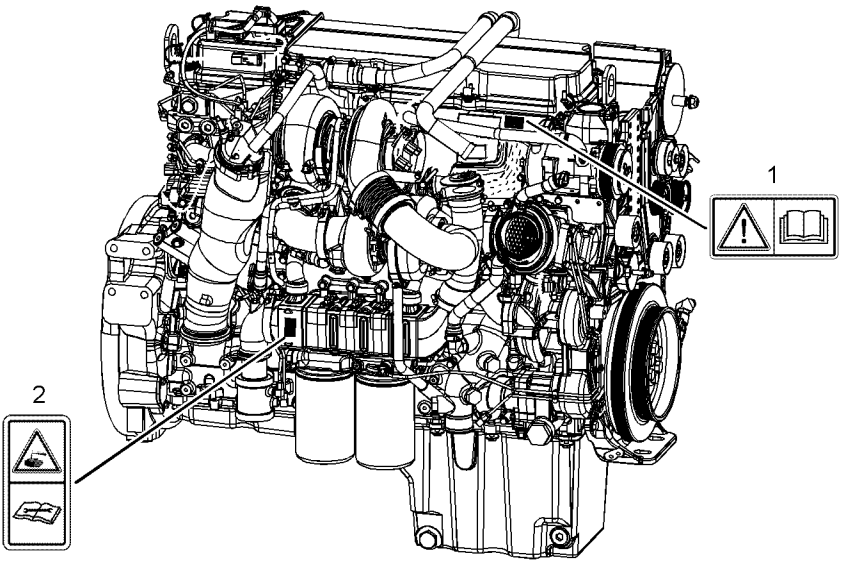

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Illustration 2

Right side of the C13 Engine

(1) The universal safety message is located on the front of the valve cover base.

(2) The safety message concerning burns from acid is located on the cooler for the clean gas induction (CGI) system.

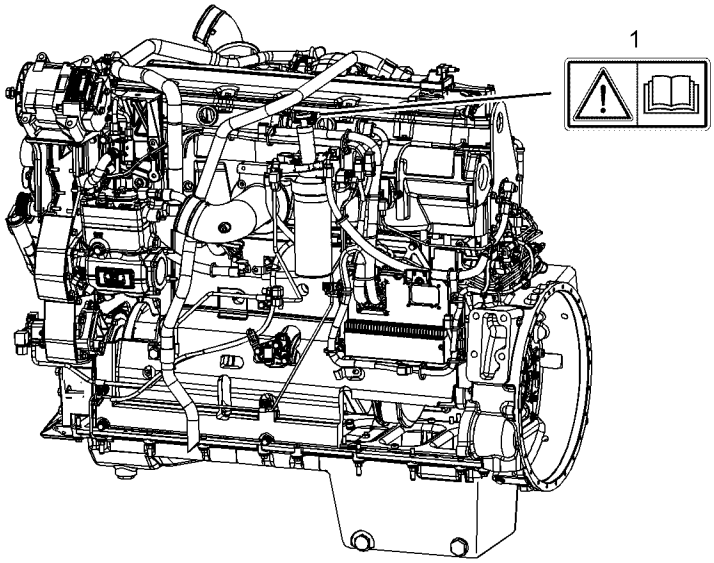

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Illustration 3

Left side of the C15 Engine

(1) The universal safety message is located on the middle of the valve cover base.

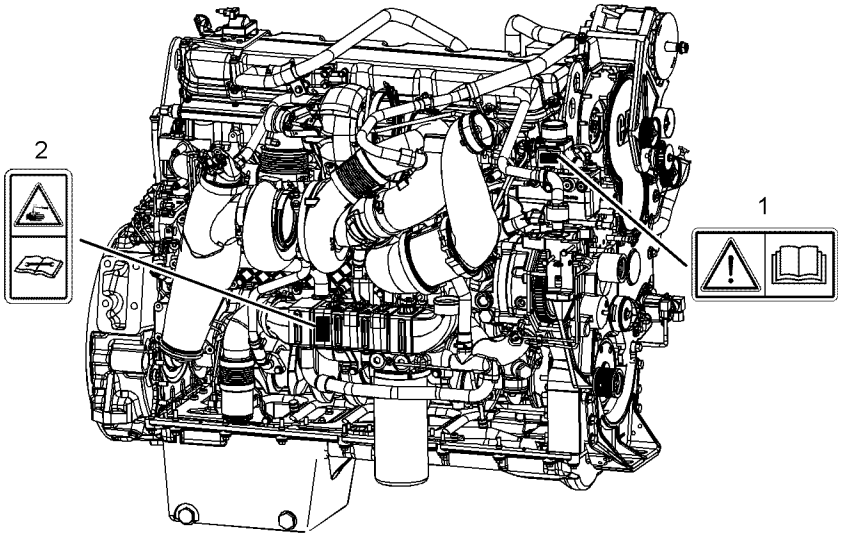

Illustration 4 g01382903

Right side of the C15 Engine

(1) The universal safety message is on the side of the regulator housing.

(2) The safety message concerning burns from acid is located on the cooler for the CGI cooler.

Universal Warning (1)

Illustration 5 g01370904

⚠ 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.

Burn Warning (2)

Illustration 6 g01382725

⚠ WARNING

Sulfuric Acid Burn Hazard, may cause serious personal injury.

The clean gas induction 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 CGI cooler during service of the engine and may travel to other downstream components. 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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General Hazard Information

SMCS Code: 1000; 7405

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

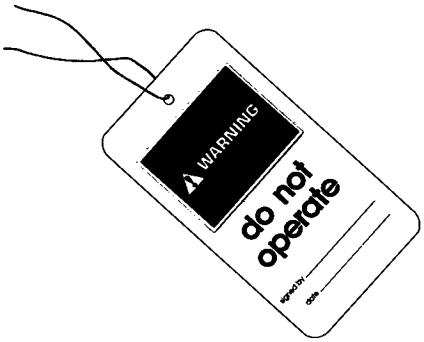

Illustration 7 g00104545

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

- Tampering with the engine installation or tampering with the OEM supplied wiring can be dangerous. Personal injury, death and/or engine damage could result.
- Vent the engine exhaust to the outside when the engine is operated in an enclosed area.
- If the engine is not running, do not release the secondary brake or the parking brake systems unless the vehicle is blocked or unless the vehicle is restrained.
- 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.
- The protective locks or the controls are in the applied position.
- Engage the secondary brakes or parking brakes.
- Block the vehicle or restrain the vehicle before maintenance or repairs are performed.
- 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.
- Disconnect the connector for the unit injector that is located on the valve cover base. This will help prevent personal injury from the high voltage to the unit injectors. Do not come in contact with the unit injector terminals while the engine is operating.
- Do not attempt any repairs or any adjustments to the engine while the engine is operating.
- Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.
- For initial start-up of a new engine or for starting an engine that has been serviced, make provisions to stop the engine if an overspeed occurs. This may be accomplished by shutting off the fuel supply and/or the air supply to the engine.
- Start the engine from the operator’s station (cab). Never short across the starting motor terminals or the batteries. This could bypass the engine neutral start system and/or the electrical system could be damaged.

Pressure Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out. This could result in personal injury. When pressure air is used for cleaning, wear a protective face shield, protective clothing, and protective shoes. 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). Always wear eye protection for cleaning the cooling system.

Fluid Penetration

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. This includes leaks that are the size of a pin hole. If fluid is injected into the skin, seek treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Fluid Spillage

Care must be used in order to ensure that the fluids are contained during the inspection, the maintenance, the testing, the adjusting, and the repair of the engine. Make provision to collect the fluid with a suitable container before any compartment is opened or before any component is disassembled. Refer to the Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog”. This publication explains the items that are needed for collecting and for containing fluids that are used in Caterpillar engines. Dispose of fluids according to local regulations.

Asbestos Information

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

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Burn Prevention

SMCS Code: 1000; 7405

Do not touch any part of an operating engine system. The engine, the exhaust, and the engine aftertreatment system can reach temperatures as high as 650 °C (1202 °F) under normal operating conditions. If the engine or the engine aftertreatment system unexpectedly fails, the temperature of the gas at the diesel particulate filter (DPF) may increase to 900°C (1652°F).

At idle engine speed and/or zero vehicle speed, an operator can request a manual regeneration. Under this condition, the exhaust gas temperature can reach 650 °C (1202 °F). Otherwise automatic regeneration can produce exhaust gas temperatures as high as 450 °C (842 °F).

Allow the engine system to cool before any maintenance is performed. 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.

Clean Gas Induction Cooler and Components Prior to the Charge Air Cooler

The clean gas induction cooler (CGI) may contain a small amount of sulfuric acid. The use of fuel with a level of sulfur that is greater than 15 ppm may increase the amount of sulfuric acid that is formed. The sulfuric acid may spill from the CGI cooler during service of the engine and flow to components downstream. 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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Fire Prevention and Explosion Prevention

SMCS Code: 1000; 7405

Illustration 8 g00704000

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

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

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

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

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

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

The temperature of the exhaust gas and of the exhaust system components may reach up to 650 °C (1202 °F) during regeneration. An unexpected failure of the engine or of the engine aftertreatment system may increase temperature at the diesel particulate filter (DPF) as high as 900 °C (1652 °F). Do not expose flammable material or explosive atmospheres to exhaust gas or to components of the exhaust system during regeneration.

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

Do not expose the engine to any flame.

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

Do not weld on lines or tanks that contain flammable fluids. Do not flame cut lines 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. All electrical wires must be properly routed and securely attached. Check all electrical wires daily. Repair any wires that are loose or frayed before you operate the engine. Clean all electrical connections and tighten all electrical connections.

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

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

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

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

Illustration 9 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.

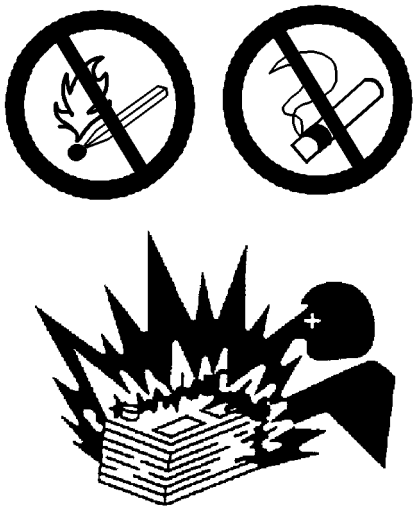

Illustration 10 g00704135

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

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

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

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

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

Fire Extinguisher

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

Lines, Tubes and Hoses

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

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

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

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

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

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

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Crushing Prevention and Cutting Prevention

SMCS Code: 1000; 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; 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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Before Starting Engine

SMCS Code: 1000

Inspect the engine for potential hazards.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

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

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

See the Service Manual for repairs and for adjustments.

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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. Also, do not disengage the parking brakes. 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 station (cab). Never short across the starting motor terminals or the batteries. This could bypass the engine neutral start system and/or the electrical system could be damaged.

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

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working properly, check the water temperature 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 well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

⚠ WARNING

DO NOT USE ETHER (starting fluids) unless specifically instructed to do so. If the engine is equipped with an Air Inlet Heater (electrically or fuel ignited manifold heater), DO NOT use ether (starting fluids) at any time. The use could result in engine damage and/or personal injury.

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Engine Stopping

SMCS Code: 1000

Stop the engine according to the procedure in the Operation and Maintenance Manual, “Engine Stopping (Operation Section)” in order to avoid overheating of the engine and accelerated wear of the engine components.

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

Stop the engine if an overspeed condition occurs during the initial start-up of a new engine or an engine that has been overhauled. This may be accomplished by shutting off the fuel supply to the engine and/or shutting off the air supply to the engine.

To stop an electronically controlled engine, cut the power to the engine.

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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. See your Operation and Maintenance Manual, “Starting the Engine” for specific starting instructions.

Grounding Practices

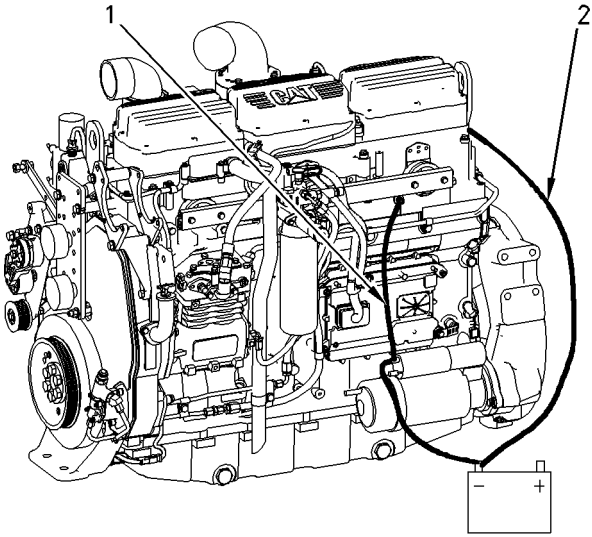

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Illustration 11

Typical example

Engine ground

(1) Recommended connections
(2) Alternate connections

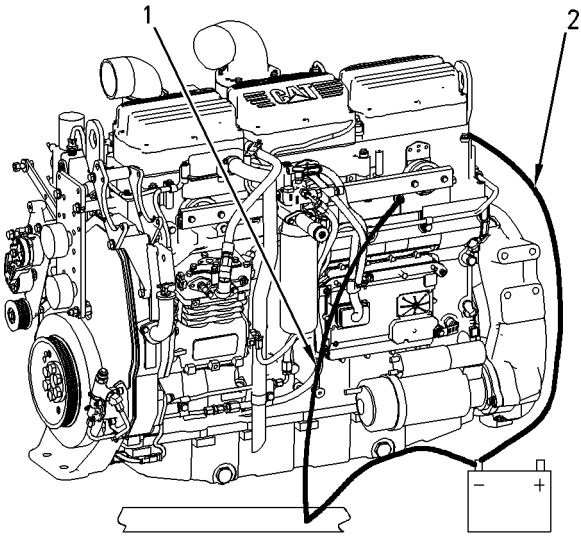

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Illustration 12

Typical example

Frame ground

(1) Recommended connections
(2) Alternate connections

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.

i02595607

Engine Electronics

SMCS Code: 1000; 1400; 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.

WARNING

Electrical Shock Hazard. The unit injector system uses 90 - 120 volts. The ECM sends this signal to the unit injectors. Do not come in contact with the unit injector harness connector while the engine is operating. Failure to follow this instruction could resulting in personal injury or death.

This engine has a comprehensive, programmable Engine Monitoring System. The Engine Control Module (ECM) has the ability to monitor the engine operating conditions. If any of the engine parameters extend outside an allowable range, the ECM will initiate an immediate action.

The following actions are available for engine monitoring control: WARNING, DERATE, and SHUTDOWN. The DERATE and SHUTDOWN engine monitoring modes have the ability to limit engine speed and/or the engine power.

Many of the parameters that are monitored by the ECM can be programmed for the engine monitoring functions. The following parameters can be monitored as a part of the Engine Monitoring System:

- Operating Altitude
- Engine Coolant Level

- Engine Coolant Temperature
- Engine Oil Pressure
- Engine Speed
- Fuel Temperature
- Intake Manifold Air Temperature
- System Voltage

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 Electronic Troubleshooting Manual for more information on the Engine Monitoring System.

Product Information Section

General Information

i02668476

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 Caterpillar dealer regarding welding on a chassis frame or rail.

Proper welding procedures are necessary in order to avoid damage to the engine's 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 bearings, hydraulic components, electrical components, 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.

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. Move the harness to a position that will not allow the harness to accidentally move back and make contact with any of the ECM pins.

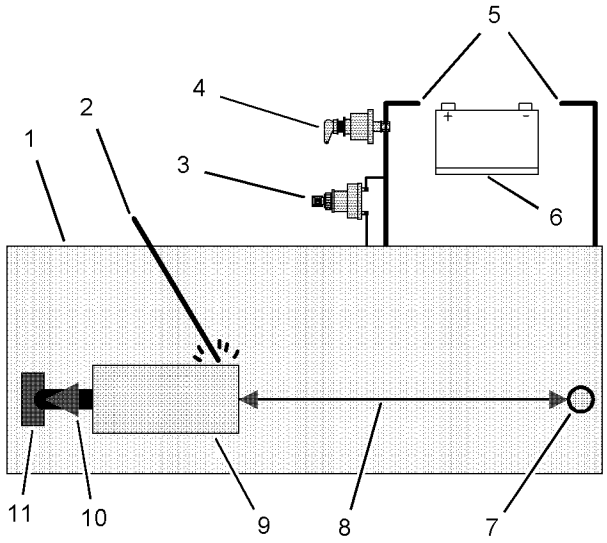


Illustration 13 g01075639

Use the example above. The current flow from the welder to the ground clamp of the welder will not cause damage to 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 in order 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.

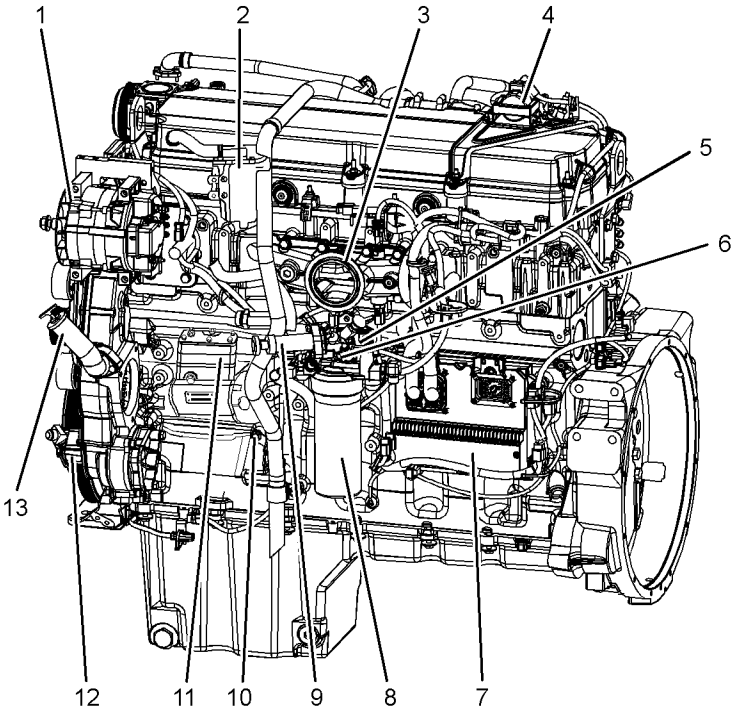
6. Use standard welding practices to weld the materials.

Model Views

i02682893

Model View Illustrations (C13 and C15 On-highway Truck Engines)

SMCS Code: 1000

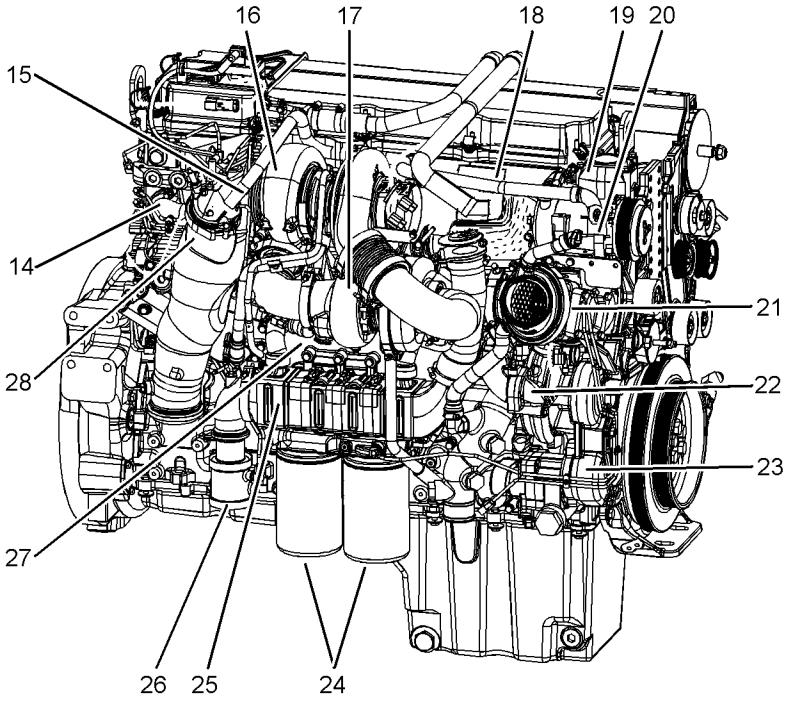


g01349809

Illustration 14

C13 Left side view

(1) Alternator
(2) Fumes disposal (open crankcase ventilation) filter
(3) Inlet air manifold
(4) Coil for the engine aftertreatment system
(5) Fuel control valves for the engine aftertreatment system
(6) Fuel filter base
(7) Engine control module (ECM)
(8) Fuel filter
(9) Fuel priming pump
(10) Oil level check
(11) Air compressor
(12) Fuel transfer pump
(13) Oil filler tube



g01352621

Illustration 15

C13 Right side view

(14) Exhaust manifold
(15) Air line for combustion of exhaust gas
(16) Low pressure turbocharger
(17) High pressure turbocharger
(18) Clean gas induction (CGI actuator)
(19) Water temperature regulator
(20) Air control valve
(21) Precooler
(22) Water pump
(23) Engine oil pump
(24) Engine oil filter
(25) CGI cooler
(26) CGI tube
(27) Engine oil cooler
(28) Aftertreatment regeneration device (ARD)

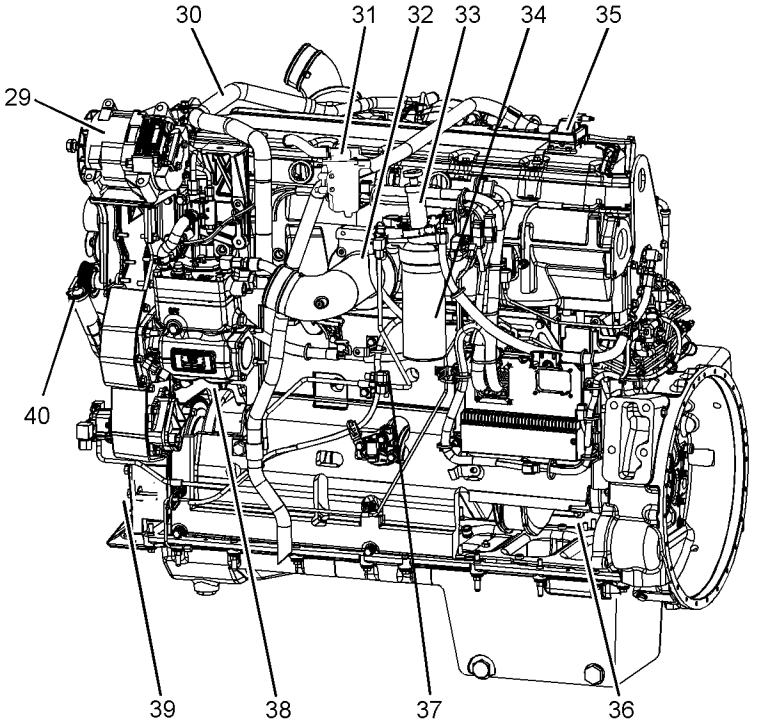
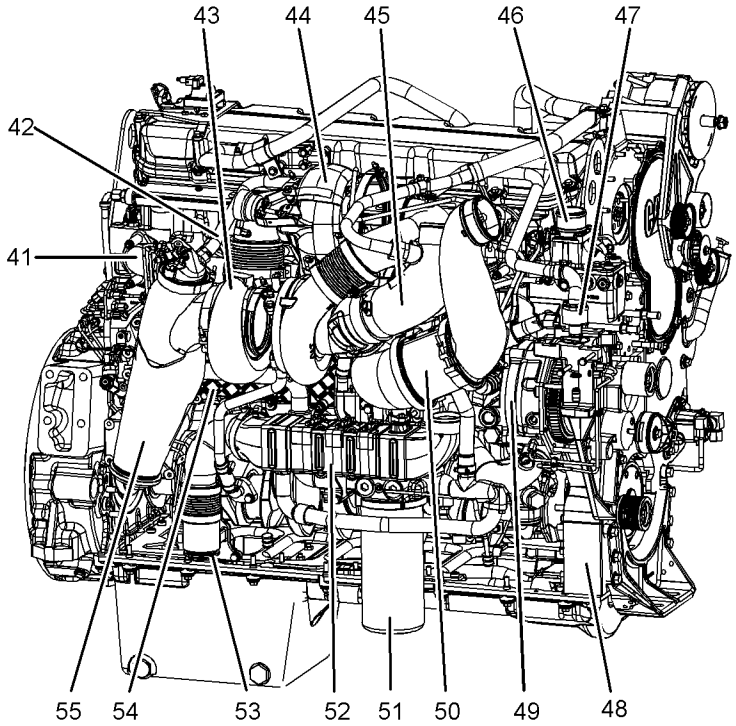


Illustration 16 g01349775

C15 Left side view

(29) Alternator
(30) Air supply tube for air compressor
(31) Fumes disposal (open crankcase ventilation) filter
(32) Inlet air
(33) Fuel priming pump
(34) Fuel filter
(35) Coil for the engine aftertreatment system
(36) ECM
(37) Oil level check
(38) Air compressor
(39) Fuel transfer pump
(40) Oil filler tube



g01349812

Illustration 17

C15 Right side view

(41) Exhaust manifold
(42) Air line for combustion of exhaust gas
(43) Low pressure turbocharger
(44) High pressure turbocharger
(45) Clean gas induction (CGI) actuator
(46) Water temperature regulator
(47) Air valve for combustion of the engine aftertreatment system
(48) Engine oil pump
(49) Water pump
(50) Precooler
(51) Engine oil filter
(52) CGI cooler
(53) CGI tube
(54) Engine oil cooler
(55) Aftertreatment regeneration device (ARD)

i02719893

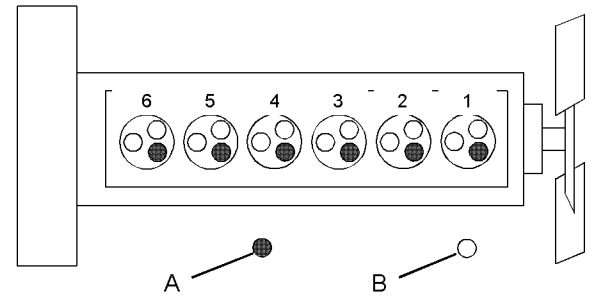
Engine Description

SMCS Code: 1000

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.

The C13 and the C15 Engines have the following characteristics: air-to-air aftercooled, direct fuel injection, four stroke cycle, in-line 6 cylinder, and turbocharged.

C13 Engine Specifications



g01075672

Illustration 18

Cylinder and valve location

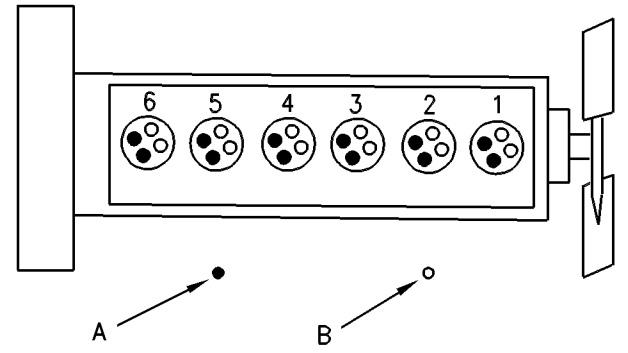
(A) Exhaust valve
(B) Inlet valve

Table 1

C13 Engine Specifications	
Arrangement and Cylinders	In-Line 6 cylinder
Bore	130 mm (5.2 inch)
Stroke	157 mm (6.2 inch)
Aspiration	ATAAC(1)
Displacement	12.5 L (763 in^3)
Firing Order	1-5-3-6-2-4
Rotation (flywheel end)	Counterclockwise

(1) Air-to-air aftercooled

C15 Engine Specifications



g00609479

Illustration 19

Cylinder and valve location

(A) Exhaust valve
(B) Inlet valve

Table 2

C15 Engine Specifications	
Arrangement and Cylinders	In-Line 6 cylinder
Bore	137.2 mm (5.4 inch)
Stroke	171.5 mm (6.8 inch)
Aspiration	ATAAC(1)
Displacement	15.2 L (928 in^3)
Firing Order	1-5-3-6-2-4
Rotation (flywheel end)	Counterclockwise

(1) Air-to-air aftercooled

Electronic Engine Features

The Caterpillar C13 and C15 Engines are designed for electronic controls. The integral on board computer controls the operation of the engine. Current operating conditions are monitored. The Engine 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

The following programmable features are included in the electronic control:

- Cruise control
- Governing of the PTO
- Vehicle speed limiter

- Fast idle

Additional Features

The following additional features provide increased engine fuel economy and serviceability:

- Cold starting capability
- Tampering detection
- Diagnostics
- Idle shutdown timer
- American Trucking Association (ATA) data link (“SAE J1587”)
- American Trucking Association (ATA) data link (“SAE J1939”)

Engine Diagnostics

The engine has built-in diagnostics in order to ensure that all of the components are functioning properly. In the event of a deviation from the programmed limits, the operator will be alerted to the condition by a “DIAGNOSTIC” lamp that is mounted on the dashboard. Under certain conditions, the engine horsepower and the vehicle speed may be limited. A Caterpillar electronic service tool may be used to display the diagnostic code.

There are four types of diagnostic codes: active, logged, event, and critical event.

Most of the diagnostic codes are logged and stored in the ECM. For additional information, refer to the Operation and Maintenance Manual, “Engine Diagnostics” topic (Operation Section).

The ECM provides an electronic governor that controls the injector output in order to maintain the desired engine rpm. The functionality of electronic governor is similar to the Caterpillar mechanical governor, but the electronic governor includes additional features.

For more information on electronic engine features, refer to the Operation and Maintenance Manual, “Engine Features and Controls” topic (Operation Section).

Engine Cooling and Lubrication

The cooling system consists of the following components:

- Centrifugal pump that is driven by belts
- Water temperature regulator which regulates the engine coolant temperature
- Oil cooler and radiator which incorporates a shunt system

The engine lubricating oil that is supplied is cooled. The engine lubricating oil is also filtered. Bypass valves provide unrestricted flow of lubrication oil to the engine components during the following conditions:

- High oil viscosity
- Plugged oil cooler or plugged oil filter elements (paper cartridge)

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 generally predicted by the average power that is demanded. The average power that is demanded is based on fuel consumption of the engine over a period of 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

When auxiliary devices, accessories, or consumables (filters, additives, catalysts, etc) which are made by other manufacturers are used on Caterpillar products, the Caterpillar warranty is not affected simply because of such use.

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 Hydraulic Electronic Unit Injectors. Caterpillar High Efficiency Fuel Filters meet these requirements. Consult your Caterpillar dealer for the proper part numbers.

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

Product Identification Information

i02533941

Engine Identification

SMCS Code: 1000

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

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

i02682956

Serial Number Plate

SMCS Code: 1000

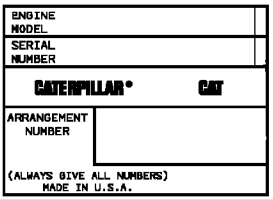


Illustration 20 g01347804

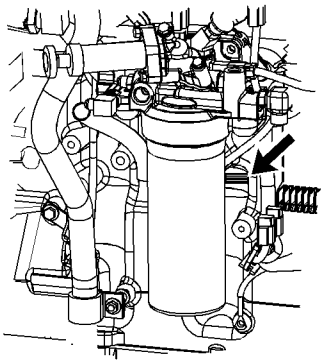


Illustration 21 g01347806

Left side view of C13 Engine

C13 The serial number plate is located on the left side of the cylinder block and on the right side of the fuel filter.

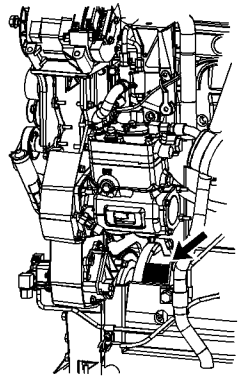


Illustration 22 g01347807

Left side view of C15 Engine

C15 The serial number plate is located at the front edge of the left side of the cylinder block.

i02682957

Information Plate

SMCS Code: 1000

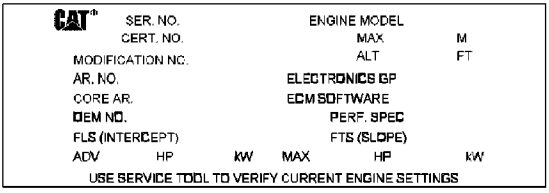


Illustration 23 g01347963

Information plate

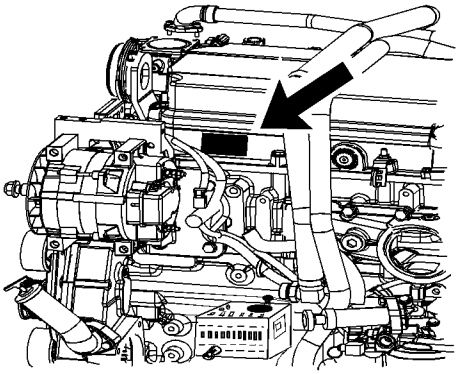


Illustration 24 g01347965

Left side view of C13 Engine

C13 The information plate is located on the left side of the valve cover base.

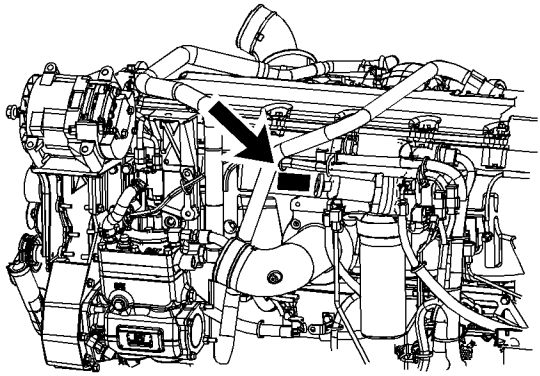


Illustration 25 g01347964

Left side view of C15 Engine

C15 The information plate is located on the left side of the cylinder head.

i00836358

Reference Numbers

SMCS Code: 1000

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

Chassis Serial No. _____

Engine Model _____

Engine Serial No. _____

Engine Arrangement No. _____

Modification No. _____

Engine Low Idle rpm _____

Engine Full Load rpm _____

Performance Specification No. _____

Engine hp _____

Primary Fuel Filter No. _____

Water Separator Element No. _____

Secondary Fuel Filter Element No. _____

Lubrication Oil Filter Element No. _____

Auxiliary Oil Filter Element No. _____

Supplemental Coolant Additive Maintenance Element No. (Optional)

_____

Total Lubrication System Capacity _____

Total Cooling System Capacity _____

Air Cleaner Element No. _____

Fan Drive Belt No. _____

Alternator Belt No. _____

i02683663

Emissions Certification Film

SMCS Code: 1000; 7405

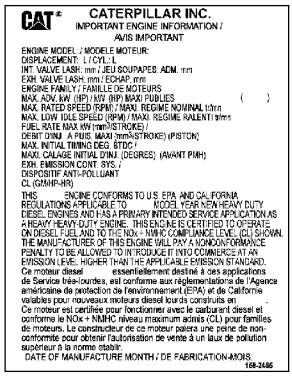

CAT®
CATERPILLAR INC.
IMPORTANT ENGINE INFORMATION /
AVIS IMPORTANT
ENGINE MODEL / MODELE MOTEUR:
DISPLACEMENT: L / CYL: L
INT. VALVE LASH: mm / JEU SOUPAPES: ADM. mm
EXH. VALVE LASH: mm / ECHAP. mm
ENGINE FAMILY / FAMILLE DE MOTEURS
MAX. ADV. IMP. (IMP) / MAX. PUBLIES ( )
MAX. RATED SPEED (RPM) / MAXI. REGIME NOMINAL t/mn
MAX. LOW IDLE SPEED (RPM) / MAXI. REGIME RALENTI t/mn
FUEL RATE MAX. kW (mm³/STROKE) /
DEBIT DINJ. A PLEIN MAXI (mm³/STROKE) (PISTON)
MAX. INITIAL TIMING DEG. BTDC /
MAXI. CALAGE INITIAL DINJ. (DEGRES) (AVANT PMH)
EXH. EMISSION CONT. SYS. /
DISPOSITIF ANTI-POLLUANT
CL (G/MHP-HR)
THIS ENGINE CONFORMS TO U.S. EPA AND CALIFORNIA
REGULATIONS APPLICABLE TO MODEL YEAR NEW HEAVY DUTY
DIESEL ENGINES AND HAS A PRIMARY INTENDED SERVICE APPLICATION AS
A HEAVY HEAVY-DUTY ENGINE. THIS ENGINE IS CERTIFIED TO OPERATE
ON DIESEL FUEL AND TO THE NOx + NMHC COMPLIANCE LEVEL (CL) SHOWN.
THE MANUFACTURER OF THIS ENGINE WILL PAY A NONCONFORMANCE
PENALTY TO BE ALLOWED TO INTRODUCE IT INTO COMMERCE AT AN
EMISSION LEVEL HIGHER THAN THE APPLICABLE EMISSION STANDARD.
Ce moteur diesel essentiellement destiné à ces applications
de Service très lourdes, est conforme aux réglementations de l'Agence
américaine de protection de l'environnement (EPA) et de Californie
valables pour nouveaux moteurs diesel lourds construits en
Ce moteur est certifié pour fonctionner avec le carburant diesel et
conforme le NOx + NMHC niveau maximum admis (CL) pour familles
de moteurs. Le constructeur de ce moteur paiera une peine de non-
conformité pour obtenir l'autorisation de vente à un taux de pollution
supérieur à la norme établir.
DATE OF MANUFACTURE MONTH / DE FABRICATION-MOIS
166-2486

Illustration 26 g01267454

Emissions certification film

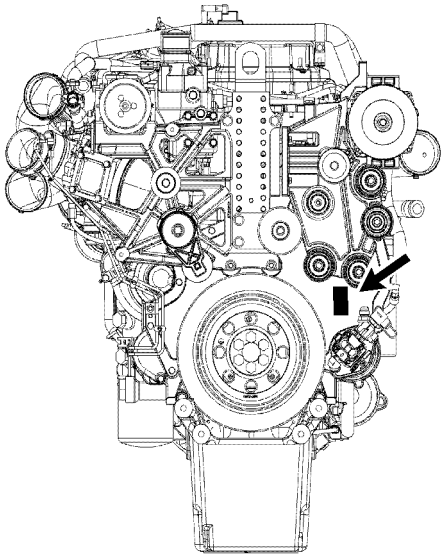


Illustration 27 g01348222

View of the front of a C13 Engine or a C15 Engine

The emissions certification film for the C13 and the C15 engines is located on the front of the engine.

i02718376

Customer Specified Parameters

SMCS Code: 1000

To record programmed specifications, use the following blanks.

Selected Engine Rating

- “Rating Number” _____
- “Multi-Torque Ratio” _____
- “Aftertreatment Configuration Number” _____

ECM Identification Parameters

- “Vehicle ID” _____

Security Access Parameters

- “ECM Wireless Communication Enable” _____

Vehicle Speed Parameters

- “Vehicle Speed Calibration” _____
- “Vehicle Speed Cal (J1939-Trans)” _____
- “Vehicle Speed Cal (J1939-ABS)” _____
- “Vehicle Speed Limit” _____
- “VSL Protection” _____
- “Tachometer Calibration” _____
- “Speedometer Calibration” _____
- “Soft Vehicle Speed Limit” _____

- “Low Speed Range Axle Ratio” _____
- “High Speed Range Axle Ratio” _____

Cruise Control Parameters

- “Low Cruise Control Speed Set Limit” _____
- “High Cruise Control Speed Set Limit” _____
- “Engine Retarder Mode” _____
- “Engine Retarder Minimum VSL Type” _____
- “Engine Retarder Minimum Vehicle Speed” _____
- “Auto Retarder in Cruise” _____
- “Auto Retarder in Cruise Increment” _____
- “Cruise/Idle/PTO Switch Configuration” _____
- “Soft Cruise Control” _____
- “Adaptive Cruise Control” _____

Idle Parameters

- “Idle Vehicle Speed Limit” _____
- “Idle RPM Limit” _____
- “Idle/PTO RPM Ramp Rate” _____
- “Idle/PTO Bump RPM” _____
- “Fast Idle RPM #1” _____
- “Fast Idle RPM #2” _____
- “Warm Up Mode Idle Speed” _____

Dedicated PTO Parameters

- “PTO Configuration” _____

- “PTO Top Engine Limit” _____
- “PTO Engine RPM Set Speed” _____
- “PTO Engine RPM Set Speed A” _____
- “PTO Engine RPM Set Speed B” _____
- “PTO to Set Speed” _____
- “Maximum PTO Enable Speed” _____
- “PTO Cab Controls RPM Limit” _____
- “PTO Kickout Vehicle Speed Limit” _____
- “Maximum PTO Vehicle Speed” _____
- “Torque Limit” _____
- “PTO Shutdown Time” _____
- “PTO Shutdown Timer Maximum RPM” _____
- “PTO Activates Cooling Fan” _____

“Engine/Gear Parameters”

- “Lower Gears Engine RPM Limit” _____
- “Lower Gears Turn Off Speed” _____
- “Intermediate Gears Engine RPM Limit” _____
- “Intermediate Gears Turn Off Speed” _____
- “Gear Down Protection RPM Limit” _____
- “Gear Down Protection Turn On Speed” _____
- “Low Idle Engine RPM” _____
- “Transmission Style” _____
- “Eaton Top 2 Override with Cruise” _____

_____

- “Top Gear Ratio” _____
- “Top Gear Minus One Ratio” _____
- “Top Gear Minus Two Ratio” _____
- “Governor Type” _____

“Emissions Parameters”

- “Aftertreatment Regeneration Device Programmable Regeneration Monitoring System” _____
- “Aftertreatment Regeneration Device Fan Enable Vehicle Speed Threshold” _____
- “Aftertreatment Regeneration Device Stationary Regeneration Strategy” _____
- “Exhaust System High Temperature Lamp Diesel Particulate Filter Outlet Temperature Threshold” _____
- “Exhaust System High Temperature Lamp Strategy” _____
- “Aftertreatment Regeneration Device Vehicle Speed Threshold” _____
- “Aftertreatment Regeneration Disable Switch” _____
- “Aftertreatment Regeneration Force Switch” _____
- “Diesel Particulate Filter Lamp” _____
- “High Exhaust Temperature Lamp” _____
- “Aftertreatment Regeneration Device Lamp Vehicle Speed Threshold” _____
- “Aftertreatment Regeneration Device Manual Disable Status” _____
- “Number of Particulate Filters” _____

Timer Parameters

- “Idle Shutdown Time (0=OFF)” _____

_____

- “Idle Shutdown Timer Maximum RPM” _____
- “Allow Idle Shutdown Override” _____
- “Minimum Idle Shutdown Outside Temp” _____
- “Maximum Idle Shutdown Outside Temp” _____
- “A/C Switch Fan On-Time” _____
- “Fan with Engine Retarder in High Mode” _____
- “Engine Retarder Delay” _____

Smart Idle Parameters

- “Battery Monitor and Engine Control Voltage” _____

Engine Monitoring Parameters

- “Engine Monitoring Mode” _____

Engine Monitoring Lamps

- “Red Stop Lamp” _____
- “Low Coolant Level Warning Lamp” _____
- “High Coolant Temperature Warning Lamp” _____
- “Low Oil Pressure Warning Lamp” _____
- “Coolant Level Sensor” _____
- “Engine Pre-Cooler Installation Status” _____

Maintenance Parameters

- “Maintenance Indicator Mode” _____
- “PM1 Interval” _____
- “Engine Oil Capacity” _____

Trip Parameters

- “Fuel Correction Factor” _____
- “Dash - Change Fuel Correction Factor” _____
- “Dash - PM1 Reset” _____
- “Dash - Fleet Trip Reset” _____
- “Dash - State Selection” _____
- “Theft Deterrent System Control” _____
- “Theft Deterrent Password” _____
- “Quick Stop Rate” _____
- “Vehicle Overspeed Threshold” _____

Vehicle Activity Report Parameters

- “Minimum Idle Time” _____

Driver Reward

- “Driver Reward Enable” _____

Input Selections

- “Transmission Neutral Switch” _____
- “Fan Override Switch” _____
- “Ignore Brake/Clutch Switch” _____
- “Torque Limit Switch” _____
- “PTO ON/Off Switch” _____
- “Remote PTO Set Switch” _____
- “Remote PTO Resume Switch” _____
- “PTO Engine RPM Set Speed Input A” _____
- “PTO Engine RPM Set Speed Input B” _____

- “Starting Aid On/Off Switch” _____
- “Two Speed Axle Switch” _____
- “Cruise Control ON/Off Switch” _____
- “Cruise Control Set/Switch” _____
- “Cruise Control Resume Switch” _____
- “Cruise Control Pause Switch” _____
- “Clutch Pedal Position Switch” _____
- “Retarder Low/High Switch” _____
- “Retarder Med/High Switch” _____
- “Service Brake Pedal Position Switch #1” _____
- “Accelerator Pedal Position” _____
- “Fast Idle Enable Switch” _____
- “PTO Engine Shutdown Switch” _____
- “Service Brake Pedal Position Switch #2” _____
- “A/C High Pressure Switch” _____
- “Vehicle Speed Input” _____

Output Selections

- “Engine Running Output” _____
- “Engine Shutdown Output” _____
- “Auxiliary Brake” _____
- “Starting Aid Output” _____
- “Fan Control Type” _____
- “Fan Pulley Ratio” _____

- “PTO Active Output” _____
- “PTO Switch ON Lamp” _____
- “Inlet Air Shut Off Relay Control” _____

Fuel Tank Parameters

- “Primary Fuel Tank Capacity” _____
- “Secondary Fuel Tank Capacity” _____

Passwords

- “Customer Password #1” _____
- “Customer Password #2” _____

Data Link Parameters

- “Powertrain Data Link” _____

Operation Section

Lifting and Storage

i02123539

Product Lifting

SMCS Code: 1000; 1404; 7002

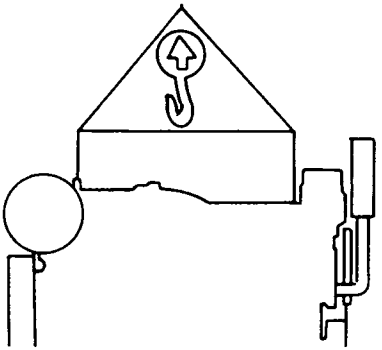


Illustration 28 g00103219

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

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

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

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

To remove the engine ONLY, use the lifting eyes that are on the engine. If the lifting eyes are missing, refer to the Parts Manual for the proper lifting eyes and bolts.

Lifting eyes are designed for the specific engine arrangement. These lifting eyes are installed when the engine is manufactured. 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.

i02110607

Product Storage

SMCS Code: 1000; 1404; 7002

If the engine will not be started for several weeks, the lubricating oil will drain from the cylinder walls and from the piston rings. Rust can form on the cylinder liner surface. Rust on the cylinder liner surface will cause increased engine wear and a reduction in engine service life.

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

- Complete all of the lubrication recommendations that are listed in this Operation and Maintenance Manual, “Maintenance Interval Schedule” (Maintenance Section).

- If freezing temperatures are expected, check the cooling system for adequate protection against freezing. See Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluids Recommendations”.

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

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

Your Caterpillar dealer can assist in preparing the engine for extended storage periods.

Gauges and Indicators

i02608265

Gauges and Indicators

SMCS Code: 1900; 7450

Your engine may not have the same gauges or all of the gauges that are described. For more information about the gauge package, see the literature that is provided by the OEM.

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

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

Caterpillar requires one lamp in addition to the gauge package that is normally provided. The amber warning lamp will communicate the status of the engine's electronic system. The optional red stop lamp is also available. This red stop lamp warns the operator of engine problems.

The following conditions are some examples of the problems:

- Low oil pressure
- High coolant temperature
- Low coolant level
- High inlet air temperature

Engine Oil Pressure – Typical oil pressure for an engine at rated speed with SAE 10W30 or with SAE 15W40 is 207 to 310 kPa (30 to 45 psi) for the C13. Typical oil pressure for an engine at rated speed with SAE 10W30 or with SAE 15W40 is 276 to 606 kPa (40 to 88 psi) for the C15.

A higher oil pressure is normal with cold oil when the engine is started. 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 the oil level. Maintain the oil level at the proper amount.

The amber warning lamp will turn on if the oil pressure drops below 35 kPa (5 psi) at low idle rpm. The diagnostic code will be logged in the Engine Control Module (ECM).

Jacket Water Coolant Temperature – Typical temperature range is 88 to 102 °C (190 to 215 °F). The maximum allowable temperature with the pressurized cooling system is 106 °C (223 °F). The red stop lamp will turn on at 109 °C (228 °F). The engine will be derated at 111 °C (232 °F). Higher temperatures may occur under certain conditions. The water temperature reading may vary according to load. The reading should never exceed the boiling point for the pressurized system that is being used.

If the engine is operating above the normal range and steam becomes apparent, perform the following procedure:

1. Reduce the load and the engine rpm.

2. Inspect the cooling system for leaks.

3. Determine if the engine must be shut down immediately or if the engine can be cooled by reducing the load.

NOTICE
Do not exceed 2300 rpm in any situation or 2100 rpm if equipped with an auxiliary engine brake system.

Tachometer – This gauge indicates engine speed. The engine can be operated at high idle without damage, but the engine should not be allowed to overspeed. The engine can overspeed by downshifting or by going downhill. An overspeed can result in serious damage to the engine.

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

Features and Controls

i02719756

Emergency Vehicle Engine Features (C13 Fire Truck Engine)

SMCS Code: 1000

S/N: S3C1-Up

S/N: LEE1-Up

If the emergency vehicle is equipped with an automatic transmission, the following modifications are available. The modifications are called the Emergency Vehicle Features.

The C13 Engine has one of the following power ratings:

- 360 kW (485 hp) or 340 kW (455 hp) multitorque rating
- 390 kW (525 hp)

The emergency vehicle engine features have the following modifications:

Temperature of the Top Tank (maximum allowable temperature) ..... 110 °C (230 °F)
High Coolant Temperature Warning ..... 109 °C (228 °F)
Very High Coolant Temperature Warning ..... 111 °C (232 °F)
Very High Coolant Temperature Shutdown ..... 115° C (240° F)

If the emergency vehicle engine is programmed to “DERATE”, reduced power will begin when the fault code for the Very High Coolant Temperature Warning flashes. The engine will continue derating until the coolant temperature reaches 115 °C (239 °F).

i02758837

Monitoring System (Dash Lamps and Controls for the Aftertreatment Regeneration Device (ARD))

SMCS Code: 1900; 7400; 7402; 7450; 7451

Reduction of Particulate Emissions

The diesel particulate filter (DPF) and the ARD work together in order to reduce particulate emissions. The generation of soot is a normal process during engine operation. The DPF collects the soot and the engine oil in the exhaust. The soot is converted into gas and the engine oil is converted into ash.

The temperature of the DPF must be above a particular value in order for regeneration to occur. The exhaust gas provides heat for the regeneration process. There are two types of regeneration:

Passive regeneration – The engine provides sufficient exhaust gas temperature for regeneration.

Active regeneration – The engine's duty cycle does not provide sufficient exhaust temperature for passive regeneration. The ARD operates in order to raise the temperature of the exhaust gas. When the regeneration process is complete, the ARD turns off.

⚠ WARNING

The temperature of the exhaust gas and the temperature of the exhaust system components can reach up to 650 °C (1202 °F) during regeneration. An unexpected failure of the engine or an unexpected failure of the aftertreatment system may increase temperature at the diesel particulate filter to as high as 900 °C (1652 °F) gas temperature. This may result in fire, burn, or explosion hazards, which may result in personal injury or death. Do not expose flammable material or explosive atmospheres to exhaust gas or to exhaust system components during regeneration.

Modes of Active Regeneration

Stationary Regeneration

A stationary regeneration is an active regeneration that is initiated by the operator via the ARD force switch. The vehicle must be stopped in order for a stationary regeneration to occur.

Engine Warm Up

The engine control module (ECM) may command the ARD to operate shortly after the engine is started in order to increase the temperature of the DPF.

The ECM checks the coolant temperature and the temperature of the DPF during the first 60 seconds immediately after the engine is started. The ECM activates the ARD if it is necessary to raise the temperature of the DPF. The ARD operates until the temperature of the DPF has risen to an acceptable value. Then, the ARD turns off. If the cooling fan is controlled by the ECM, the cooling fan is engaged while the ARD is operating.

Enhanced Passive Plus

Enhanced passive plus controls the soot load during long periods of engine operation at idle. Enhanced passive plus causes the ARD to operate at a low temperature for a set duration. Then, the ARD turns off. This process occurs at periodic intervals that depend on the soot load.

The High Exhaust System Temperature Lamp (HEST) does not illuminate during enhanced passive plus due to the lower temperature of the exhaust.

Regeneration During Power Take-Off Operation

The “Aftertreatment Regeneration Device PTO Mode Stationary Regeneration” parameter must be programmed to “ENABLED” in order for stationary regenerations to occur during PTO operation. Factory passwords are required in order to change the value of this parameter.

A stationary regeneration occurs during PTO operation when all of the following conditions are met:

- “Level 1” soot load or higher
- Coolant temperature is greater than 60 °C (140 °F).

- Exhaust temperature is greater than 100 °C (212 °F).
- The clutch is disengaged.
- The transmission is in neutral.
- The parking brake is on.
- The PTO is on.
- The ARD force switch is properly activated.

The duration of the stationary regeneration during PTO operation depends on engine speed and other operating conditions.

Engine Speed

Stationary regeneration during PTO operation can occur at any engine speed between low idle and the top engine limit. Stationary regeneration occurs at the programmed speed.

Operation of the Cooling Fan

If the ECM is controlling the cooling fan, the cooling fan is engaged during stationary regeneration.

Lamps

Five dash lamps may be affected by the CRS. Only the amber warning lamp is required to be installed by the vehicle manufacturer. The remaining lamps are optional. The optional lamps may be retrofitted to the vehicle.

Lamp That Is Installed By The Vehicle Manufacturer

Amber Warning Lamp – This lamp indicates that the soot load has increased. Active regeneration or stationary regeneration is required.

Optional Lamps

DPF Lamp – This lamp provides a general indication of the soot load. The lamp is off when the soot load is low. This lamp is on when an active regeneration or stationary regeneration is required in order to reduce the soot load. The lamp flashes when the soot load has increased to a very high level. The lamp also flashes whenever the ARD disable switch is activated.

High Exhaust System Temperature Lamp (HEST) – This lamp is illuminated when the exhaust temperature is greater than 450 °C (842 °F) and the vehicle speed is less than 8 km/h (5 mph).

Red Stop Lamp – This lamp indicates that the soot load is very high.

Aftertreatment Disable Lamp – This lamp is illuminated whenever the ARD disable switch is activated.

Switch Inputs

The engine aftertreatment system does not require input from the operator in order to work correctly. However, the ARD can receive switch inputs in order for the operator to manually control the system. The switches are optional. A vehicle may be retrofitted with the switches.

Two switch inputs are provided. The inputs can be provided by a single switch or by two switches.

Single Switch

Top Position

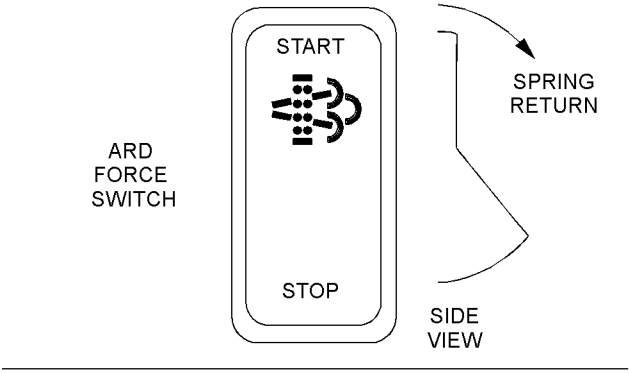


Illustration 29 g01356895

The top position for a single switch initiates a stationary regeneration when all of the following conditions are met:

- The soot load is level one or higher. The DPF lamp is illuminated or the DPF lamp is flashing.
- The coolant temperature is greater than 60 °C (140 °F).
- The exhaust temperature is greater than 100 °C (212 °F).
- The air inlet shutoff is not activated.
- The clutch is disengaged.
- The brake pedal is released.
- The transmission is in neutral.
- The throttle position is less than seven percent.
- The parking brake is engaged.
- The vehicle speed is zero mph.
- The power take-off switch is off and stationary regeneration is not allowed during operation of the PTO.

Depress the switch for at least two seconds in order to initiate a stationary regeneration if the switch is wired directly to the ECM. Refer to the owner's manual in order to determine the operation of this position if the switch is wired to a J1939 device.

If all of the conditions are met, the DPF lamp turns off.

Note: The engine speed increases to 1400 RPM on C13 and C15 Engines. The engine speed increases to 1200 RPM on C7 and C9 Engines.

If the ECM is controlling the cooling fan, the cooling fan is enabled during the stationary regeneration. Stationary regeneration begins.

The HEST lamp illuminates while the exhaust temperature exceeds 450 °C (842 °F).

The duration of the stationary regeneration depends on the soot load. Engine speed returns to idle when the stationary regeneration is complete.

If stationary regeneration is attempted and all of the conditions are not met, the DPF lamp does not turn off. Engine speed does not increase.

Middle Position

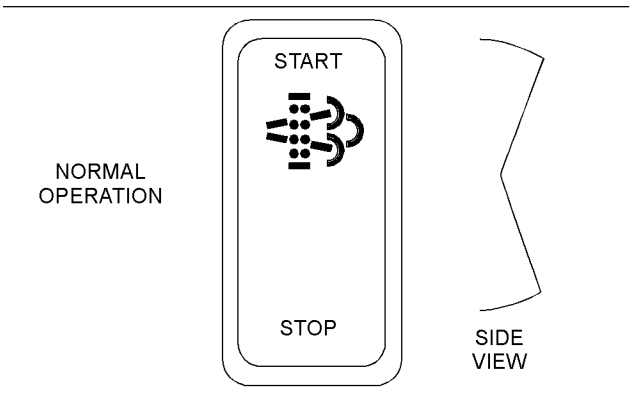


Illustration 30 g01356907

This position is for normal operation. The engine aftertreatment system operates automatically. Active regeneration occurs according to engine operating conditions.

Bottom Position

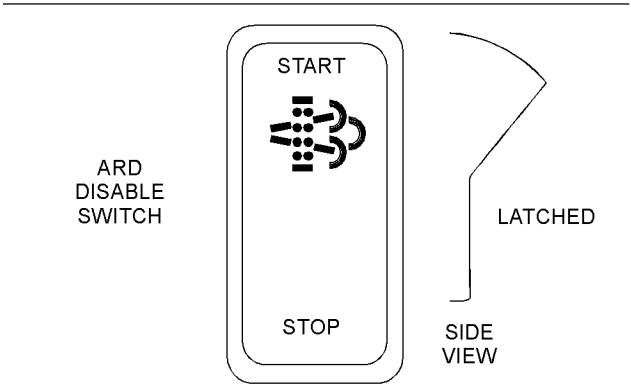


Illustration 31 g01356909

This position disables the engine aftertreatment system. This position must only be used for special circumstances.

Use this position only for a short period of time. Soot load increases as engine operation continues. Engine power is reduced as the soot load increases.

The DPF lamp flashes once per second when this switch is activated.

Two Switches

ARD Force Switch – This switch is a momentary contact switch that provides the same functionality as the top position of the single switch. The ECM ignores this switch if the ARD disable switch is activated.

ARD Disable Switch – This switch is an on/off switch that provides the same functionality as the bottom position of the single switch.

System Response as Soot Load Increases

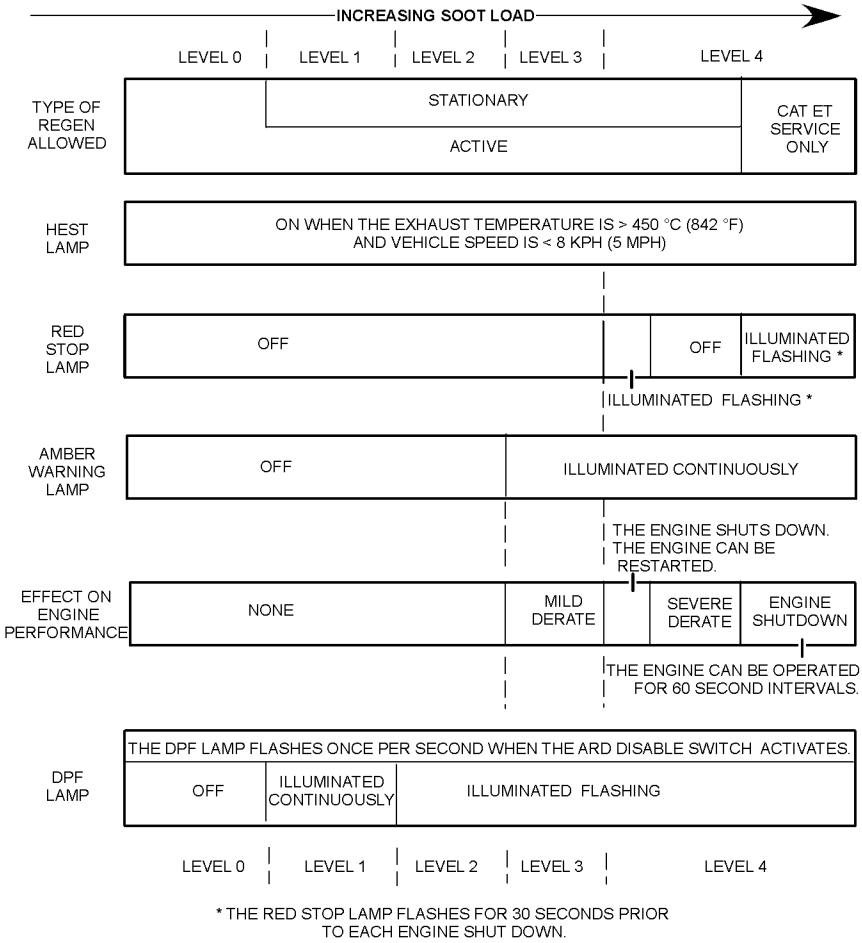
The programming of the “ARD Programmable Regeneration Monitoring System Status” parameter determines the system response as the soot load increases.

If the ARD is not functioning correctly, the amber warning lamp will be illuminated and the DPF lamp will be illuminated. Also, an active regeneration may not occur due to the following conditions:

- Less than one hour has passed since the last completed active regeneration.
- The engine is not at the normal operating temperature.

Illustration 32 describes the system's response when the "ARD Programmable Regeneration Monitoring System Status" parameter is programmed to "SHUTDOWN".

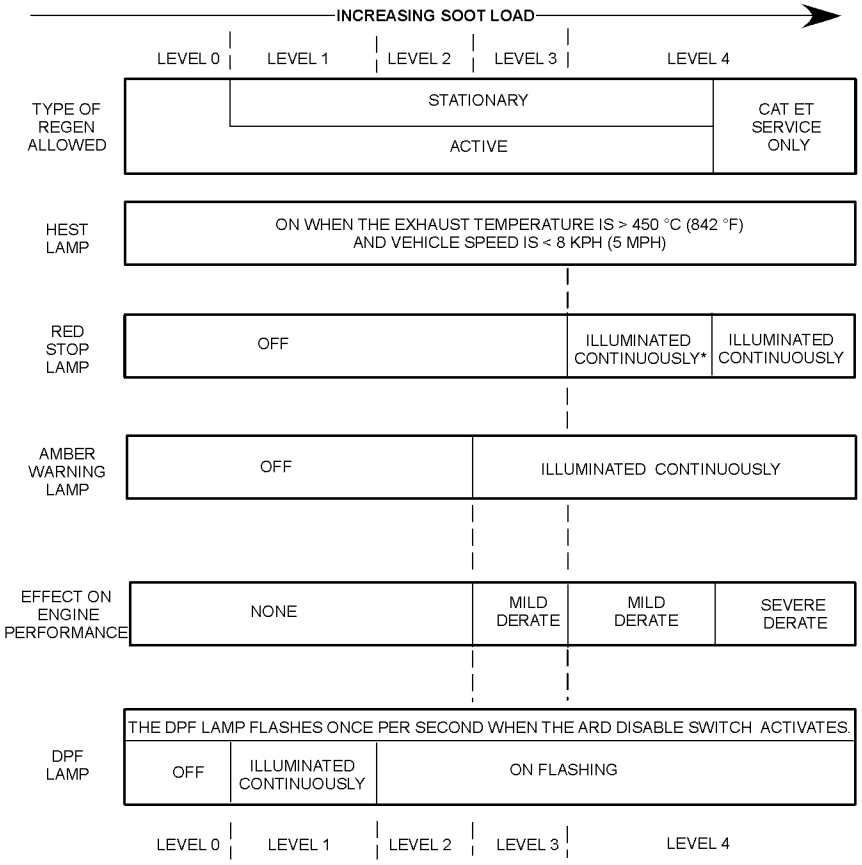
Illustration 33 describes the system's response when the "ARD Programmable Regeneration Monitoring System Status" parameter is programmed to "DERATE".



g01356896

Illustration 32

This figure details the system operation when the “ARD Programmable Regeneration Monitoring System Status” parameter is programmed to “SHUTDOWN”.



g01356898

Illustration 33

This figure details the system operation when the “ARD Programmable Regeneration Monitoring System Status” parameter is programmed to “DERATE”.

i02608348

Monitoring System

SMCS Code: 1900; 7400; 7402; 7450; 7451

⚠ WARNING

If the shutdown mode has been selected and the red stop lamp activates, engine shutdown may take as little as 20 seconds from the time the red stop lamp is activated. Depending on the application, special precautions should be taken to avoid personal injury. The engine can be restarted following shutdown for emergency maneuvers, if necessary.

NOTICE

The Engine Monitoring System is not a guarantee against catastrophic failures. Programmed delays and derate schedules are designed to minimize false alarms and provide time for the operator to stop the engine.

Programmable features monitor the following conditions:

- Coolant temperature
- Oil pressure
- Inlet manifold air temperature
- Cooling system level

Coolant Level Sensor

The system can be programmed with one of the following options:

"ENABLED" – The system will monitor the input from the coolant level sensor. The system is programmed to this value when the engine is shipped by Caterpillar.

"DISABLED" – The system will not monitor the input from the coolant level sensor.

Programmable Options and Systems Operation

WARNING

If the Warning/Derate/Shutdown mode has been selected and the warning indicator activates, bring the engine to a stop whenever possible. Depending on the application, special precautions should be taken to avoid personal injury.

The engine can be programmed to the following modes:

- “Warning”
- “Derate”
- “Shutdown”

“Warning”

The amber warning lamp and the red stop lamp illuminate and the warning signal is activated continuously in order to alert the operator that one or more of the engine parameters is not within normal operating range.

“Derate”

The amber warning lamp and the red stop lamp illuminate. After the warning, the engine will derate rpm and power. The red stop lamp will begin to flash when the derating occurs.

When the engine is fully derated, the engine power is limited to 120 kW (160 hp). During a low oil pressure condition, the engine can be limited to 1350 rpm.

“Shutdown”

The amber warning lamp and the red stop lamp illuminate. After the warning, the engine will derate rpm and power. The engine will continue to derate rpm until a shutdown of the engine occurs. The engine can be restarted after a shutdown for use in an emergency.

A shutdown of the engine may occur in as little as 20 seconds. The engine can be restarted after a shutdown for use in an emergency. However, the cause of the initial shutdown may still exist. The engine may shut down again in as little as 20 seconds.

If there is a signal for coolant loss, there will be a 10 second delay in order to verify the condition. The system will derate the engine rpm for 40 seconds before the engine will shut down if the engine has been programmed to shut down.

If there is a signal for low oil pressure or for coolant temperature, there will be a two second delay in order to verify the condition. The system will derate the engine rpm for 30 seconds before the engine will shut down if the engine has been programmed to shutdown.

For more information or assistance for repairs, consult your Caterpillar dealer.

Note: The Customer Specified Parameters may be secured by customer passwords. The engine may have all of the parameters that are programmed or any combination of the parameters that are programmed. Refer to the Operation and Maintenance Manual, “Customer Specified Parameters” topic (Product Information Section) for more information on the programmed parameters of the engine. Refer to the Electronic Troubleshooting for more information.

Engine Diagnostics

i02608560

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 amber warning 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 Caterpillar electronic service tools.

Note: The amber warning 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.

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.

i02610528

Diagnostic Lamp

SMCS Code: 1000; 1900; 1901; 1902; 7451

When the ignition switch is first turned on, the amber warning lamp will go through the following procedure:

- The amber warning lamp will illuminate for five seconds.
- The amber warning lamp will turn off.

Whenever the Engine Control Module (ECM) detects an active fault or condition the lamp will illuminate. If the lamp turns on and if the lamp stays on after initial start-up, the ECM has detected a system problem.

The amber warning lamp is also used for the Idle Shutdown Timer. The lamp will start to flash at a rapid rate 90 seconds before the programmed idle time expires. The engine will shut down after the 90 second interval. To disable the Idle Shutdown Timer, the “ALLOW IDLE SHUTDOWN OVERRIDE” must be programmed to “YES”. The clutch pedal or the service brake pedal must be depressed during the final 90 seconds while the amber warning lamp is flashing. A diagnostic “EVENT” code or Override of the Idle Shutdown Timer will be logged in the ECM.

i01174828

ECM Snapshot

SMCS Code: 1901

The ECM can record a snapshot of the engine parameters and vehicle parameters. The snapshot records the parameters for a period of 13 seconds that surrounds the event, 9 seconds before the trigger and 4 seconds after the trigger. A technician can use a service tool in order to view this snapshot information.

Triggering Snapshot Information

An operator can aid in the troubleshooting of intermittent problems by taking a “snapshot” when the problem is experienced. A snapshot can be triggered by using the Cruise Control Set/Resume Switch. Use the following procedure in order to perform this function:

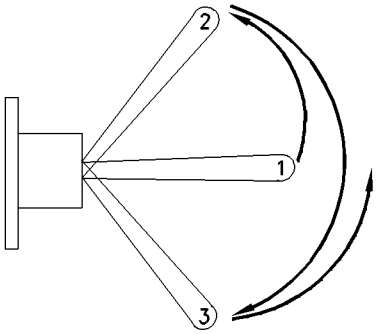


Illustration 34 g00627693

(1) OFF position
(2) SET position
(3) RESUME position

1. Toggle the switch quickly from the OFF position (1) to the SET position (2).

2. Toggle the switch quickly from the SET position (2) to the RESUME position (3).

3. Toggle the switch quickly from the RESUME position (3) back to the OFF position (1).

Note: The switch must be toggled within a one second time period in order to take a snapshot of the engine parameters. The procedure can also be performed in the reverse order.

Storage of Snapshots In the ECM

The ECM can store a maximum of four snapshots that are triggered manually. The newest snapshot will replace the oldest snapshot if a fifth snapshot that is triggered manually is taken.

Snapshots are automatically cleared by the ECM after 100 hours of operation. Also, the snapshots can be cleared manually by using an Electronic Service Tool.

i02610237

Fault Logging

SMCS Code: 1000; 1900; 1901; 1902

The system provides the capability of Fault Logging. When the Engine 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.

i02610250

Engine Operation with Active Diagnostic Codes

SMCS Code: 1000; 1900; 1901; 1902

If the amber warning lamp illuminates during normal engine operation, the system has identified a situation that is not within the specification. Use Caterpillar electronic service tools to check the active diagnostic codes.

Note: If the customer has selected “DERATE” and if there is a low oil pressure condition, the Electronic Control Module (ECM) will limit the engine power until the problem is corrected. The customer may select a shut down mode. The shut down mode will shut down the engine for three conditions: low oil pressure, high coolant temperature, and low coolant level. If the oil pressure is within the normal range, the engine may be operated at the rated speed and load. However, maintenance should be performed as soon as possible.

The active diagnostic code should be investigated. The cause of the problem should be corrected as soon as possible. If the cause of the active diagnostic code is repaired and there is only one active diagnostic code, the amber warning lamp will turn off.

Refer to the Troubleshooting Manual for more information on the relationship between these active diagnostic codes and engine performance.

i02610451

Engine Operation with Intermittent Diagnostic Codes

SMCS Code: 1000; 1900; 1901; 1902

If the amber warning lamp illuminates during normal engine operation and the amber warning lamp shuts off, an intermittent fault may have occurred. If a fault has occurred, the fault will be logged into the memory of the Electronic Control Module (ECM).

In most cases, it is not necessary to stop the engine because of an intermittent code. However, the operator should retrieve the logged fault codes and the operator should reference the appropriate information in order to identify the nature of the event. The operator should log any observation that could have caused the lamp to light. Examples of such conditions are low power or limits of the engine speed.

This information can be useful to help troubleshoot the situation. The information can also be used for future reference. For more information on diagnostic codes, refer to the Troubleshooting Guide for this engine.

i01563987

Customer Specified Parameters

SMCS Code: 1000; 1900; 1901; 1902

Customer specified parameters that will enhance the fuel efficiency and the operator's convenience can be programmed into the Electronic Control Module (ECM). Some parameters may affect engine operation. This may lead to complaints from the operator about power or about performance. Certain engine parameters may be programmed by the customer by using Caterpillar electronic service tools in order to influence the operation of the engine:

The customer specified parameters can be changed as often as needed. Password protection is provided so that the customer can change the parameters. The customer can authorize someone else to change the parameters. Ensure that a record of the parameters is kept in the Operation and Maintenance Manual, "Customer Specified Parameters" (Product Information Section). For detailed instructions on programming the engine for optimum performance and for optimum fuel economy, consult your Caterpillar dealer.

Engine Starting

i02610552

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.

Under-the-Hood Inspection

Perform the required daily maintenance and other periodic maintenance before you start the engine. Inspect the engine compartment. This inspection can help prevent major repairs at a later date. Refer to the Operation and Maintenance Manual, “Walk-Around Inspection” topic (Maintenance Section) for more information.

- For the maximum service life of the engine, make a thorough inspection before you start 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.

- Do not start the engine or do not 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 all of the shutoffs 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. Observe the coolant level in the coolant recovery tank (if equipped). Maintain the coolant level to the “FULL” mark on the coolant recovery tank.
- If the engine is not equipped with a coolant recovery tank maintain the coolant level within 13 mm (.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 (if equipped). Service the air cleaner when the yellow diaphragm enters the red zone, or when the red piston locks in the visible position.
- Ensure that any driven equipment has been disengaged. Remove any electrical loads.
- Inspect the exhaust system.

- Ensure that the J1939 datalink has been disconnected.

Cold Weather Starting

Starting the engine and operation in cold weather is dependent on the type of fuel that is used, the oil viscosity, and other optional starting aids. For more information, refer to the Operation and Maintenance Manual, “Cold Weather Operation” topic (Operation Section).

The engine should be operated at low rpm and low power demand until the engine reaches normal operating temperature. The engine will reach normal operating temperature faster when the engine is operated at low rpm and low power demand instead of idling the engine until the engine reaches normal operating temperature.

Air Inlet Heater

⚠ WARNING

DO NOT USE ETHER (starting fluids) unless specifically instructed to do so. If the engine is equipped with an Air Inlet Heater (electrically or fuel ignited manifold heater), DO NOT use ether (starting fluids) at any time. The use could result in engine damage and/or personal injury.

Note: There will be an indicator lamp on the dashboard of the vehicle that is marked “AIR INLET HEATER”.

For detailed information on the operation of the Air Inlet Heater, refer to System Operation, “Air Inlet and Exhaust”.

Use the following procedure in order to start the engine:

1. Engage the parking brake. Place the transmission in NEUTRAL. If the vehicle is equipped with a manual transmission, depress the clutch pedal in order to disengage the flywheel clutch. This reduces transmission drag and this prevents movement of the vehicle. Depressing the clutch helps to reduce the battery drain. In cold weather, this can mean the difference between starting the engine and not starting the engine.

2. Turn the keyswitch to the ON position. The air inlet heater may preheat the system in order to improve cold weather starting.

Note: The “AIR INLET HEATER” indicator lamp will flash for a minimum of two seconds regardless of the coolant temperature. If the “AIR INLET HEATER” indicator lamp flashes for more than two seconds, wait until the indicator lamp stops flashing (approximately 30 seconds) before attempting to start the engine. If the indicator lamp continues to flash, the ECM will control the air inlet heater during a restart of the engine. Restarting the engine at this point can cause excessive white smoke.

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. Turn the keyswitch to the START position in order to crank the engine. The air inlet heater will turn ON if the sum of the coolant temperature and the inlet air temperature is less than 25 °C (77 °F). Do not push the throttle or do not hold the throttle downward while the engine is cranked. The system will automatically provide the correct amount of fuel in order to start the engine. If the engine does not start after 15 to 20 seconds of cranking, release the keyswitch. If the sum of the coolant temperature and the inlet air temperature is less than 25 °C (77 °F), the preheat for the air inlet heater will restart. Turn the keyswitch to the OFF position. Allow the starting motor to cool for two minutes. Repeat Steps 2 and 3.

NOTICE

Oil pressure should rise within 15 seconds after the engine starts. Do not increase engine speed 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.

4. Release the keyswitch to the ON or RUN position immediately after the engine starts. After the engine starts, check in order to ensure that the transmission is still in the NEUTRAL position and release the clutch pedal (manual transmission). Once a normal engine oil pressure and air pressure are reached, the vehicle may be operated at a light load and speed.

After the engine has started, the air inlet heater may continue to operate in a “Continuous” mode and/or in an “Intermittent” mode. The air inlet heater will turn OFF when the sum of the coolant temperature and the air inlet temperature exceeds 35 °C (95 °F).

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. This will warm up the engine more quickly. Do not exceed the recommended rpm in order to increase the speed of the warm-up. Limit unnecessary idle time to ten 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 in order to start the engine.

Problems with the Wiring Harness

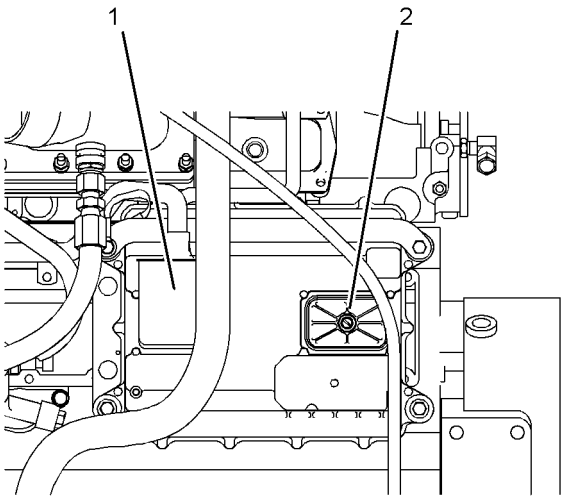


Illustration 35 g01075737

(1) Engine harness
(2) Connection for the chassis harness (vehicle OEM)

Locate the ECM. Two harness connectors are attached to the ECM. One connector is engine harness (1) and the other connector is the chassis harness. Check the connectors in order to ensure that the connectors are 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 in order to ensure that the wire is secure.

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

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Starting with Jump Start Cables

SMCS Code: 1000; 1401; 1402; 1900

WARNING

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

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

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

For information on troubleshooting the charging system, refer to Special Instruction, REHS0354, “Charging System Troubleshooting”.

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

NOTICE

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

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

When using an external electrical source to start the engine, turn the 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 the OFF position. 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.

Engine Operation

i02718375

Engine Operation

SMCS Code: 1000

Proper operation, driving techniques and maintenance are key factors in obtaining the maximum service life and economy of Caterpillar engines. The recommendations in this Operation and Maintenance Manual will help to lower operating costs. For more information, refer to Special Publication, LEDT2254, “CAT Answers Your Questions About Truck Performance” or consult your Caterpillar dealer.

Idling

Idle speed is adjustable on Caterpillar electronic engines. Consult your Caterpillar dealer for information. The idle rpm is preset between 600 and 700 rpm.

Avoid excess idling. An engine can burn from 2.8 L (0.7 US gal) to 5.7 L (1.5 US gal) of fuel per hour while the engine is idling. Excessive idling causes carbon buildup, engine slobber, and soot loading of the diesel particulate filter (DPF). This is harmful to the engine.

If extended idle time is required, control the engine rpm to 1000 rpm or above 1000 rpm. Ensure that the coolant temperature exceeds 82° C (180° F). Consult your Caterpillar dealer for assistance.

Fast idle can be programmed within the range of 700 rpm to the top engine limit. Fast idle requires an “ON/OFF” switch on the dashboard. Consult your Caterpillar dealer for assistance.

Idle Shutdown Timer

The idle shutdown timer can be programmed in order to shut down the engine after a specific time period of idling. The idle time can be programmed from three minutes to 1440 minutes (24 hours). If the idle shutdown timer is set to 0 minutes, the idle shutdown feature is disabled. If the setting of the timer is unknown, allow the engine to idle. Observe the time that elapses before the engine shuts down. The following conditions must be met in order to activate the idle shutdown timer:

- The idle shutdown feature must be selected.
- No vehicle speed is detected by the Electronic Control Module (ECM).
- The engine is not under load.
- The engine is at operating temperature.

After the vehicle is stationary, the idle shutdown timer begins. The engine can be operating at low idle or at an idle rpm that is selected by the idle governor. The “CHECK ENGINE/DIAGNOSTIC” lamp will flash rapidly for 90 seconds prior to shutdown. Movement of the vehicle automatically resets the idle shutdown timer to the programmed setting.

The following conditions must be met in order to override the idle shutdown timer:

1. Program the “ALLOW IDLE SHUTDOWN OVERRIDE” to “YES”.
2. The “CHECK ENGINE/DIAGNOSTIC” lamp will flash rapidly for 90 seconds prior to shutdown. Depress the service brake or the clutch pedal during the 90 seconds when the “CHECK ENGINE/DIAGNOSTIC” lamp flashes.

After an idle shutdown, the engine can be restarted without turning the ignition switch to the OFF position.

The override function is disabled if the “ALLOW IDLE SHUTDOWN OVERRIDE” is programmed to “NO”.

Getting Started

Caterpillar electronic engines do not require long warm-up periods that needlessly waste fuel. Typically, the engine should be at normal operating temperature in a few minutes. Begin operating the engine at low load. After normal oil pressure is reached and the temperature gauges begin to rise, the engine may be operated at full load.

To get the vehicle in motion, use a gear that will result in a smooth start. Move the load without increasing the engine rpm above low idle or without slipping the clutch. Engage the clutch smoothly. Slipping the clutch and engaging the clutch can cause stress to occur on the drive train. This can also cause fuel to be wasted.

Use progressive shifting techniques. Progressive shifting is using only the rpm that is required in order to upshift into the next gear. Progressive shifting improves fuel economy.

- Keep the engine rpm to a minimum. Use an rpm that is from 1200 to 1600 rpm.
- Use only enough rpm to pick up the next gear.

Progressive shifting also reduces the acceleration rate. Top gear is reached sooner because less time is needed to synchronize the gears during shifting. In addition, the engine is operating at the highest range of torque.

The amount of rpm that is required to upshift increases as the vehicle speed increases, unless upshifts are made on upgrades. Experience with the vehicle will show the amount of rpm that is required to upshift under various conditions.

Note: These engines may be programmed to encourage progressive shifting. The acceleration rate may slow down at certain rpm in lower gears. If this occurs, progressive shift parameters may have been programmed into the ECM. Progressive shift parameters will limit the rpm when the vehicle is driven in higher gears. These parameters may be protected by customer passwords. If the vehicle can be operated in a higher gear at a vehicle speed that is desired, select the highest gear that is available to pull the load. This recommendation will help to obtain fuel economy. The engine will be operating at the lowest rpm that is required to pull the load.

Vehicle Efficiency

An efficient vehicle performs the desired amount of work while the power demand on the engine is minimized. The following factors are major contributors to power demand:

- Aerodynamic drag (wind resistance)
- Rolling resistance of the tires
- Gross weight of the vehicle
- Losses in the drive train and the load from the engine driven accessories

For more information about vehicle efficiency, refer to Special Publication, LEDT2254, “CAT Answers Your Questions About Truck Performance”.

Fuel Economy

Fuel is the largest single operating cost of today’s on-highway vehicle engines. Improved fuel economy can have a substantial impact on operating profit. The following items are the most significant factors that influence vehicle fuel economy:

- Driver techniques
- Vehicle efficiency
- Operating conditions
- Engine efficiency

A No. 1 grade of fuel contains less energy per volume and increases fuel consumption. A greater volume of fuel must be injected in order to yield the same amount of work as a No. 2 fuel. The difference in the fuel economy between the two grades of fuel can be as great as 0.2 km/L (0.5 mpg) to 0.3 km/L (0.7 mpg). Refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” for information about the Ultralow Sulfur Diesel fuel (ULSD) that is required for this engine.

For more information about fuel economy, refer to Special Publication, LEDT2254, “CAT Answers Your Questions About Truck Performance”.

Rolling hills provide a great opportunity to reduce fuel consumption. Avoid downshifting on small hills. The vehicle should not be downshifted even if the engine must be lugged down to an rpm that is below the peak torque rpm. When the vehicle is going down a hill, use gravity instead of the engine’s power to regain vehicle speed.

On grades that require more than one downshift, allow the engine to lug to peak torque rpm. If the engine is running at peak torque rpm or above peak torque rpm and the rpm stabilizes, remain in that gear.

Long steep down grades should be anticipated. Reduce the speed of the vehicles before you crest the top of a hill and before you proceed down a long, steep grade. Minimize the amount of braking that is used in order to maintain a safe speed for maximizing fuel efficiency.

The engine's ability to hold the vehicle back increases with engine rpm. Select a gear that runs the engine near the high engine rpm limit for long steep hills when braking is required.

Speed reductions and future stops should be anticipated. Downshifts should be avoided. The amount of braking should be minimized in order to improve fuel consumption. By coasting to a stop, a vehicle can travel a considerable distance without consuming any fuel.

Cruising

Vehicles that are driven faster consume more fuel. Increasing the cruising speed from 88 km/h (55 mph) to 104 km/h (65 mph) will increase the fuel consumption of a typical Class 8 vehicle by approximately 0.4 km/L (1 mpg). When a vehicle is driven fast in order to allow more time for stops, the stops become very expensive. Cruising allows the engine to operate in the most efficient rpm range (1100 to 1500 rpm).

Cruise Control

The functionality of the cruise control can vary depending on the vehicle manufacturer. The cruise control switch may be programmed to operate in one of two modes:

- The SET position may operate as the SET/ACCEL SWITCH position or the SET/DECEL position.
- The RESUME position may operate as the RESUME/DECEL position or the RESUME/ACCEL position.

Refer to the markings on the Cruise Control switch or refer to your "Truck Service Manual".

Perform the following steps in order to set the Cruise Control:

1. After accelerating to the desired speed, turn the "ON/OFF" switch to the ON position.
2. Press the "SET/RESUME" switch to the SET position.

The ECM will control the vehicle speed until the clutch pedal or the service brake is depressed or the "ON/OFF" switch is turned to the OFF position.

Note: The vehicle can also be accelerated to the desired speed and the cruise control speed can be set by pressing the “SET/RESUME” switch to the ACCEL position.

Perform the following step in order to reset the cruise control:

1. Press “RESUME” and the vehicle will return to the set speed.

   Momentarily pressing or bumping the “SET/RESUME” switch to the ACCEL position will increase vehicle speed by one mph. Press the switch to the DECEL position in order to decrease the speed by one mph. The operating range of the cruise control has been programmed into the ECM.

Soft Cruise Control

The cruise control can be programmed to operate in one of two modes, “Soft Cruise = YES” or “Soft Cruise = NO”.

Soft cruise control provides an operating range of 8 km/h (5 mph) around the setting for the cruise control. Engines that are shipped from Caterpillar are programmed to operate in the “Soft Cruise = YES” mode. Soft cruise Control allows the vehicle to accelerate slightly while the engine is under power. The vehicle can proceed down a hill while momentum is gained for the next hill. Improved fuel economy can be gained in this mode.

When “Soft Cruise = NO” is programmed, the “SET” speed is maintained. Consult your Caterpillar dealer for more information.

Idle Mode

The cruise control function of the electronic engine works as an engine speed governor when the vehicle is stationary or when the vehicle is operated at a vehicle speed below the idle vehicle speed limit. The engine speed governor is activated and deactivated in the same way as the cruise control.

The engine speed governor will operate at any engine rpm from low idle to the maximum idle rpm limit. The maximum idle rpm limit is actually less than the rated engine rpm. The maximum idle governor speed is a Customer Specified Parameter.

Perform the following procedure in order to activate idle mode:

1. Set the “ON/OFF” switch to the ON position. The throttle can then be used to determine the desired engine rpm.

2. When the desired engine rpm is reached, place the “SET/RESUME” switch to the SET position and release the switch. The engine rpm will be maintained at this speed.

Note: If the “SET/RESUME” switch is held for more than one second in the ACCEL position, the ECM will increase the engine rpm until the “SET/RESUME” switch is released. If the parameter is programmed, the ECM will increase the engine rpm up to the idle engine rpm limit, or to the top engine limit (TEL).

Perform one of the following procedures in order to disengage the idle mode:

- Move the “Cruise/Idle ON/OFF” switch to the OFF position.
- Depress the clutch pedal.
- Depress the service brake pedal.

Perform the following procedure in order to resume the idle mode:

1. Ensure that the “Cruise/Idle ON/OFF” switch is in the ON position.

2. Move the “SET/RESUME” switch momentarily to the RESUME position.

Note: If the “SET/RESUME” switch is held for more than one second in the DECEL position, the ECM will decrease the engine rpm until the switch is released. A new set rpm is established when the switch is released.

Uphill Operation

For optimum performance of the engine, lug down the engine between 1100 rpm and 1200 rpm, before the transmission is downshifted. Continue to downshift in this manner until you reach a gear that maintains the desired speed. Continue to operate the engine at 1100 rpm to 1200 rpm if the vehicle will crest the top of the hill without a downshift in the transmission. Begin upshifting as the grade of the hill decreases and the engine begins to accelerate above 1600 rpm. Driving this way will provide optimum fuel economy and performance.

Note: Allowing the engine to lug below peak torque is permissible if the vehicle is cresting the top of a hill. However, extended operation at engine speeds below peak torque (1200 rpm) will raise the exhaust temperature and the cylinder pressure. This can lead to reduced engine service life.

Downhill Operation

NOTICE
Do not exceed 2300 rpm in any situation or 2100 rpm if equipped with an auxiliary engine brake system.

On downgrades, do not coast while the clutch pedal is depressed. Do not coast with the transmission in neutral. If no engine power is needed, disengage the Cruise Control.

Select the correct gear that does not allow the engine speed (rpm) to exceed 2300 rpm. If equipped, use the auxiliary brake in order to control the speed of the vehicle. Usually, the same gear that would be used to go up a hill can be used to go down the hill. Refer to the rated rpm that is on the engine information plate.

Reduction of Particulate Emissions

The diesel particulate filter(DPF) and the aftertreatment regeneration device (ARD) work together in order to reduce particulate emissions. The DPF collects the soot and the engine oil in the exhaust. The DPF converts the soot into a gas which is released into the atmosphere. The DPF converts the engine oil into ash. Ash from the engine oil remains in the DPF until the ash is cleaned out of the DPF. This process is called regeneration.

The temperature of the DPF must be above a particular value in order for regeneration to occur. The exhaust gas provides heat for the regeneration process. There are two types of regeneration:

Passive Regeneration – The engine provides sufficient exhaust gas temperature for regeneration.

Active Regeneration – The engine's duty cycle does not provide sufficient exhaust temperature for passive regeneration. The ARD operates in order to raise the temperature of the exhaust gas. When the regeneration process is complete, the ARD turns off.

The driver will receive information on the status of the ARD from dash lamps and the driver will be able to request a regeneration through the use of a switch. Refer to this Operation and Maintenance Manual, “Monitoring System” for more information.

Eaton Top 2 Transmission

Note: The following information is applicable to engines with the EatonTop 2 transmission.

The ECM controls the shifting of the two highest gears of the transmission. A downshift of one gear from the top gear will occur automatically. The downshift will occur when the load that is on the engine increases. An example of an increasing load would be climbing a hill.

The throttle activated downshift is available in order to provide the operator with additional control of the gears for the Eaton Top 2 transmission. The throttle activated downshift enables the operator to downshift faster than the automatic downshift.

Throttle Activated Downshift

The throttle activated downshift enables the operator to downshift easily. It is useful for passing or for climbing hills. The following conditions must be met in order for the throttle activated downshift to be used:

- The transmission is in the top gear.
- The engine rpm is below 1350 rpm for transmissions with ten speeds forward.
- The engine rpm is below 1450 rpm for transmissions with thirteen speeds forward.
- The engine rpm is below 1450 rpm for transmissions with eighteen speeds forward.

Downshifting One Gear From the Top Gear

In order to downshift one gear from the top gear, the following steps must be performed:

1. Release foot from the throttle pedal.

2. Fully depress the throttle pedal to the floor in order to provide full throttle.

To allow synchronization of the downshift, the engine rpm may increase by 400 rpm.

Upshifting To The Top Gear From One Gear Below The Top Gear

The transmission can be shifted to the top gear when the transmission is one gear from the top gear. In order to upshift to the top gear, slightly release the throttle from the full throttle position.

If the throttle is not slightly released, the transmission will automatically upshift to the top gear when the engine rpm reaches one of the following limits:

- 40 rpm below the programmed top engine Limit
- 40 rpm below the programmed gear down protection limit

Preventing Downshifting One Gear From the Top Gear

In order to prevent downshifting one gear from the top gear, do not release the throttle pedal and then provide full throttle.

If the conditions are met and the Throttle Activated Downshift is not desired, do not release the throttle and then provide full throttle. Continue driving the vehicle. A downshift of one gear from the top gear will occur automatically. The downshift will occur when the load that is on the engine increases. An example of an increasing load would be climbing a hill.

Refer to the Eaton, “Driver Instructions” for more information on the Eaton Top 2 transmission.

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Compression Brake (If Equipped)

SMCS Code: 1119; 1129

Compression Brake Controls

Read the following information in order to become familiar with the compression brake controls that are in the vehicle.

The compression brake controls may vary slightly depending on the design of the vehicle cab. The basic operation of the compression brake does not change if the switches are in a different location.

Standard Operator Controls

ON/OFF Switch – This switch activates the system for the compression brake.

Progressive Braking Switch – This switch allows various settings for different conditions.

LOW Setting – This switch position will activate the braking function on two cylinders. This setting will provide approximately one-third of the total available braking horsepower. This setting is typically used on flat roads when light loads are hauled.

MED Setting – This switch position will activate the braking function on four cylinders. This setting will provide approximately two-thirds of the total available braking horsepower. This setting is typically used when the LOW setting is not adequate in order to provide the desired braking horsepower.

HIGH Setting – This switch position will activate the braking function on all six cylinders. This setting will provide full braking horsepower. This setting is typically used on downhill grades or the setting is used when heavy loads are involved. Use this setting only when there is good traction.

In addition to the switch controls that were previously discussed, other switches are available. A control switch exists for the compression brake that is activated by the position of the clutch pedal. There is also a switch that is activated by the position of the accelerator pedal.

The function of the compression brake operates in much the same manner regardless of a manual transmission or an automatic transmission. However, some vehicles are equipped with autoshift transmissions. In this situation, the compression brake may actuate in order to help the transmission make an upshift. This feature is controlled automatically through the transmission control module. This automatic control can happen even if the compression brake switch is in the OFF position.

Additional system controls may temporarily interrupt the operation of the compression brake. These parameters vary by OEM, but the parameters may occur under the following conditions.

- Engine speed is below 1000 rpm.
- The vehicle slows to a preset speed.
- This may occur when the torque converter shifts out of lockup in vehicles with automatic transmissions. This is usually between 10 to 25 mph.

Compression Brake Operation

The information that is shown in the Operation and Maintenance Manual, “Auxiliary Engine Brakes” must be read and understood before proceeding to the following information.

Additional Guidelines

- Before descending a long grade or a steep grade, test the compression brake in order to ensure proper operation.
- **Never exceed a safe control speed.**
- Do not use the compression brake when the vehicle is “bobtailed”.
- Do not use the compression brake when an empty trailer is pulled on wet pavement or slippery pavement. This is particularly important if the vehicle has a single drive axle.
- Do not shift gears without using the clutch when the compression brake is turned on. Do not make a double clutch when the compression brake is activated. Power train damage may occur.

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Caterpillar Driver Information Display (Messenger)

SMCS Code: 7490

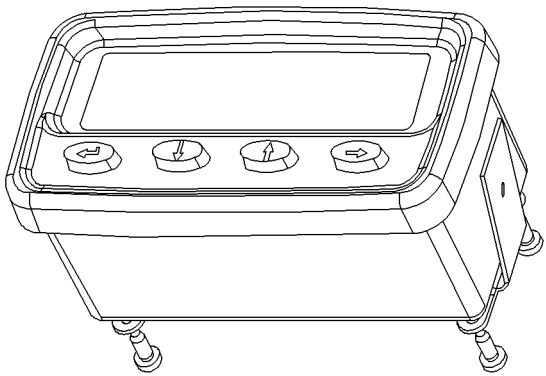

Illustration 36 g00916428

Messenger display

This display is intended to allow the driver to monitor the vehicle and engine information while the vehicle is being operated. The display may also display stored trip information. When possible, the driver should select the proper display screen before operating the vehicle.

Diagnostic Data

Engine diagnostic codes may be displayed for the driver. The Messenger display will automatically display potentially serious engine problems. When one of these codes appears, the driver should bring the vehicle to a safe stop. After the display of a serious diagnostic code, the engine may shut down within 20 seconds.

Engine Operating Information

The Messenger display provides information on cruise control set speed, PTO engine rpm set speed, fuel temperature to the engine, boost and oil pressure, coolant temperature, and intake manifold temperature.

Engine/Vehicle Information

The Messenger display provides the following information: the quantity of fuel that has been used, the fuel economy, the average vehicle speed, idle time, PTO time, percent idle hour, idle fuel, and PTO fuel. These parameters may relate to trip segments or to the engine history. A driver and a fleet trip segment is available. For the driver trip segment, the driver determines the start and stop points. For the fleet trip segment, the vehicle owner determines the start and stop points. The vehicle may be operated in separate states. The fleet trip segment may be tied to each of these states. The fleet trip segment may be split between two drivers and two ID codes.

Maintenance Information

The system has an oil and filter change indicator which allows the display to indicate when the next maintenance is due.

Theft Deterrent

Messenger provides the capability to allow the engine to start or the capability to prevent the engine from starting. The Messenger display can shut down the engine after entering a password with four characters into the display when the engine is at idle.

Adjustment to Fuel Correction Factor

Messenger provides the capability to adjust the fuel correction factor of the ECM.

Configuration of the Display

Messenger can provide information in either English, French, or Spanish. Units of measure can be displayed in English (miles per hour, US gallons, psi, and °F), English (miles per hour, Imperial gallons, psi, and °F), or Metric units (kilometer per hour, liters, kPa, and °C). The French or Spanish manuals may be ordered by contacting a Caterpillar dealer.

Entry of Driver ID

The Messenger display provides the capability to enter the ID of multiple drivers. This allows the ECM to log information for multiple drivers. This is useful in driving applications that involve several drivers.

State Crossing

Messenger allows the driver to enter the current state.

Access to Parameters

The availability of parameters is determined by the engine manufacturer, the model year of the engine, and the ECM settings for the customer programmable parameters.

Engine Stopping

i02612745

Stopping the Engine

SMCS Code: 1000; 7000

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.

Prior to stopping an engine that is being operated at low loads, operate the engine at low idle for 30 seconds before stopping. If the engine has been operating at highway speeds and/or at high loads, operate the engine at low idle for at least three minutes. This procedure will cause the internal engine temperature to be reduced and stabilized.

Ensure that the engine stopping procedure is understood. Stop the engine according to the shutoff system on the vehicle or refer to the instructions that are provided by the OEM of the vehicle.

- To stop the engine, turn the ignition keyswitch to the OFF position.

After Stopping the Engine

- 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. Use Ultra Low Sulfur Diesel (ULSD) fuel only.

NOTICE
Only use antifreeze/coolant mixtures recommended in the Refill Capacities and Recommendations topic that is in this Operation and Maintenance Manual. Failure to do so can cause engine damage.

- Allow the engine to cool. Check the coolant level. Maintain the cooling system at 13 mm (.5 inch) from the bottom of the pipe for filling.

- 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.

Cold Weather Operation

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Fuel Related Components in Cold Weather

SMCS Code: 1000; 1250

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 Filters

A primary fuel filter and/or a water separator is installed between the fuel tank and the engine mounted fuel filter. The location of the primary fuel filter is important in cold weather operation. The primary fuel filter and the fuel supply line are commonly affected by cold fuel. The best location for the primary fuel filter is in the engine compartment. Here, the primary fuel filter will benefit from the radiant heat of the engine. A primary fuel filter that is mounted outside the frame rails or in any location that is exposed to wind can be a persistent problem in cold weather.

Fuel Heaters

Fuel heaters help to prevent fuel filters from plugging in cold weather due to waxing. A fuel heater should be installed. The fuel should 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.

Maintenance Section

Refill Capacities

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Refill Capacities and Recommendations

SMCS Code: 1348; 1395; 7560

NOTICE
Every attempt is made to provide accurate, up to date information. By use of this document, you agree that Caterpillar Inc. is not responsible for errors or omissions. The recommendations provided are the latest recommendations for the Caterpillar 2007 model year On-highway Diesel Engines.

NOTICE
These recommendations are subject to change without prior notice. Contact your Caterpillar dealer for the most up to date recommendations.

Note: Instructions for the installation of the filter are printed on the side of each Caterpillar spin-on filter. For filters that are not Caterpillar filters, refer to the installation instructions that are provided by the supplier of the filter.

Diesel Engine Oil

Cat DEO-ULS (Diesel Engine Oil-Ultra Low Sulfur)

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

Cat DEO-ULS is available in SAE 15W-40 viscosity grade.

Cat DEO-ULS is formulated with the correct amounts of detergents, dispersants, and alkalinity in order to provide superior performance in Caterpillar On-highway Diesel Engines.

Cat DEO-ULS has been tested and approved by Caterpillar. Using Cat DEO-ULS and following the directions of Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluid Recommendations” ensures the following results:

- Optimum engine life
- Optimum engine performance

Refer to Special Instruction, PEHJ0159, “DEO-ULS Data Sheet” for additional details.

Consult your Caterpillar dealer for part numbers and for available sizes of containers.

Note: Cat DEO-ULS multigrade exceeds the requirements of the Cat ECF-1-a, Cat ECF-2, and Cat ECF-3 specifications. Cat DEO-ULS multigrade exceeds the performance requirements for the following API oil categories: API CJ-4, API CI-4, API CI-4 PLUS, API CH-4, API CG-4, and API CF.

Commercial Oils

Note: Non-Caterpillar commercial oils are second choice oils.

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

Note: If Cat DEO-ULS is not used, Caterpillar strongly recommends the use of commercial oils that meet the following categories and/or specifications:

- Caterpillar ECF-3 specification
- API CJ-4 category

NOTICE

The Caterpillar ECF-3 specification was developed in order to protect 2007 model year and newer on-highway diesel engines that are designed to use fuels with 15 ppm sulfur. Oils that meet the Caterpillar ECF-3 specification are designed with the following objectives: protection of the emissions control systems, compliance with the emissions standards, reduction of engine wear, reduction of piston deposits, and reduction of oil consumption. Oils that meets the API CJ-4 standard are Caterpillar ECF-3 compliant.

Oils that have not met the performance requirements of the Caterpillar ECF-3 specification and/or the performance requirements for the API CJ-4 oil category may cause reduced engine life, more frequent cleaning of the diesel particulate filter (DPF) , and reduced life of the DPF.

NOTICE

Failure to follow these oil recommendations can cause shortened engine service life due to deposits and/or excessive wear.

Note: Note: Refer to the latest edition of Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluids Recommendations” for additional information. Contact your Caterpillar dealer in order to confirm that you have the newest recommendations for fluids.

Lubricant Viscosity Recommendations

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

Refer to Table 3 (minimum temperature) in order to determine the required oil viscosity for starting a cold engine.

Refer to Table 3 (maximum temperature) in order to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

NOTICE

In selecting oil for any engine application, both the oil viscosity and oil performance category/specification as specified by the engine manufacturer must be defined and satisfied. Using only one of these parameters will not sufficiently define oil for an engine application.

Table 3

Engine Oil Viscosities for Ambient Temperatures		
	Ambient Temperature	
Viscosity Grade	Minimum	Maximum
SAE 0W-30	−40 °C (−40 °F)	30 °C (86 °F)
SAE 0W-40	−40 °C (−40 °F)	40 °C (104 °F)
SAE 5W-30	−30 °C (−22 °F)	30 °C (86 °F)
SAE 5W-40	−30 °C (−22 °F)	50 °C (122 °F)
SAE 10W-30	−18 °C (0 °F)	40 °C (104 °F)
SAE 10W-40	−18 °C (0 °F)	50 °C (122 °F)
SAE 15W-40	−9.5 °C (15 °F)	50 °C (122 °F)

Note: Supplemental heat is recommended below the minimum recommended ambient temperature.

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 condition of the lubricated compartment. 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 Caterpillar 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, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluids Recommendations” in order to obtain additional information about S·O·S Services oil analysis. You can also contact your local Caterpillar dealer in order to obtain additional information about the S·O·S Services oil analysis program.

Refill Capacities (Engine Oil)

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 additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.

Table 4

Approximate Refill Capacities of the Engine Lubrication System				
Compartment or System	C13 with Front or Rear Sump and 2 Filters	C13 with Front or Rear Sump and 1 Filter	C13 with Center Sump	C15
Approximate sump capacity of the crankcase includes standard oil filters that are factory installed. (1)	38.5 L (41 qt)	36.5 L (38.5 qt)	32.5 L (34 qt)	38.5 L (41 qt)
Capacity of the Auxiliary Oil Filter System(2)				
Total Capacity of the Lubrication System(3)				

(1) Engines with auxiliary oil filters will require additional oil. Optional bypass oil filters that are supplied by Caterpillar require an additional 2.5 L (2.6 qt) of oil. If the engine is equipped with another type of auxiliary oil filter, refer to the OEM specifications for the capacity of the auxiliary oil filter.

(2) Fill in the capacity of the auxiliary oil filter system (if equipped) in the space that is provided.

(3) Fill in the total capacity of the lubrication system. Add the auxiliary oil filter system to the correct capacity of the oil sump in order to find the total capacity of the lubrication system.

Fuel

NOTICE

Caterpillar recommends the filtration of distillate fuel through a fuel filter with a rating of five microns(c) absolute or less as the fuel is dispensed to the fuel tank for the engine.

Ultralow Sulfur Diesel (ULSD)

Model Year 2007 Caterpillar On-highway Diesel Engines require the use of Ultralow Sulfur Diesel fuel (ULSD) in order to meet the United States Environmental Protection Agency 2007 emissions regulations for on-highway diesel engines.

Caterpillar Engines are certified with the fuel that is prescribed by the Environmental Protection Agency in the US. Engines that are manufactured by Caterpillar are certified by use of the fuel that is prescribed by the European Certifications. Caterpillar does not certify diesel engines on any other fuel.

Note: The owner and the operator of the engine has the responsibility of using the fuel that is prescribed by the United States Environmental Protection Agency and other appropriate regulatory agencies.

NOTICE

Model year 2007 and newer Caterpillar on-highway diesel engines REQUIRE the use of ULSD fuel in order to meet the United States Environmental Protection Agency (EPA) 2007 emissions regulations for on-highway diesel engines. In the US, failure to use ULSD in these engines is illegal and punishable with civil penalties. Model year 2007 and newer Caterpillar on-highway diesel engines are designed to operate on ULSD. Failure to use ULSD in these engines will reduce engine efficiency and durability. Failure to use ULSD may also damage emission control systems and reduce fuel economy. In addition, certain other governments/localities MAY require the use of ULSD fuel. Consult federal, state, and local authorities for guidance on fuel requirements for your area.

When ULSD is used, there are concerns with fuel viscosity, lubricity, and thermal stability. The fuel viscosity, lubricity, and thermal stability limits stated in the Caterpillar Specification for Distillate Diesel Fuel for on-highway diesel engines address these concerns. In North America, diesel fuel that is identified as “ASTM D975 Grade No. 1-D S15” or “ASTM D975 Grade No. 2-D S15” and meet the “ASTM D975 Thermal Stability Guideline X2.10.2.2”, generally meet the Caterpillar requirements for ULSD fuel.

Fuel pumps that dispense ULSD fuel in the United States should generally display the following label:

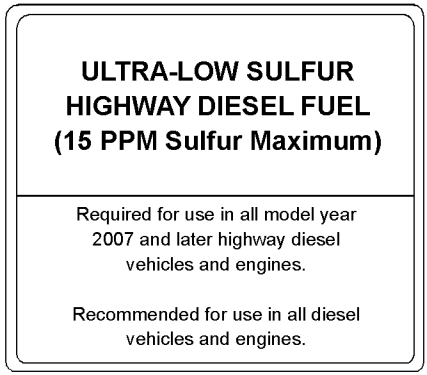


Illustration 37 g01356714

(Fuel pumps in California will not display this label because all diesel fuel that is sold in California must be ULSD fuel.)

Note: Refer to the latest edition of Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluids Recommendations” for additional information.

Fuel Additives

Many types of fuel additives are available. Caterpillar does not generally recommend the use of fuel additives.

In special circumstances, Caterpillar recognizes the need for fuel additives. Fuel additives need to be used 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 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 cause the amount of sulfur in the fuel to be greater than 15 ppm.

Contact your fuel supplier for those circumstances when fuel additives are required. Your fuel supplier can recommend the best additives for your application and for the proper level of treatment.

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

Refill Capacities (Fuel System)

Refer to the Operation and Maintenance Manual that is provided by the OEM for capacities of the fuel system.

Lubricating Grease

NOTICE
These recommendations are subject to change without notice. Contact your local Caterpillar dealer for the most up to date recommendations.

Caterpillar provides various greases that vary in performance from a moderate performance to an extremely high performance. These greases service the entire line of Caterpillar products in the wide variety of climates throughout the world. From this variety of Caterpillar grease products, you can find a Caterpillar grease that will meet or exceed the performance requirements of most on-highway trucks.

The performance requirements of your engine must be determined before you select any Caterpillar grease. Consult the recommendations for greases that are made by the OEM for the equipment. Then, consult with your Caterpillar dealer for a list of greases that have the performance specifications and the available sizes of containers.

Note: Always choose grease that meets or exceeds the recommendations that are specified by the equipment manufacturer for the application.

If it is necessary to choose a single grease to use for all of the equipment at one site, 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. This 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.

Note: Purge all of the old grease from a joint before you change from one type of grease to another type of grease. Some greases are not chemically compatible with other greases. Consult your supplier in order to determine if the greases are compatible.

If you are not certain that the old grease is compatible with the new grease, purge the old grease from the system before applying the new grease.

Note: All Caterpillar greases are compatible with each other.

Note: Refer to the latest edition of Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluids Recommendations” for additional information that relates to lubrication for your engine.

Coolant

NOTICE
These recommendations are subject to change without prior notice. Contact your Caterpillar dealer for the most up to date recommendations.

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

NOTICE
If the truck 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 to prevent damage caused by freezing coolant.

NOTICE
Frequently check the specific gravity of the coolant for proper freeze protection or for anti-boil protection.

NOTICE
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.

The following two coolants are used in Caterpillar diesel engines:

Preferred – Cat ELC (Extended Life Coolant) or a commercial extended life coolant that meets the Caterpillar EC-1 specification

Acceptable – Cat DEAC (Diesel Engine Antifreeze/Coolant) or a commercial heavy-duty coolant that meets “ASTM D4985”, or “ASTM D6210” specifications

Note: Cat DEAC does not require a treatment with an Supplemental Coolant Additive (SCA) at the initial fill. However, a commercial heavy-duty coolant that only meets the “ASTM D4985” specification WILL require a treatment with an SCA at the initial fill. A commercial heavy-duty coolant that meets the “ASTM D6210” specification will NOT require a treatment with an SCA at the initial fill. Read the label or the instructions that are provided by the manufacturer of the commercial heavy-duty coolant.

Note: These coolants WILL require a treatment with a supplemental coolant additive on a maintenance basis.

Table 5

Service Life Before Flushing and Before Refilling	
Coolant	**Service Life**(1)(2)(3)
Cat ELC	965,606 kilometers (600,000 miles), 12,000 hours, or 6 years
Commercial coolant that meets the Caterpillar EC-1 specification	482,803 kilometers (300,000 miles), 6000 hours, or 6 years
Cat DEAC	321,869 kilometers (200,000 miles), 3000 hours, or 3 years
Commercial Heavy-Duty Coolant that meets “ASTM D4985” or “ASTM D6210”	241,402 kilometers (150,000 miles), 3000 hours, or 1 year

(1) Use the interval that occurs first.

(2) Refer to the specific engine Operation and Maintenance Manual, “Maintenance Interval Schedule” for the interval for servicing the water temperature regulator.

(3) Caterpillar truck engines that have excessive idle time must reduce the coolant change intervals to one-half of the kilometers (miles) that are allowed or Caterpillar truck engines that have excessive idle time must base the coolant service life on the hours that are stated. Engine hours of operation are reported in the ECM (Electronic Control Module). Refer to the OMM for the specific engine for additional information.

Note: Add the Cat ELC Extender at the halfway point of the coolant change interval.

Refer to Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluids Recommendations” for further information.

Note: These coolant change intervals are only possible with annual S·O·S Services Level 2 coolant sampling and analysis.

S·O·S Services Coolant Analysis

Testing the engine coolant is important to ensure that the engine is protected from internal cavitation and from corrosion. The analysis also tests the ability of the coolant to protect the engine from boiling and from freezing. The S·O·S Services Coolant Analysis can be performed at your Caterpillar dealer. Caterpillar 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.

NOTICE

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

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

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

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

Note: Refer to the latest edition of Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluids Recommendations” for additional information that relates to coolant for your engine.

Recommended Interval for S·O·S Services Coolant Sample

Table 6

Recommended Interval		
Type of Coolant	**Level 1**	**Level 2**
Cat DEAC	Every 24140 kilometers (15000 miles)(1)(2)	Yearly(2)(3)
Cat ELC	Optional(3)	Yearly(3)

(1) This is also the recommended sampling interval for all commercial coolants that meet Cat EC-1 (Engine Coolant specification - 1)

(2) The recommended sampling interval for all other conventional heavy-duty coolant/antifreeze is 20120 kilometers (12500 miles).

(3) 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.

New Systems, Refilled Systems, and Converted Systems

Perform an S·O·S coolant analysis (Level 2) at the following maintenance intervals.

- Every Year
- Initial 500 service hours

Perform this analysis at the interval that occurs first for new systems, for refilled systems, or for converted systems that use Cat ELC (Extended Life Coolant) or use Cat DEAC (Diesel Engine Antifreeze/Coolant). This 500 hour check will also check for any residual cleaner that may have contaminated the system.

Refill Capacity (Coolant System)

The total cooling system capacity will vary depending on the radiator that is provided by the vehicle manufacturer. The table for the capacity of the cooling system is blank. The customer should fill in the table.

Table 7

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

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

i02819724

Maintenance Interval Schedule (C13 and C15 On-highway Engines with Standard (Deep) Oil Pans)

SMCS Code: 1000; 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, filters, and the installation of new components due to normal wear and aging. The performance of this product may be diminished if proper maintenance intervals and procedures are not followed. Components may experience accelerated wear if proper maintenance intervals and procedures are not followed.

Use whichever of the following that occurs first in order to determine the maintenance intervals: fuel consumption, mileage, service hours, and calendar time . Products that operate in severe operating conditions may require more frequent maintenance.

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

When Required

Daily

PM Level 1 - Every 48 000 km (30 000 miles) or 15 520 L (4100 US gal) of Fuel or 500 Service Hours

Initial 500 Hours (for New Systems, Refilled Systems, and Converted Systems)

Every 80 500 km (50 000 miles) or 1500 Service Hours

Every 144 800 km (90 000 mi) or 1500 Service Hours

Between 24 000 and 96 000 km (15 000 and 60 000 miles) (Between the First and Fourth Oil Change)

PM Level 2 - Every 320 000 km (200 000 miles) or 125 000 L (33 000 US gal) of Fuel or 4000 Service Hours or 2 Years

PM Level 3 - Every 483 000 km (300 000 miles) or 190 000 L (50 000 US gal) of Fuel or 6000 Service Hours or 3 Years

Every Year

Every 483 000 km (300 000 miles) or 3 Years

Every 966 000 km (600 000 miles) or 6 Years

i02819727

Maintenance Interval Schedule (C13 Engines with Standard (Deep) Sumps and 500 HP Field Up Rates or C13 Engines with Standard (Deep) Sumps and 525 HP RV Ratings or C13 Engines with Center Oil Pans)

SMCS Code: 1000; 7500

S/N: S3C1-Up

S/N: LEE1-Up

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, filters, and the installation of new components due to normal wear and aging. The performance of this product may be diminished if proper maintenance intervals and procedures are not followed. Components may experience accelerated wear if proper maintenance intervals and procedures are not followed.

Use whichever of the following that occurs first in order to determine the maintenance intervals: fuel consumption, mileage, service hours, and calendar time . Products that operate in severe operating conditions may require more frequent maintenance.

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

When Required

Daily

PM Level 1 - Every 32 000 km (20 000 miles) or 9464 L (2500 US gal) of Fuel or 300 Service Hours

Initial 500 Hours (for New Systems, Refilled Systems, and Converted Systems)

Every 80 500 km (50 000 miles) or 1500 Service Hours

Every 144 800 km (90 000 mi) or 1500 Service Hours

Between 24 000 and 96 000 km (15 000 and 60 000 miles) (Between the First and Fourth Oil Change)

PM Level 2 - Every 320 000 km (200 000 miles) or 125 000 L (33 000 US gal) of Fuel or 4000 Service Hours or 2 Years

PM Level 3 - Every 483 000 km (300 000 miles) or 190 000 L (50 000 US gal) of Fuel or 6000 Service Hours or 3 Years

Every Year

Every 483 000 km (300 000 miles) or 3 Years

Every 966 000 km (600 000 miles) or 6 Years

i01807350

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

SMCS Code: 1064-070; 1064-081

The air-to-air aftercooler is OEM installed in many applications. Please refer to the OEM specifications for information that is related to the aftercooler.

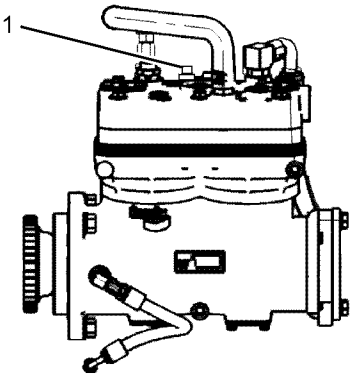
i02426101

Air Compressor - Inspect

SMCS Code: 1803-040

⚠ 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.



g01212654

Illustration 38

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.

i02676048

Alternator - Inspect

SMCS Code: 1405-040

Caterpillar recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and proper battery charging. Inspect the ammeter (if equipped) during engine operation in order to ensure proper battery performance and/or proper performance of the electrical system. Make repairs, as required.

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

i02818690

ARD Nozzle - Clean

SMCS Code: 1050-070

The liquid cleaner that is used to clean the nozzle for the Aftertreatment Regeneration Device (ARD) is available at your Caterpillar dealer. The cleaner is already measured into a dispenser.

Turn the ignition switch to the OFF position. Wait for 10 seconds. Turn the ignition switch to the ON position. Wait for **5 minutes** before proceeding with the cleaning procedure.

The port for cleaning the nozzle will be located on the fuel filter base or near the fuel filter base. Use an square drive in order to remove the access plug from the cleaning port. Inspect the access plug for damage. An undamaged plug may be reused.

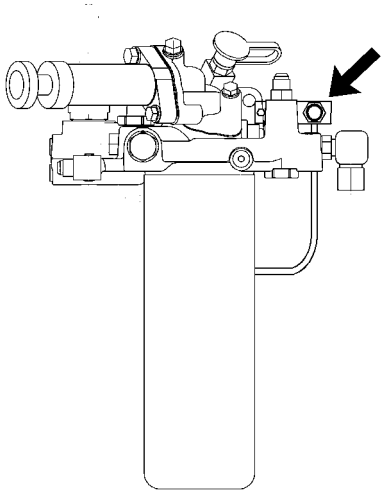


Illustration 39 g01346063

The cleaning port is located near the fuel filter base.

Remove the red cap from the dispenser immediately before use. Ensure that no debris is present on the dispenser. Make sure that the cleaning port is free of debris.

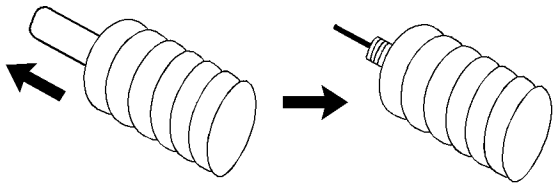


Illustration 40 g01348096

Insert the tip of the dispenser completely into the cleaning port.

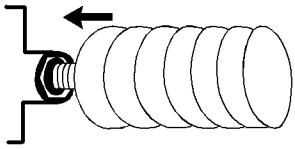


Illustration 41 g01346064

Squeeze the container in order to dispense the fluid. All of the fluid should be dispensed before the dispenser is removed from the cleaning port. Remove the dispenser and ensure that all of the liquid was dispensed. Inspect the cleaning port in order to ensure that no part of the dispenser remains in the cleaning port.

Insert an undamaged access plug into the cleaning port. Torque the plug to 10 ± 1 N·m (7.38 ± 0.7 lb ft). Start the engine and run the engine for at least five minutes at low idle. This will allow the purge air pump to push the cleaning fluid through the nozzle.

i02814290

ARD Spark Plug - Inspect/Replace

SMCS Code: 1555-040; 1555-510

Removing the Spark Plug

NOTICE
If the engine is running or the key is in the ON position the ARD plug will continue to fire. Turn the key to the OFF position before servicing the ARD plug.

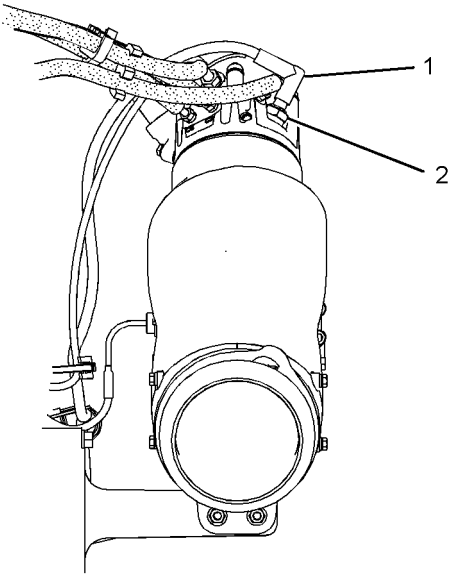


Illustration 42 g01308813

(1) Wiring harness
(2) Spark plug

1. Remove wire harness (1) from spark plug (2).

⚠ 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.

The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the air nozzle is deadheaded.

2. Debris may have collected in the spark plug well. Thoroughly remove any debris. Use compressed air. The maximum air pressure for cleaning purposes must be below 205 kPa (30 psi). Ensure that the area around the spark plug is clean and free of dirt and debris.

3. Use a deep well socket and a breaker bar to loosen the spark plug. If necessary, see your Caterpillar dealer for the part number of the socket. After the spark plug has been loosened, use the socket to remove the spark plug by hand in order to detect problems with the threads. After the spark plug has been removed, inspect the used spark plug and the gasket.

If the spark plug could not be removed by hand, clean the threads with a 305-2389 brush. This tool scrapes debris from the seat and from the threads.

NOTICE
Do not use a thread tap. A thread tap will remove metal unnecessarily. The threads could be stripped and the combustion group could be damaged.

Inspecting the Spark Plug

Inspect the spark plug closely for damage. The condition of the spark plug can indicate the operating condition of the engine.

The terminal post must not move. If the terminal post can be moved by hand, discard the spark plug.

Inspect the insulator for cracks. If a crack is found, discard the spark plug.

Inspect the shell for damage. Cracks can be caused by overtightening the spark plug. Overtightening can also loosen the shell. Discard any spark plug that has a shell that is cracked or loose.

Inspect the electrode for excessive wear. Flat surfaces with sharp edges provide the best conditions for creating a spark. An electrode will become worn from use. The surfaces erode. A higher voltage is required in order to produce a spark.

Installing the Spark Plug

Note: Do not use anti-seize compound on the spark plug. Most of the heat is transferred through the threads and the seat area of the spark plug. Contact of the metal surfaces must be maintained in order to provide the heat transfer that is required.

1. Ensure that the spark plug is clean and free of dirt and oil.

NOTICE

Do not overtighten the spark plug. The shell can be cracked and the gasket can be deformed. The metal can deform and the gasket can be damaged. The shell can be stretched. This will loosen the seal that is between the shell and the insulator, allowing combustion pressure to blow past the seal. Serious damage to the engine can occur.

Use the proper torque.

2. Install the spark plug by hand until the spark plug contacts the ARD. Torque the spark plug to the proper specification. Refer to Specifications, “Spark Plug” for the proper torque specification.

3. Connect the wiring harness.

i02153996

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.

1. Turn the key start switch to the OFF position. Remove the key and all electrical loads.

2. Turn OFF the battery charger. Disconnect the charger.

3. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the ground plane. Disconnect the cable from the NEGATIVE “-” battery terminal.

4. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.

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

5. Remove the used battery.

6. Install the new battery.

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

7. Connect the cable from the starting motor to the POSITIVE “+” battery terminal.

8. Connect the cable from the ground plane to the NEGATIVE “-” battery terminal.

i02601752

Battery Electrolyte Level - Check

SMCS Code: 1401-535

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

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

i01492654

Battery or Battery Cable - Disconnect

SMCS Code: 1402-029

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.

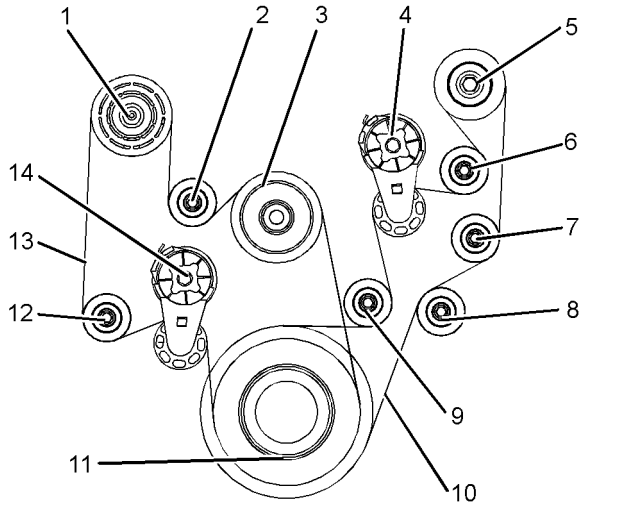
3. Tape the leads in order to help prevent accidental starting.

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

i02684077

Belts - Inspect/Adjust/Replace

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



g01348668

Illustration 43

C13 Engines

(1) Air conditioner compressor
(2) Idler pulley
(3) Fan pulley
(4) Tensioner for the alternator belt
(5) Alternator
(6) Idler pulley
(7) Idler pulley
(8) Idler pulley
(9) Idler pulley
(10) Alternator belt
(11) Crankshaft pulley
(13) Fan drive belt
(12) Idler pulley
(14) Tensioner for the fan drive belt

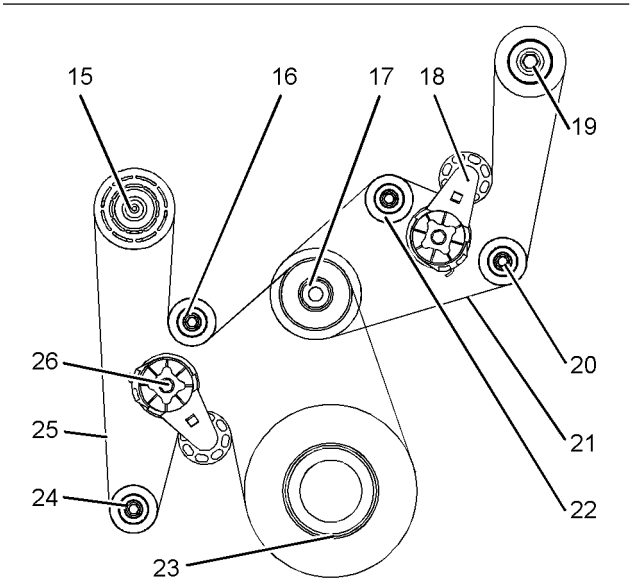


Illustration 44 g01348669

C15 Engines

(15) Air conditioner compressor
(16) Idler pulley
(17) Fan pulley
(18) Tensioner for the alternator belt
(19) Alternator
(20) Idler pulley
(21) Alternator belt
(22) Idler pulley
(23) Crankshaft pulley
(24) Idler pulley
(25) Fan drive belt
(26) Tensioner for the fan drive belt

Your engine is equipped with two serpentine belts. For maximum engine performance and maximum utilization of your engine, inspect the belts for wear and for cracking. Replace the belts, if necessary.

To replace the fan drive belt, perform the following steps:

1. Insert a ratchet with a square drive into the square hole that is located in the tensioner for the fan drive belt. Rotate the tensioner clockwise in order to relieve tension on the fan drive belt. Remove the fan drive belt.

2. Install the new fan drive belt correctly, as shown. Be sure that the belt is fully seated on the pulleys. The correct tension will automatically be applied when the ratchet is removed.

To replace the alternator belt, perform the following steps:

1. Insert a ratchet with a square drive into the square hole that is located in the tensioner for the fan drive belt. Rotate the tensioner clockwise in order to relieve tension on the fan drive belt. Remove the fan drive belt.

2. Then insert a ratchet with a square drive into the square hole that is located in the tensioner for the alternator belt.

3. Rotate the tensioner counterclockwise in order to relieve tension on the alternator belt. Remove the alternator belt.

4. Install the new alternator belt correctly, as shown. Be sure that the belt is fully seated on the pulleys. The correct tension will automatically be applied when the ratchet is removed.

5. Install the fan drive belt correctly, as shown. Be sure that the belt is fully seated on the pulleys. The correct tension will automatically be applied when the ratchet is removed.

i01406684

Compression Brake - Inspect/Adjust

SMCS Code: 1119-025; 1119-040

The maintenance of the compression brake should be performed in conjunction with scheduled engine maintenance. The correct tune-up kit is required when parts are replaced on the compression brake. Refer to the Parts Manual for additional information.

Note: The slave piston lash adjustment must be performed after the engine valve lash adjustment is performed. Make the slave piston adjustment while the engine is stopped. Refer to the Systems Operation, Testing and Adjusting module for additional information.

Table 8

Component	Required Maintenance
Wiring and Terminal Connections	Inspect
Clutch/Throttle/Buffer Screw	Adjust
Slave Piston Lash Adjusting Screw	Adjust/Inspect
Solenoid Valves	Inspect
Crosshead Bridges/Valve Stem Caps	Inspect
Injector/Exhaust Rocker Arm Screws	Inspect
Master Piston/Fork Assembly	Inspect
Slave pistons	Inspect
External Hose Assembly	Inspect
Housings	Inspect
Fuel Pipes	Inspect
Hold Down Bolts	Inspect
Accumulator Springs(1)	Inspect
Solenoid Harness(1)	Inspect
Solenoid Seal Rings(1)	Inspect
Control Valve Springs(1)	Inspect
Control Valves(1)	Inspect
Oil Seal Rings(1)	Inspect
Master Piston Return Springs(1)	Inspect
Terminal Lead Out(1)	Inspect
Crosshead Pin Assembly(1)	Inspect

(1) Contained in tune-up kits

i01426993

Compression Brake - Inspect/Adjust/ Replace

SMCS Code: 1119-025; 1119-040; 1119-510

The maintenance of the compression brake should be performed in conjunction with scheduled engine maintenance. The correct tune-up kit is required when parts are replaced on the compression brake. Refer to the Parts Manual for additional information.

Note: The slave piston lash adjustment must be performed after the engine valve lash adjustment is performed. Make the slave piston adjustment while the engine is stopped. Refer to the Systems Operation, Testing and Adjusting Module for additional information.

Refer to the Disassembly and Assembly Module for instructions on replacing the components.

Table 9

Component	Required Maintenance (300,000 miles)	Required Maintenance (600,000 miles)
Wiring and Terminal Connections	Inspect	Inspect
Clutch/Throttle/Buffer Screw	Adjust/Replace	Adjust/Replace
Slave Piston Lash Adjusting Screw	Adjust/Inspect	Adjust/Replace
Solenoid Valves	Inspect	Replace
Crosshead Bridges/ Valve Stem Caps	Inspect	Inspect
Injector/Exhaust Rocker Arm Screws	Inspect	Inspect
Master Piston/Fork Assembly	Inspect	Inspect
Slave pistons	Inspect	Inspect
External Hose Assembly	Inspect	Inspect
Housings	Inspect	Inspect
Fuel Pipes	Inspect	Inspect
Hold Down Bolts	Inspect	Replace
Accumulator Springs(1)	Replace	Inspect
Solenoid Harness(1)	Replace	Inspect
Solenoid Seal Rings(1)	Replace	Inspect
Control Valve Springs(1)	Replace	Inspect
Control Valves(1)	Replace	Inspect
Oil Seal Rings(1)	Replace	Inspect
Master Piston Return Springs(1)	Replace	Inspect
Terminal Lead Out(1)	Replace	Inspect
Crosshead Pin Assembly(1)	Replace	Inspect

(1) Contained in tune-up kits

i02126636

Cooling System 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 Tools 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 coolant/antifreeze. 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 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.

i02126647

Cooling System 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 Tools 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.

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 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.

i02413609

Cooling System Coolant Extender (ELC) - Add

SMCS Code: 1352-045; 1395-081

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

Dispose of all fluids according to local regulations and mandates.

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

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

3. It may be necessary to drain enough coolant from the cooling system in order to add Cat ELC Extender .

4. Refer to the schedule that is found in Operation and Maintenance Manual , “Maintenance Interval Schedule”. This schedule lists the interval for adding Cat ELC Extender to this engine.

5. Use the formula in Table 10 to determine the proper amount of Cat ELC Extender for your cooling system. The total cooling capacity will vary depending on the radiator that is provided by the vehicle manufacturer.

Table 10

Formula For Adding Cat ELC Extender To Cat ELC
V × 0.02 = X
V is the total capacity of the cooling system.
X is the amount of Cat ELC Extender that is required.

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

For more information about Cat ELC Extender, refer to Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluid Recommendations”.

i01197583

Cooling System Coolant Level - Check

SMCS Code: 1395-082

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

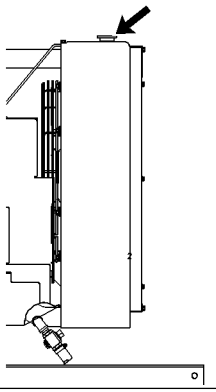


Illustration 45 g00285520
Cooling system filler cap

⚠ 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.

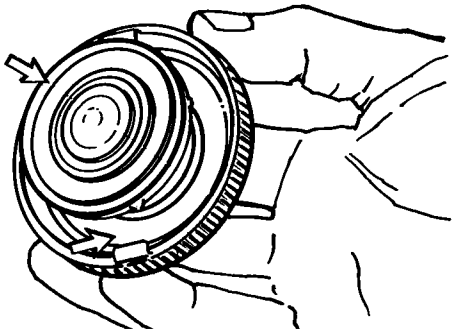


Illustration 46 g00103639

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.

i02762476

Cooling System Coolant Sample (Level 1) - Obtain

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

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

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

Use the following guidelines for proper sampling of the coolant:

- Complete the information on the label for the sampling bottle before you begin to take the samples.

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

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.

Submit the sample for Level 1 analysis.

For additional information about coolant analysis, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations” article or consult with your Caterpillar dealer.

i02185620

Cooling System Coolant Sample (Level 2) - Obtain

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

Note: Refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” for the proper maintenance interval for your application.

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

Submit the sample for Level 2 analysis.

For additional information about coolant analysis, see Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engines Fluids Recommendations” or consult your Caterpillar dealer.

i02413358

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

SMCS Code: 1352-045; 1395-081

Note: This procedure is NOT required for applications that use Cat Extended Life Coolant (ELC).

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

Note: Test the Supplemental Coolant Additive (SCA) or test the SCA concentration as part of an S·O·S Coolant Analysis.

Test the SCA Concentration

Coolant, Antifreeze and SCA

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

⚠ WARNING

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

Use the 8T-5296 Coolant Conditioner Test Kit or use the 4C-9301 Coolant Conditioner Test Kit in order to check the concentration of the SCA. Refer to the Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluid Recommendations” for more information.

Add the SCA, If Necessary

NOTICE

Do not exceed the recommended amount of supplemental coolant additive concentration. 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 radiator tube blockage, overheating, and/or accelerated water pump seal wear. Never use both liquid supplemental coolant additive and the spin-on element (if equipped) at the same time. The use of those additives together could result in supplemental coolant additive concentration exceeding the recommended maximum.

⚠ 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.

Follow the instructions that are provided by the OEM or follow the instructions that are provided by the manufacturer of the coolant conditioner element on engines that are equipped with a coolant conditioner element.

1. Slowly loosen the cooling system filler cap in order to relieve the pressure. Remove the cooling system filler cap.

Note: Always discard drained fluids according to local regulations.

2. If necessary, drain some coolant from the cooling system into a suitable container in order to allow space for the extra SCA.

3. Add the proper amount of SCA. Refer to Special Publication, SEBU6385, "Caterpillar On-highway Diesel Truck Engine Fluid Recommendations" for more information on SCA requirements.

4. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets are damaged, replace the old cooling system filler cap with a new cooling system filler cap. Install the cooling system filler cap.

i02623972

Cooling System Water Temperature Regulator - Replace

SMCS Code: 1355-510

Replace the water temperature regulator before the water temperature regulator fails. This is a recommended preventive maintenance practice. Replacing the water temperature regulator reduces the chances for unscheduled downtime.

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

i00934535

Crankshaft Vibration Damper - Inspect

SMCS Code: 1205-040

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

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

Visconic Damper

The visconic damper has a weight that is located inside a fluid filled case. The weight moves in the case in order to limit torsional vibration.

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

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

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

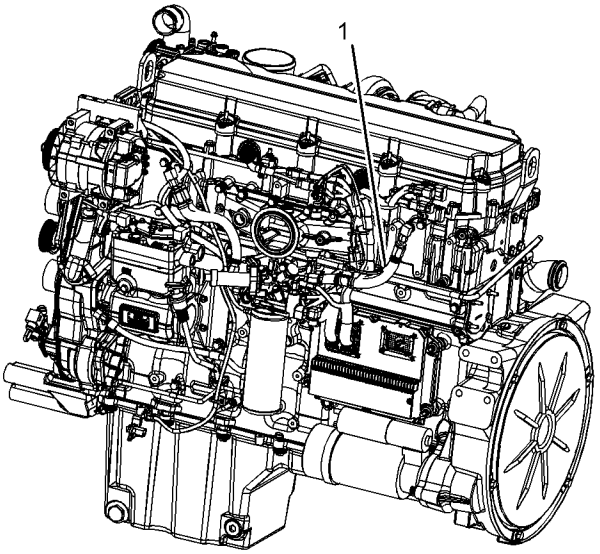
- The damper is dented, cracked, or leaking.
- The paint on the damper is discolored from heat.
- The engine has had a failure because of a broken crankshaft.
- Analysis of the oil has revealed that the front main bearing is badly worn.
- There is a large amount of gear train wear that is not caused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

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

i02325374

Cylinder Head Grounding Stud - Inspect/Clean/Tighten

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



g01161494

Illustration 47

C13 Engine

(1) Cylinder head grounding stud

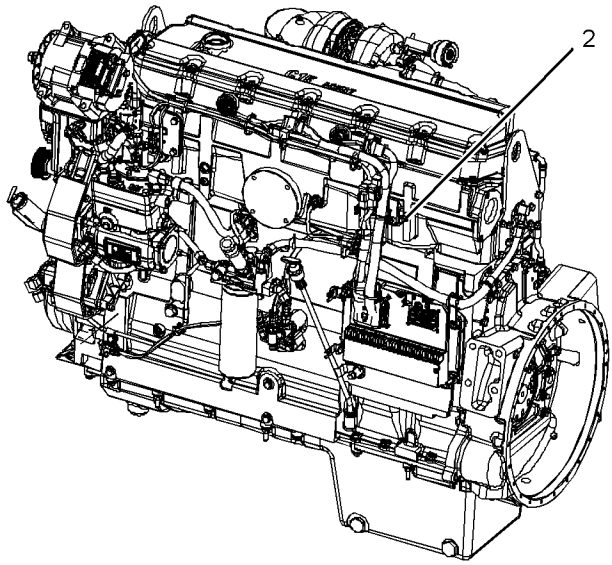


Illustration 48 g01161493

C15 engines

(2) Cylinder head grounding stud

Inspect the OEM vehicle wiring harness for the following conditions:

- Connections that are loose or disconnected
- Mounting hardware that is missing
- Insulation that is chafed or cut
- Wires that are bare

The cylinder head grounding stud must have a wire ground to the battery. Tighten the cylinder head 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.

1. Clean the cylinder head grounding stud and the terminals for the cylinder head ground strap with a clean cloth.

2. If the connections are corroded, clean the connections with a solution of baking soda and water.

3. Keep the cylinder head grounding stud and the strap clean and coated with MPGM grease or petroleum jelly.

i02718365

Diesel Particulate Filter - Clean

SMCS Code: 1091-070

Refer to table 11 in order to determine the minimum maintenance interval for cleaning ash from the diesel particulate filter (DPF). The intervals may vary because of the following operational factors: idle time for the engine, route, and ambient conditions.

Optimum intervals for cleaning the DPF require the use of the following products:

- Oil that meets the performance requirements of the Caterpillar ECF-3 specification
- Ultra low sulfur diesel fuel (ULSD)

Refer to this Operation and Maintenance Manual , “Refill Capacities and Recommendations” for more information.

Table 11

Minimum Maintenance Intervals for Cleaning Ash from the DPF					
Engine	**Rating**		**Comments**	**Minimum Interval (Distance)**	**Minimum Interval (Hours)**
C13	305	500	Including RV	241400 kilometers (150000 miles)	4500
C15	435	550	Including RV	241400 kilometers (150000 miles)	4500
	600	625	Dual DPF	241400 kilometers (150000 miles)	4500

Note: All maintenance and service for the DPF must be performed with a tool that has been approved by Caterpillar. Contact your Caterpillar dealer for more information.

Exceptions to Minimum Maintenance Intervals

A number of specialty vehicle applications impose certain restraints on the locations of exhaust system components. These applications are primarily classified as medium service and heavy duty service. The Environmental Protection Agency has determined that a DPF that has a reduced size may be installed in a vehicle if the DPF is cleaned more frequently.

The EPA has issued a list of vehicle applications which may be suitable for a DPF with a reduced volume. The vehicle applications are listed below.

- Beverage truck
- Maintenance truck (with integral toolbox)
- Trash collection truck (with hydraulic packing or picking apparatus)
- Fire truck
- Airport refueling truck (with exhaust directed toward the front of the truck)
- Utility truck (with integral toolboxes and outrigger apparatus)
- Snowplow (with the plow located under the chassis)
- Dump truck
- Concrete mixer
- Car hauler (with integral open racks)
- Street sweeper
- Armored car
- Day cab truck with no rear seat (only a day cab truck for which the entire DPF is located in front of the vertical plane established by the back side of the cab)

Use which ever interval occurs first, 128750 kilometers (80000 miles) or 2400 hours, in order to determine the minimum maintenance interval for a DPF with a reduced volume. This minimum maintenance interval is only valid for engines that are built in 2007, 2008, or 2009.

Note: The following vehicles are not qualified for reduced maintenance intervals, even when the vehicles are included in the above list.

- Any vehicle with an exhaust system that is mounted vertically
- Any vehicle that has a DPF that is mounted behind the cab and outside of the frame rails

Please consult your Caterpillar dealer in order to determine if a DPF with a reduced volume is installed in your vehicle. A DPF with a reduced volume requires a more frequent maintenance interval.

i02070777

Electronic Unit Injector - Inspect/Adjust

SMCS Code: 1251-025; 1251-040; 1290-025; 1290-040

⚠ WARNING

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

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting the unit injectors.

The electronic unit injectors use high voltage. Disconnect the unit injector enable circuit connector in order to prevent personal injury. Do not come in contact with the injector terminals while the engine is running.

The operation of Caterpillar engines with improper adjustments of the electronic unit injector can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.

Only qualified service personnel should perform this maintenance. Refer to the following topics for your engine for the correct procedure: Refer to the Systems Operation, Testing and Adjusting, “Electronic Unit Injector - Test” for the test procedure, and Systems Operation, Testing and Adjusting, “Electronic Unit Injector - Adjust” for the correct procedure for adjusting the injectors.

NOTICE

The camshafts must be correctly timed with the crankshaft before an adjustment of the lash for the fuel injector is made. The timing pins must be removed from the camshafts before the crankshaft is turned or damage to the cylinder block will be the result.

i01646701

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.

i02353651

Engine Air Cleaner Element (Dual Element) - Clean/Replace (If Equipped)

SMCS Code: 1054-037; 1054-510

See this Operation and Maintenance Manual, “Engine Air Cleaner Element - Clean/Replace” for information on servicing the primary air filter.

Inspecting and Replacing the Secondary Air Cleaner Element (If Equipped)

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 air-borne 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.

Operating conditions (dust, dirt, and debris) may require more frequent service of the air cleaner element. 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. Your Caterpillar dealer has the proper air cleaner elements for your application. Consult your Caterpillar dealer for the correct air cleaner element.

The secondary air cleaner element is not serviceable or washable. The secondary air cleaner element should be removed and discarded for every three cleanings of the primary air cleaner element.

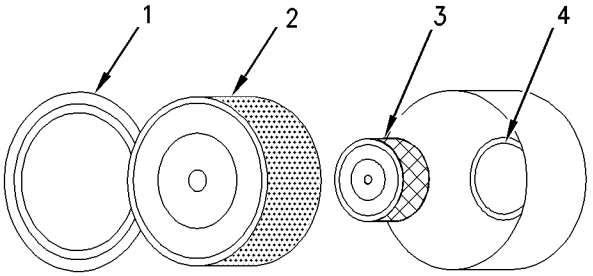


Illustration 49 g00736431

(1) Cover
(2) Primary air cleaner element
(3) Secondary air cleaner element
(4) Air inlet for the turbocharger

1. Remove the cover. Remove the primary air cleaner element.

2. Cover the air inlet for the turbocharger with adhesive material in order to keep dirt out of the turbocharger.

3. Clean the inside of the air cleaner cover and body with a clean, dry cloth.

4. Remove the adhesive covering that covers the air inlet for the turbocharger. Install the secondary air cleaner element. Install a primary air cleaner element that is new or clean.

5. Install the air cleaner cover.

6. Reset the air cleaner service indicator.

i00857000

Engine Air Cleaner Element - Clean/Replace

SMCS Code: 1054-070; 1054-510

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

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.

- Operating conditions (dust, dirt and debris) may require more frequent service of the air cleaner element.
- The air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Replace the dirty paper air cleaner elements with clean air cleaner elements. Before installation, the 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.

Your Caterpillar dealer has the proper air cleaner elements for your application. Consult your Caterpillar dealer for the correct air cleaner element or follow the instructions that are provided by the OEM.

i01900118

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 the air cleaner element and the pressure that is measured 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 air cleaner housing or in a remote location.

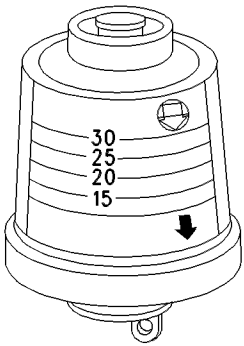


Illustration 50 g00103777

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 yellow core when the engine is accelerated to the engine rated speed. The yellow core should latch approximately at the greatest vacuum that is attained.

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

The service indicator may need to be replaced frequently in environments that are severely dusty, if necessary. 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).

i02126741

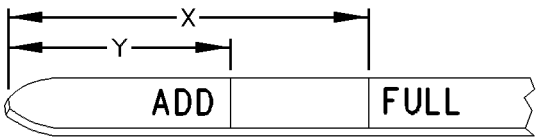
Engine Oil Level - Check

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.

Note: The location of the oil level gauge and the oil filler cap will vary with the truck model.



g00110310

Illustration 51

(Y) “ADD” mark
(X) “FULL” mark

NOTICE
Perform this maintenance with the engine stopped.

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 the correct oil to use, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic (Maintenance Section). Do not fill the crankcase above “FULL” mark (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 will help to provide the most accurate oil analysis.

i02819726

Engine Oil Level Gauge - Calibrate

SMCS Code: 1326-524

Check Calibration at the First Oil Change

The engine oil level will vary depending on the angle and the slant of the engine installation. The angle is the front to back tilt. The slant is the sideways tilt.

The oil level gauge markings must be verified in order to ensure that it is correct. Verify the oil level gauge markings at the first oil change.

Verify the “ADD” mark and verify the “FULL” mark that is on the oil level gauge. Use the following procedure.

NOTICE
The vehicle must be parked on a level surface in order to perform this maintenance procedure.

1. Operate the engine until normal operating temperature is achieved. Stop the engine. Remove the crankcase oil drain plugs. The oil drain plug from the deep portion of the oil pan should be removed. The oil drain plug from the shallow portion of the oil pan should be removed. This will allow all of the oil to drain. Drain the oil from the crankcase for 20 minutes.

2. Remove the used oil filter(s). Install the new oil filter(s). Install the oil drain plugs and tighten to 70 ± 15 N·m (50 ± 11 lb ft).

Note: Your engine may be equipped with auxiliary oil filters. The auxiliary oil filters require a different volume of oil. Refer to the OEM specifications for the auxiliary oil filter.

3. Refer to table 12. Pour the quantity of oil with the label “A” into the crankcase. Allow enough time for the oil to drain into the crankcase. Approximately 20 minutes should be allowed. Check the oil level. Wait for several minutes and check the oil level again. Proceed after the oil level stops changing.

4. Check the oil level on the oil level gauge. The oil level should be at the “ADD” mark. If the oil level is not at the existing “ADD” mark, grind off the “ADD” mark and engrave the new “ADD” level. Use an engraving pen in order to engrave the new “ADD” mark.

5. Pour the quantity of oil with the label “B” into the crankcase. Allow enough time for the oil to drain into the crankcase.

6. Check the oil level on the oil level gauge. The oil level should be at the “FULL” mark. If the oil level is not at the existing “FULL” mark, grind off the “FULL” mark. Use an engraving pen in order to engrave the new “FULL” mark.

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

7. Pour the quantity of oil with the label “C” into the crankcase. This quantity of oil will fill the oil filter. Start the engine and run the engine enough to ensure that the lubrication system is filled. Inspect the engine for oil leaks.

8. Stop the engine and allow enough time for the oil to drain into the crankcase.

9. Check the oil level on the oil level gauge. If the oil level is not at the calibrated “FULL” mark, fill the crankcase to the calibrated “FULL” mark. Record the amount of oil that was addednext to quantity D in the table below. Record the oil capacity of the lubrication system for future oil changes.

Table 12

Quantity of Oil	C13 with Front or Rear Sump and 2 Filters	C13 with Front or Rear Sump and 1 Filter	C13 with Center Sump	C15
Quantity A	26.5 L (28 qt)	26.5 L (28 qt)	20.5 L (22 qt)	28.5 L (30 qt)
Quantity B	6 L (6 qt)	6 L (6 qt)	6 L (6 qt)	6 L (6 qt)
Quantity C	6 L (6 qt)	4 L (4 qt)	6 L (6 qt)	4 L (4 qt)
Quantity D				
Total Capacity of the Lubrication System for Engine Oil				

i01935337

Engine Oil Sample - Obtain

SMCS Code: 1000-008; 1348-554-SM; 7542-554-OC, SM

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

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

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, PEHP6001, “How To Take A Good Oil Sample”. Consult your Caterpillar dealer for complete information and assistance in establishing an S·O·S program for your engine.

i02819353

Engine Oil and Filter - Change

SMCS Code: 1318-510; 1348-044

⚠ WARNING

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

NOTICE
The vehicle must be parked on a level surface for this maintenance procedure.

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

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

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. Catch the oil in a suitable container. Recycle the used oil, or dispose of the used oil properly.

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

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

   Tighten the oil drain plug to the following torque: ..... 70 ± 15 N·m (50 ± 11 lb ft)

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” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Do NOT mix the used oil with the fuel. Dispose of the used oil according to local regulations.

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.

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

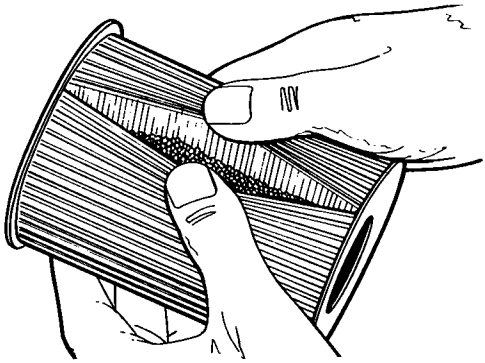


Illustration 52 g00588944

Element with debris

2. Cut the oil filter open with a 175-7546 Oil Filter Cutter. Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

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

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

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

Illustration 53 g00103713

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

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

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

5. Install the new 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. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic for more information about: selecting the correct engine oil and finding the correct refill capacity for your engine. Fill the crankcase with the proper amount of oil.

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 two minutes. Perform this procedure in order 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 ten minutes.

4. Use the oil level gauge in order to check the oil level. Maintain the oil level between the "ADD" and "FULL" marks on the oil level gauge.

Adjustments to the Oil Change Intervals

Many conditions affect the selection of an oil change interval. Some of the conditions that affect the selection of oil are listed: oil that meets the Caterpillar ECF-3 specification, oil analysis at 16,100 km (10,000 miles), and premium oil filters.

All engines do not consume fuel and oil at the same rate due to several factors: manufacturing tolerances, maintenance variations, and engine application. The amount of fuel that is consumed is in direct relation to the maximum oil change interval that is selected. It is essential to include an S·O·S oil analysis before an adjustment of the oil change interval is considered. An S·O·S oil analysis should be used to verify the adjustments to the oil change intervals. Use tables 13 and 14 in order to determine the adjustment to the oil change intervals. For more information on extending oil change intervals, contact your local Caterpillar dealer.

Tables for Adjusted Oil Change Intervals

Note: Use of tables 13 and 14 assumes the use of a recommended oil type. See this Operation and Maintenance Manual, “Refill Recommendations and Capacities” article for further information.

In order to understand the tables for maximum permissible oil change intervals, use the following procedures.

1. Determine the average fuel consumption of the vehicle.

2. Determine the gross vehicle weight (GVW) of the vehicle.

3. Determine the percent of idle time for the vehicle. A download of the histogram data from the ECM can provide a more accurate “percent idle time” measurement. Contact your nearest Caterpillar dealer for information on obtaining data from the ECM.

4. The intersection of the column and the row lists the maximum number of kilometers or miles between oil change intervals.

For example, a C13 engine with an average fuel consumption of 3 km/L (7 mpg) in a light-duty application will have a maximum permissible oil change interval of 40,250 kilometers (25,000 miles) with a shallow oil sump. The maximum permissible oil change interval for the same situation with a deep oil sump would be 64,350 km (40,000 miles).

For more information about optimizing oil change intervals, see your Caterpillar dealer.

Note: Metric units are listed before English units.

Table 13

Maximum Permissible Oil Change Intervals for C13 On-highway Engines with Standard (Deep) Sumps and Standard Ratings			
	Severe Duty	**Normal Duty**	**Light Duty**
Fuel Consumption Kilometers Per Liter (Miles Per Gallon)	Less than 2.6 km/L (6 MPG)	2.6 km/L (6 MPG) to 3 km/L (7 MPG)	Greater than 3 km/L (7 MPG)
Gross Vehicle Weight	More than 36300 kg (80000 lb)	36300 kg (80000 lb) or less	36300 kg (80000 lb) or less
Minimum Oil Sump Capacity(1)	38.5 L (41 qt)	38.5 L (41 qt)	38.5 L (41 qt)
Idle Time	More than 40%	20% to 40%	Less than 20%
Oil Classification	Cat DEO-ULS (2) Commercial oils that meet the performance requirements of the Caterpillar ECF-3 Commercial oils that meet the performance requirements of the API CJ-4 category		
Kilometers (Miles)	32,200 kilometers (20,000 miles)	48,300 kilometers (30,000 miles)	64,350 kilometers (40,000 miles)

(1) If the oil sump capacity is greater than the oil sump capacity that is listed in Table 13, the oil change interval can be extended 1600 kilometers (1000 miles) for every 2 L (2 qt) increase in oil sump capacity.

(2) If the oil that is used is not Cat DEO-ULS, then the oil must conform to the requirements of the Caterpillar ECF-3 specification or the oil must conform to the requirements of the API CJ-4 category. Refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” for further information.

Table 14

Maximum Permissible Oil Change Intervals for C15 On-highway Engines			
	Severe Duty	**Normal Duty**	**Light Duty**
Fuel Consumption Kilometers Per Liter (Miles Per Gallon)	Less than 2.3 km/L (5.5 MPG)	2.3 km/L (5.5 MPG) to 2.8 km/L (6.5 MPG)	Greater than 2.8 km/L (6.5 MPG)
Gross Vehicle Weight	More than 36300 kg (80000 lb)	36300 kg (80000 lb) or less	36300 kg (80000 lb) or less
Minimum Oil Sump Capacity(1)	38.5 L (41 qt)	38.5 L (41 qt)	38.5 L (41 qt)
Idle Time	More than 40%	20% to 40%	Less than 20%
Oil Classification	Cat DEO-ULS (2) Commercial oils that meet the performance requirements of the Caterpillar ECF-3 specification Commercial oils that meet the performance requirements of the API CJ-4 category		
Kilometers (Miles)	32,200 kilometers (20,000 miles)	48,300 kilometers (30,000 miles)	64,350 kilometers (40,000 miles)

(1) If the oil sump capacity is greater than the oil sump capacity that is listed in Table 14, the oil change interval can be extended 1600 kilometers (1000 miles) for every 2 L (2 qt) increase in oil sump capacity.

(2) If the oil that is used is not Cat DEO-ULS, then the oil must conform to the requirements of the Caterpillar ECF-3 specification or the oil must conform to the requirements of the API CJ-4 category. Refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” for further information.

i01458399

Engine Storage Procedure - Check

SMCS Code: 1000-535

The oil change interval may be extended to 12 months for a vehicle that is operated seasonally and placed in storage for the remainder of the year by using the required storage procedures and the required start-up procedures. This extension is permitted if the following categories for oil change intervals in the Operation and Maintenance Manual, “Maintenance Interval Schedule” have not been reached:

- Mileage
- Operating hours
- Fuel consumption

If an engine is out of operation and if use of the engine is not planned, special precautions should be made. If the engine will be stored for more than three months, a complete protection procedure is recommended. For more detailed information on engine storage, see Special Instruction, SEHS9031, “Storage Procedure For Caterpillar Products”.

If the engine will not be started for several weeks, the lubricating oil will drain from the cylinder walls and from the piston rings. Rust can form on the cylinder liner surface. Rust on the cylinder liner surface will cause increased engine wear and a reduction in engine service life. Caterpillar recommends the use of volatile corrosion inhibitor (VCI) oil in order to prevent internal engine damage due to moisture during storage. These inhibitors in the VCI oil act by evaporating inside the engine. The inhibitors then condense over the inside surfaces of the engine. The evaporation process and the condensing process offers full protection to surfaces that cannot be reached with preservatives. 0.9 L (1.0 qt) of 4C-6792 VCI oil will treat 28.4 L (30.0 qt) of engine oil. This will give a 3 percent concentration of VCI oil. The engine must be completely sealed when the engine is stored in order for the VCI oil to function properly. The VCI oil is easily cleaned from the engine when you remove the engine from storage. The volatile vapors are removed by simply running the engine to operating temperature. A mineral oil base is left behind after the volatile vapors are removed.

i02562758

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

NOTICE

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

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

The initial valve lash adjustment on new engines, rebuilt engines, or remanufactured engines should be performed at the first oil change. The initial valve lash adjustment on new engines, rebuilt engines, or remanufactured engines must be performed before the fourth oil change, or at the fourth oil change. The adjustment is necessary due to the initial wear of the valve train components and to the seating of the valve train components.

This maintenance is part of a lubrication and preventive maintenance schedule in order to help provide maximum engine life.

⚠ WARNING

Ensure that the engine can not 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.

To obtain an accurate measurement, allow the valves to cool before this maintenance is performed.

The following components should be inspected and adjusted when the valves are inspected and adjusted.

- Valve actuators
- Injectors
- Compression brakes

Refer to Systems Operation, Testing and Adjusting, “Engine Valve Lash - Inspect/Adjust” in your service manual for more information.

i01765711

Engine Valve Rotators - Inspect

SMCS Code: 1109-040

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

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

Perform this procedure after the valve lash has been set.

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

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

i01771215

Fan Drive Bearing - Lubricate

SMCS Code: 1359-086-BD

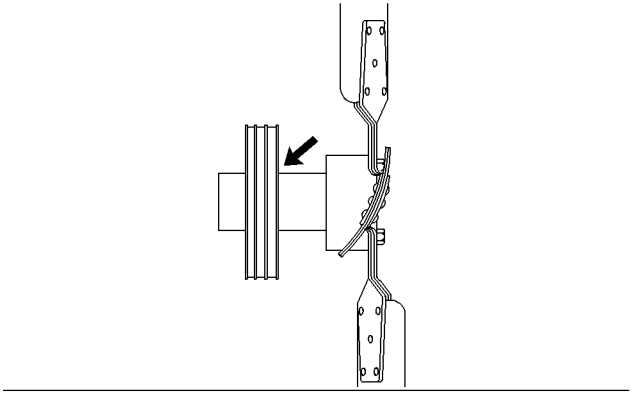


Illustration 54 g00746166

Typical location of the grease fitting that is for the fan drive bearing

The belt guards have been removed in this illustration.

Note: In some applications, the fan drives are supplied by the OEM. Refer to the OEM specifications if the fan drive is not supplied by Caterpillar.

Lubricate the grease fitting that is on the fan drive bearing with Bearing Lubricant or the equivalent.

Inspect the fan drive pulley assembly for wear or for damage. If the shaft is loose, an inspection of the internal components should be performed. Refer to the Service Manual for additional information.

i02686139

Fuel System - Prime

SMCS Code: 1258-548

⚠ WARNING

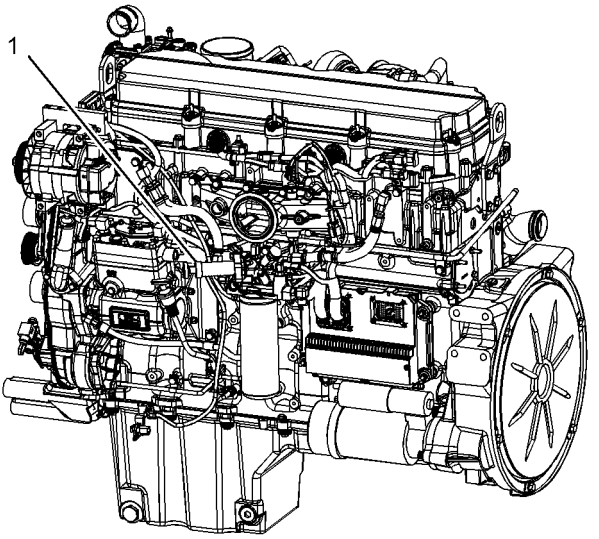
Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE

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

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.



g01186208

Illustration 55

Left side view of engine

(1) Fuel priming pump (if equipped)

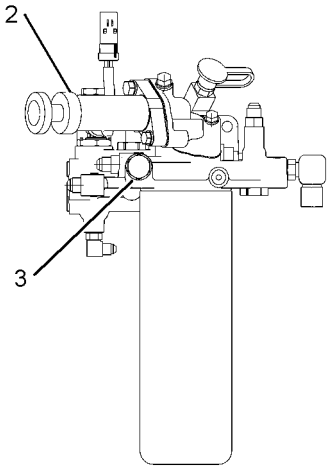


Illustration 56 g01326675

Detailed view of the fuel filter and priming pump

(2) Fuel priming pump
(3) Air purge fitting

If the fuel system runs out of fuel or if air is introduced into the fuel system, either of the following procedures may be followed. If necessary, fill the fuel tank with clean diesel fuel.

Using the Engine to Prime the Fuel System

1. Turn the ignition switch to the OFF position.

2. Unlock the fuel priming pump (if equipped) by turning the cap counterclockwise.

3. Purging air from the fuel system requires the air purge fitting to be opened. Turn the air purge fitting counterclockwise by three full turns. Do not remove the fitting.

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

4. Crank the engine for 30 seconds. Use a suitable container to catch the fuel while you crank the engine. Allow the starting motor to cool for two minutes.

Note: Most of the air should be purged from the system after four or five cranking cycles.

5. Repeat Step 4 until the engine starts and runs. If the engine runs rough, continue to operate the engine at low idle until the engine runs smoothly.

6. Observe the air purge fitting. When a small drop of fuel appears at the threads of the air purge fitting, close the air purge fitting. After the air purge fitting is closed, tighten the air purge fitting. Refer to Specifications, SENR3130 for the correct torque.

Note: Failure to tighten all fittings could result in serious fuel leaks.

7. After the engine has operated smoothly for 30 seconds, turn the priming valve to the LOCK position.

Note: The life of the injectors may be shortened if the priming valve is left in the unlocked position.

8. Clean any residual fuel from the engine components.

9. Once the engine runs smoothly, stop the engine. Turn the ignition switch to the OFF position.

Using the Fuel Priming Pump (If Equipped) to Prime the Fuel System

1. Turn the ignition to the OFF position.

2. Unlock the priming pump by turning the cap counterclockwise.

3. Purging air from the fuel system requires the air purge fitting to be opened three full turns. Open the air purge fitting. Do not remove the fitting.

4. Continue to operate the fuel priming pump until a strong resistance is felt. Listen for an audible click from the fuel manifold. The click will indicate that the valve has opened and the fuel system is pressurized. Lock the fuel priming pump.

Note: The life of the injectors may be shortened if the priming valve is left in the unlocked position.

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

5. Crank the engine. If the engine starts but the engine runs rough, continue to operate the engine at low idle until the engine runs smoothly.

Note: If the engine will not start, further priming is necessary. If the engine starts but the engine continues to misfire, further priming is necessary.

6. Observe the air purge fitting. When a small drop of fuel appears at the threads of the air purge fitting, close the air purge fitting . After the air purge fitting is closed, tighten the air purge fitting. Refer to Specifications, SENR3130 for the correct torque.

Note: Failure to tighten all fittings could result in serious fuel leaks.

7. Clean any residual fuel from the engine components.

8. Once the engine runs smoothly, stop the engine. Turn the ignition switch to the OFF position.

i02697860

Fuel System Primary Filter - Replace

SMCS Code: 1260-510

⚠ 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.

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: Caterpillar requires the filtration of distillate fuel through a fuel filter that has a rating of ten microns[c] absolute or less.

For information on the maintenance of the primary fuel filter, refer to the literature that is provided by the OEM of the vehicle.

i02686193

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.

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. Stop the engine. Turn the ignition switch to the OFF position or disconnect the battery. Refer to the Operation and Maintenance Manual, “Battery or Battery Cable - Disconnect” topic (Maintenance Section) for more information. Shut off the fuel supply valve (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.

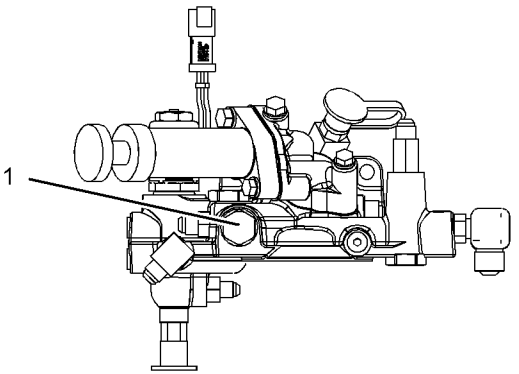


Illustration 57 g01269066

(1) Air purge fitting

2. In order to relieve fuel pressure, turn the air purge fitting counterclockwise by three full turns. Do not remove the fitting.

3. Remove the used fuel filter and discard the used fuel filter.

4. Close the air purge fitting. Refer to Special Publication, SENR3130, “Torque Specifications” for the proper torque.

5. Clean the gasket sealing surface of the fuel filter base. Ensure that all of the old gasket is removed. 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.

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 Hydraulic Electronic Unit Injectors. Caterpillar High Efficiency Fuel Filters meet these requirements. Consult your Caterpillar dealer for the proper part numbers.

6. Install the new fuel filter. Spin the fuel filter onto the fuel filter base until the gasket contacts the base. Instructions for the installation of the filter are printed on the side of each Caterpillar spin-on filter. For non-Caterpillar filters, refer to the installation instructions that are provided by the supplier of the filter.

7. Open the fuel supply valve. Turn the ignition switch to the ON position or reconnect the battery. Open the fuel supply valve (if equipped).

8. Prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime” topic (Maintenance Section) for more information. Start the engine and inspect the fuel system for leaks.

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

i02529854

Fuel System Water Separator - Inspect/Drain (If Equipped)

SMCS Code: 1263

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” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Drain any water from the water separator daily.

For more information on the inspection and draining procedures for the water separator, refer to the literature that is provided by the OEM of the vehicle, or refer to the literature that is provided by the OEM of the water separator.

i02571779

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

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.

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

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

Fill the fuel tank after operating the engine in order to drive out moist air. This 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 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.

Fuel Storage Tanks

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

- Weekly
- Oil change
- Refill of the tank

This will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank. A 4 micron [c] filter for the breather vent on the fuel tank is also recommended. Refer to Special Publication, SENR9620, “Improving Fuel System Durablity”.

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.

i02677555

Fumes Disposal Filter Element - Replace (Open Crankcase Ventilation (OCV) Filter)

SMCS Code: 1074

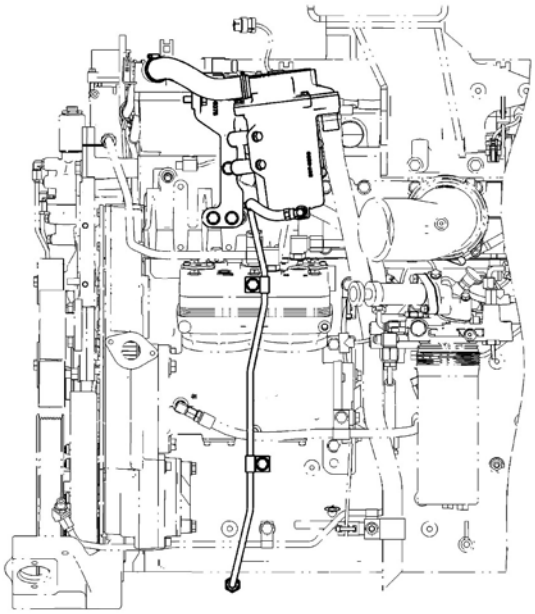


Illustration 58 g01345566

The filter for the open crankcase ventilation system 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.

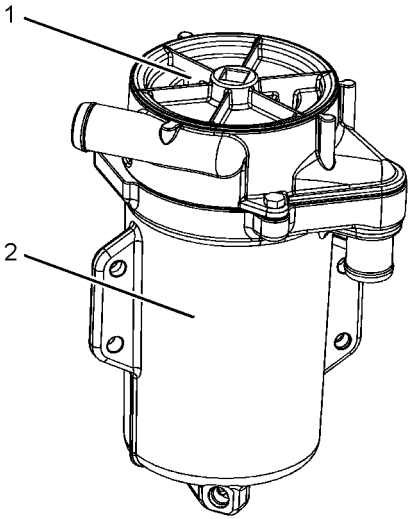


Illustration 59 g01345570

(1) Filter element
(2) Housing for the filter element

Remove the filter with a 12.7 mm (0.5 inch) allen wrench. The filter may not be used again. Dispose of the filter. Place a new filter inside the filter housing. Tighten the filter to the correct torque with a 12.7 mm (0.5 inch) allen wrench. The torque specification is located on the top of the filter.

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.

i02357283

Hoses and Clamps - Inspect/Replace

SMCS Code: 7554-040; 7554-510

⚠ 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.

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking
- Softness
- Loose clamps

Replace hoses that are cracked or soft. Tighten any loose clamps.

NOTICE

Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement

- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

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

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

Replace the Hoses and the Clamps

⚠ WARNING

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

1. Stop the engine. Allow the engine to cool.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

Note: Drain the coolant into a suitable, clean container. The coolant can be reused.

3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.

4. Remove the hose clamps.

5. Disconnect the old hose.

6. Replace the old hose with a new hose.

7. Install the hose clamps with a torque wrench.

Note: Refer to the Specifications, SENR3130, “Torque Specifications” in order to locate the proper torques.

8. Refill the cooling system.

9. Clean the cooling system filler cap. Inspect the cooling system filler cap’s gaskets. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.

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

i02559063

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.

The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the air nozzle is deadheaded.

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

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

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

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

Inspect the fins for damage. Bent fins may be opened with a "comb". Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

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

i02413678

Severe Service Application - Check

SMCS Code: 1000-535

Operation and maintenance practices affect the service life of the components when the engine is operated in severe service applications.

The following factors are crucial to the service life of the engine:

- The level of maintenance
- Operating speeds
- Operating loads
- Gross vehicle weights

Reduce the maintenance intervals for engines that operate in severe service applications.

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

- The weight is higher than the weight that is listed in the table.

Table 15

Engine Model	Gross Vehicle Weight
C7 On-highway truck engine	22680 kg (50000 lb)
C9 On-highway truck engine	27215 kg (60000 lb)
C13 On-highway truck engine	36287 kg (80000 lb)
C15 On-highway truck engine	36287 kg (80000 lb)

- Frequent low speed operation (less than 20 Miles per Hour)
- Use of fuel with more than 15 ppm sulfur
- No water separator

- Frequent operation in dusty conditions or off-highway operation
- High load factor operation (less than 6 miles per gallon or off-highway operation)
- Frequent high altitude operation above 1525 m (5000 ft)
- Extreme ambient temperature conditions that may cause the lubricating properties of the fuel to diminish
- Frequent plugging of the fuel filter
- Extended maintenance intervals of the fuel system
- Inadequate maintenance of fuel storage tanks (excessive water, sediment, microorganism growth, etc.)
- Extending maintenance beyond the recommended maintenance intervals
- Use of fuels, coolants or lubricants that are not specified by Caterpillar in Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluids Recommendations”
- Frequent operation at low idle (more than 20%)
- Frequent cold starts at temperatures below −18 °C (0 °F)
- Frequent dry starting (starting after more than 3 days of shutdown)
- Frequent hot shutdowns (minimum five minute cool down periods after high load factor operation)
- If the engine is stored over 3 months, see Special Instruction, SEHS9031, “Storage Procedure for Caterpillar Products”.

For additional information about severe service applications, consult your Caterpillar dealer.

i00651416

Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

Caterpillar Inc. recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for proper operation. Check the electrical connections and clean the electrical connections. Refer to the Service Manual for more information on the checking procedure and for specifications or consult your Caterpillar dealer for assistance.

i02778459

Turbocharger - Inspect

SMCS Code: 1052-040; 1052

Periodic inspection and cleaning is recommended for the turbocharger compressor housing (inlet side). A risk of corrosion exists for the compressor side of the turbocharger if ultralow sulfur diesel fuel is not used. A risk of corrosion exists for the compressor side of the turbocharger if unfiltered air intake occurs.

If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel can cause additional damage to the pistons, the valves, and the cylinder head. A failed turbocharger can cause damage to the diesel particulate filter.

NOTICE

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

Minor leakage of a turbocharger housing under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is repaired or replaced.

An inspection of the turbocharger can minimize unscheduled downtime. An inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

Note: Turbocharger components require precision clearances. The turbocharger cartridge must be balanced due to high rpm. Severe Service Applications can accelerate component wear. Severe Service Applications require more frequent inspections of the cartridge.

Removal and Installation

For options regarding the removal, installation, repair and replacement, consult your Caterpillar dealer. Refer to the Service Manual for this engine for the procedure and specifications.

Cleaning and Inspecting

1. Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil. Clean the interior of the pipes in order to prevent dirt from entering during reassembly.

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

3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the wheel, there is a possibility of a failed turbocharger oil seal.

   The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the inlet air (plugged air filters), which causes the turbocharger to slobber.

4. Use a dial indicator to check the end clearance on the shaft. If the measured end play is greater than the Service Manual specifications, the turbocharger should be repaired or replaced. An end play measurement that is less than the minimum Service Manual specifications could indicate carbon buildup on the turbine wheel. The turbocharger should be disassembled for cleaning and for inspection if the measured end play is less than the minimum Service Manual specifications.

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

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

7. Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

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Valve Actuators - Inspect/Adjust

SMCS Code: 1105-025; 1105-040

The valve actuators should be inspected and adjusted when adjustments to the following components occur.

- Valves
- Injectors
- Compression brakes

Refer to the System Operation, Test and Adjust Manual for the proper adjustment procedure.

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Walk-Around Inspection

SMCS Code: 1000-040

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.

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” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

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.

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. If it is necessary, make repairs or correct fluid levels.

- 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.
- Check the cooling system coolant level. 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. 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.
- Check the engine oil level. 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 tie-wraps around fuel lines.

- Check the water separator (if equipped) for water on a daily basis. Drain any water from the water separator. If necessary, drain the water and the sediment from fuel tanks in order to ensure that only clean fuel enters the fuel system.

- 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. Check the air cleaner service indicator (if equipped).

- 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.

- 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.

i00864339

Water Pump - Inspect

SMCS Code: 1361-040; 1361

Overconcentration of coolant additive (conditioner), mineral deposits from hard water, or cooling system contamination can accelerate the wear on the water pump seal.

Replace the Water Pump Seal, If Necessary

Inspect the water pump for leaks. 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.

Removal and Installation

Refer to the Service Manual for more information on the removal and installation of the water pump, or consult your Caterpillar dealer for assistance.

Inspect the Bearing for the Water Pump Pulley

Inspect the water pump pulley for unusual noise, excessive looseness and/or vibration of the bearings.

Refer to the Service Manual for more information on the removal and installation of the water pump pulley, or consult your Caterpillar dealer for assistance.

Warranty Section

Warranty Information

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Federal Emission Control Warranty

SMCS Code: 1000

Emissions Warranty

New Heavy Duty Engines Powering On-Highway Vehicles - MY 2007 and later C13 and C15

Caterpillar Inc. warrants to the initial owner and to the subsequent owner of a C13 or C15 diesel engine (powering an on-highway truck) that such an engine is:

1. Designed, built and equipped so as to conform, at the time of sale, with all applicable regulations adopted by the United States Environmental Protection Agency (EPA).

2. Caterpillar Inc. or any of its subsidiaries (“Caterpillar”) warrants new 12.5 liter up to and including 15.2 liter engines sold by it for use in powering on-highway vehicles to be free from defects in materials and workmanship for the following periods:

   - The **standard warranty period** for new engines powering on-highway vehicles, other than those powering recreational vehicles, fire trucks, emergency service vehicles and ambulances, is 24 months after date of delivery to the first user.

   - The **standard warranty period** for new engines powering recreational vehicles, fire trucks, emergency service vehicles and ambulances, is 60 months or 321,869 kilometers (200,000 miles), whichever occurs first, after date of delivery to the first user.

Extended Warranty

An **extended warranty period** applies to new engines powering on-highway vehicles (other than those powering recreational vehicles, fire trucks, emergency service vehicles and ambulances) and applies solely to the following components: cylinder block casting, crankshaft, connecting rod assemblies, cylinder head casting, camshaft, main bearing bolts, flywheel housing, oil cooler housing, water pump housing, air intake housing, and electronic control module.

These parts are warranted against defects in material and workmanship for 60 months or 804,672 kilometers (500,000 miles) or 10,000 operating hours, whichever occurs first after date of delivery to the first user. This warranty runs concurrently with the standard warranty period.

Following the standard warranty periods specified above, the emission warranty of 60 months or 161,000 kilometers (100,000 miles), whichever occurs first, after the date of delivery to the initial owner would be effective.

If an emission related part fails during any of the warranty periods, the part will be repaired or replaced. Any such part repaired or replaced under warranty is warranted for the remainder of the warranty period.

During the term of this warranty, Caterpillar Inc. will provide through a Caterpillar dealer or other establishment authorized by it, repair or replacement of any warranted part at no charge to the truck engine owner.

In an emergency, repairs may be performed at any service establishment, or by the owner, using any replacement part. It is recommended that emission related parts be replaced with genuine Caterpillar Inc. parts.

Caterpillar Inc. will reimburse the owner for their expenses, including diagnostic charges for such an emergency repair. These expenses shall not exceed the Caterpillar Inc. suggested retail price for all warranted parts replaced, and labor charges based on Caterpillar Inc. recommended time allowance for the warranty repair and the geographically appropriate hourly labor rate.

As a condition of reimbursement, replaced parts and receipted invoices must be presented at a place of business of a Caterpillar dealer or other establishment authorized by Caterpillar Inc.

This warranty covers the following emission related parts and components:

- Turbocharger System

- Inlet Manifold
- Fuel Injection System
- Crankcase Ventilation System
- Electronic Engine Control System
- Exhaust Aftertreatment System
- Clean Gas Induction System
- Aftertreatment Regeneration Device
- Miscellaneous valves, switches, hoses, clamps, connectors, tubing and sealing devices used in the above systems

Limitations and Responsibilities

The warranty is subject to the following:

Caterpillar Inc. Responsibilities

During the emission warranty period, if a defect in material or workmanship of an emission related part or component is found, Caterpillar Inc. will provide:

- New, Remanufactured or repaired parts and/or components, approved pursuant to EPA Regulations, required to correct the defect.

Note: Items replaced under this warranty become the property of Caterpillar Inc.

- Reasonable and customary labor, during normal working hours that is required to make the warranty repair. This includes labor in order to remove and install the engine, if necessary.

Owner Responsibilities

During the emission warranty period, the owner is responsible for:

- Premium or overtime labor costs, unless essential to prevent loss to perishable goods.

- Costs to investigate complaints which are not caused by a defect in Caterpillar Inc. material or workmanship.
- Providing timely notice of a warrantable failure and promptly making the product available for repair.

Limitations

Caterpillar Inc. is not responsible for resultant damages to an emission related part or component resulting from:

- Any application or installation Caterpillar Inc. deems improper.
- Attachments, accessory items or parts not sold nor approved by Caterpillar Inc.
- Improper truck engine maintenance, repair or abuse.
- Use of improper fuels, lubricants or fluids.
- Owner's unreasonable delay in making the product available after being notified of a potential product problem.

This warranty is in addition to Caterpillar Inc. standard warranty, applicable to the truck engine product involved.

Remedies under this warranty are limited to the provision of material and services as specified herein. Caterpillar Inc. is not responsible for incidental or consequential damages.

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California Emission Control Warranty Statement

SMCS Code: 1000

Owner Warranty Rights and Obligations

The California Air Resources Board (CARB) and Caterpillar Inc. are pleased to explain the emission control system warranty on your 2007 or later truck engine.

In California, new motor vehicle engines must be designed, built and equipped to meet the state's stringent anti-smog standards. Caterpillar Inc. must warrant the emission control system on your truck engine for the duration of time listed below provided there has not been any abuse, neglect or improper maintenance of your truck engine.

Your emission control system may include parts such as the fuel injection system and engine computer, if equipped. Also included may be hoses, connectors, clamps and other emission related components.

Where a warrantable condition exists, Caterpillar Inc. will repair the truck engine at no cost to the owner including diagnosis, parts and labor.

Manufacturer's Warranty Coverage

1. Caterpillar Inc. or any of its subsidiaries (Caterpillar) warrants new 12.5 liter up to and including 15.2 liter engines sold by it in California for use in powering on-highway vehicles to be free from defects in materials and workmanship for the following periods:

- The **standard warranty period** for new engines powering on-highway vehicles, other than those powering recreational vehicles, fire trucks, emergency service vehicles and ambulances is 24 months after date of delivery to the first user.

- The **standard warranty period** for new engines powering recreational vehicles, fire trucks, emergency service vehicles and ambulances, is 60 months or 321,869 kilometers (200,000 miles), whichever occurs first, after date of delivery to the first user.

Extended Warranty

An **extended warranty period** applies to new engines powering on-highway vehicles (other than those powering recreational vehicles, fire trucks, emergency service vehicles and ambulances) and applies solely to the following components: cylinder block casting, crankshaft, connecting rod assemblies, cylinder head casting, camshaft, main bearing bolts, flywheel housing, oil cooler housing, water pump housing, air intake housing, and electronic control module.

These parts are warranted against defects in material and workmanship for 60 months or 804,672 kilometers (500,000 miles) or 10,000 operating hours, whichever occurs first after date of delivery to the first user. This warranty runs concurrently with the standard warranty period.

Following the standard warranty periods specified above, the emission warranty of 60 months, 161,000 kilometers (100,000 miles), or 3000 service hours of operation, whichever occurs first, after the date of delivery to the initial owner would be effective.

If an emission related part or component on your truck engine is defective, the part or component will be repaired or replaced by Caterpillar Inc. This is your emission control system WARRANTY.

Owner's Warranty Responsibilities

- As the truck engine owner, you are responsible for the performance of the required maintenance listed in the truck engine owner's manual (Operation and Maintenance Manual). Caterpillar Inc. recommends that you retain all receipts and records covering the maintenance on your truck engine, but cannot deny warranty solely for the lack of receipts and records or for your failure to ensure the performance of all scheduled maintenance.

- You are responsible for presenting your truck engine to a Caterpillar Inc. dealer as soon as a truck engine problem exists. The warranty repairs should be completed in a reasonable amount of time, not to exceed 30 days.

- As the truck engine owner, you should also be aware that Caterpillar Inc. may deny you warranty coverage if your truck engine or an emission component or part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

If you have questions regarding your warranty rights and responsibilities, contact:

Caterpillar Inc.
Manager, Truck Engine Business
P.O. Box 0600
Mossville, IL 61552
Phone 800-447-4986

OR

California Air Resources Board (CARB)
9528 Telstar Ave.
El Monte, CA 91731

Emissions Warranty

Caterpillar Inc. warrants to the initial owner and subsequent owner of a diesel engine (powering an on-highway truck), that such an engine is:

1. Designed, built and equipped so as to conform, at the time of sale, with all applicable regulations adopted by the California Air Resources Board (CARB).

2. Free from defects in materials and workmanship in specific emission related parts for a period of 60 months, 161 000 km (100 000 miles) or 3000 service hours of operation, whichever occurs first, after the date of delivery to the initial owner.

If an emission related part fails during the warranty period, it will be repaired or replaced. Any such part repaired or replaced under warranty is warranted for the remainder of the warranty period.

During the term of this warranty, Caterpillar Inc. will provide through a Caterpillar dealer or other establishment authorized by it, repair or replacement of any warranted part at no charge to the truck engine owner.

In an emergency, repairs may be performed at any service establishment, or by the owner, using any replacement part. It is recommended that emission related parts be replaced with genuine Caterpillar Inc. parts.

The manufacturer shall reimburse the owner for expenses, including diagnosis not to exceed the manufacturer's suggested retail price for all warranted parts replaced and labor charges based on the manufacturer's recommended time allowance for the warranty repair and the geographically appropriate hourly labor rate.

A part not being available within 30 days or a repair not being complete within 30 days constitutes an emergency.

As a condition of reimbursement, replaced parts and receipted invoices must be presented at a place of business of a Caterpillar dealer or other establishment authorized by Caterpillar Inc.

This warranty covers the following emission related parts and components.

- Exhaust Aftertreatment System (If Equipped)

- Fuel Injection System

- Inlet Manifold
- Turbocharger System
- Electronic Engine Control System
- Miscellaneous hoses, clamps, connectors and sealing devices used in the above systems.

Any replacement part may be used for maintenance or repairs. The owner should ensure that such parts are equivalent in design and durability to genuine Caterpillar parts. Use of non-genuine Caterpillar parts does not invalidate the warranty. However, Caterpillar Inc. is not liable for parts which are not genuine Caterpillar parts.

Limitations and Responsibilities

These warranties are subject to the following:

Caterpillar Inc. Responsibilities

During the emission warranty period, if a defect in material or workmanship of a warranted part or component is found, Caterpillar Inc. will provide:

- New, Remanufactured or repaired parts and/or components required to correct the defect.

Note: Items replaced under this warranty become the property of Caterpillar Inc.

- Reasonable and customary labor, during normal working hours that is required to make the warranty repair. This includes diagnosis and labor to remove and install the engine, if necessary.

Owner Responsibilities

During the emission warranty period, the owner is responsible for:

- The performance of all required maintenance. A warranty claim will not be denied because the scheduled maintenance was not performed. However, if the lack of required maintenance was the reason for the repair, then the claim will be denied.
- Premium or overtime labor costs, unless essential to prevent loss to perishable goods.

- Costs to investigate complaints which are not caused by a defect in Caterpillar Inc. material or workmanship.
- Providing timely notice of a warrantable failure and promptly making the product available for repair.

Limitations

Caterpillar Inc. is not responsible for resultant damages to an emission related part or component resulting from:

- Any application or installation Caterpillar Inc. deems improper as explained in the Operation and Maintenance Manual.
- Attachments, accessory items or parts not authorized for use by Caterpillar Inc.
- Improper truck engine maintenance, repair or abuse.
- Owner's unreasonable delay in making the product available after being notified of a potential product problem.

This warranty is in addition to Caterpillar Inc. standard warranty, applicable to the truck engine product involved.

Remedies under this warranty are limited to the provision of material and services as specified herein. Caterpillar Inc. is not responsible for incidental or consequential damages such as downtime or loss-of-use of truck.

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Emissions Warranty Information

SMCS Code: 1000

Maintenance Recommendations

Caterpillar Inc. truck engines are certified by the United States Environmental Protection Agency (EPA) and the California Air Resources Board in order to comply with exhaust emission standards and gaseous emission standards that are prescribed by law at the time of manufacture.

Efficiency of the emission control and the engine performance depends on adherence to proper operation and maintenance recommendations and use of recommended fuels and lubricating oils. According to recommendations, major adjustments and repairs should be made by your authorized Caterpillar dealer.

Various chemical fuel additives which claim to reduce visible smoke are available commercially. Although additives have been used to solve some isolated smoke problems in the field, additives are not recommended for general use. The engines should be certified without smoke depressants according to federal smoke regulations.

Take corrective steps immediately after worn parts which may affect emission levels are discovered in order to ensure the proper operation of the emission control systems. The use of genuine Caterpillar parts is recommended. Suppliers of non-Caterpillar parts must ensure the owner that the use of such parts will not adversely affect emission levels.

Regular maintenance intervals with a special emphasis on the following items are necessary in order to keep exhaust emissions within acceptable limits for the useful life of the engine. Refer to the Operation and Maintenance Manual, “Severe Service Application - Check” topic (Maintenance Section). If the engine is operating under severe conditions, adjust the maintenance schedule accordingly. See your authorized Caterpillar dealer in order to help analyze your specific application, operating environment and maintenance schedule adjustments.

The following information is an explanation of maintenance items for emission related components. See the Operation and Maintenance Manual, “Maintenance Interval Schedule” (Maintenance Section) for the specific interval for the following items.

EXHAUST AFTERTREATMENT SYSTEM – Aftertreatment systems are sensitive to the type of fuel and lubricants used and the operating schedule. Poor quality fuel, lubricants or fluids may cause increases in exhaust backpressure or clogging resulting in loss of power. An authorized Caterpillar truck engine dealer can determine if the aftertreatment system needs service.

CLEAN GAS INDUCTION (CGI) – A maintenance indicator light monitors the CGI system. An authorized Caterpillar truck engine dealer can determine if the CGI system needs service.

FUEL INJECTORS – Fuel injector tips are subject to wear as a result of fuel contamination. This damage can cause the following conditions: an increase in fuel consumption, black smoke, misfire, and rough running engine. The fuel injector should be inspected, tested and replaced, if necessary. Fuel injectors can be tested by an authorized Caterpillar truck engine dealer.

Additionally, a maintenance indicator light indirectly monitors the fuel injector tip component of the Aftertreatment Regeneration Device (ARD). An authorized Caterpillar truck engine dealer can determine if the ARDsystem needs service.

TURBOCHARGER – Check for any unusual sound or vibration in the turbocharger. Inspect the inlet piping and connections and inspect the exhaust piping and connections. Check the condition of the bearing. Perform the maintenance that is described in the Operation and Maintenance Manual, “Maintenance Interval Schedule” (Maintenance Section).

ELECTRONIC ENGINE CONTROL – This component is a device that is designed to control engine operation with respect to the amount of fuel injected, the injection timing as well as controlling the black smoke emission of the engine during the engine’s operation when low inlet manifold pressure exists.

Any erratic engine behavior may indicate a need for replacement or repair. Your Caterpillar dealer is equipped with the necessary tools, personnel and procedures in order to perform this service.

The owner is encouraged to keep adequate maintenance records. However, the absence of such records will not invalidate the warranty. Refer to the Operation and Maintenance Manual, “Maintenance Log” (Reference Materials Section).

The vehicle owner may perform routine maintenance, repairs and other work that is outside of the warranty. The work may be done at any repair facility. Such work does not need to be performed at a designated station that is determined by the warranty in order for the warranty to remain in force.

Customer Assistance (Emission Control Systems Warranty)

Caterpillar Inc. intends to ensure that the Emission Control Systems warranty is properly administered. If you do not receive adequate warranty service under the Emission Control Systems Warranty, call or write to the following address:

Caterpillar Inc.
Manager, Truck Engine Business
P.O. Box 0600 Mossville, IL 61552
309-578-6288

Authorized dealers are recommended for major maintenance and for repair work. Authorized dealers are staffed with trained personnel and proper tools. Authorized dealers are aware of the latest maintenance methods and procedures. If owners or other persons desire to perform the work, a Service Manual should be purchased and current service information should be obtained from a Caterpillar dealer.

Refer to the TEPS Directory for information regarding an authorized dealer or call the following toll free number:

1-800-447-4986

Reference Information Section

Customer Service

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Customer Assistance

SMCS Code: 1000

USA and Canada

When a problem arises concerning the operation of your engine or concerning the service of your engine, call the phone number that is provided on the label that is located on the engine.

The Caterpillar representative may determine that your problem can best be handled by your local Caterpillar dealer.

Your satisfaction is a primary concern to Caterpillar and to Caterpillar dealers. If you have a problem that has not been handled to your complete satisfaction, follow these steps:

1. Discuss your problem with a manager from the dealership.

2. If your problem cannot be resolved at the dealer level without additional assistance, use the phone number that is listed below to talk with a Field Service Coordinator:

   1-800-447-4986

   The normal hours are from 8:00 to 4:30 Monday through Friday Central Standard Time.

3. If your needs have not been met still, submit the matter in writing to the following address:

   Caterpillar Inc.
   Manager, Customer Service, Engine Division
   Mossville Bldg AC
   P.O. Box 610
   Mossville, Illinois 61552-0610

Please keep in mind: probably, your problem will ultimately be solved at the dealership, using the dealership's facilities, equipment, and personnel. Therefore, follow the steps in sequence when a problem is experienced.

Outside of the USA and of Canada

When a problem arises concerning the operation of an engine or concerning the service of an engine, the problem will normally be managed by the dealer in your area.

If a problem arises outside the USA and outside Canada, and if the problem cannot be resolved at the dealer level, consult the appropriate Caterpillar office.

Latin America, Mexico, Carribean
Caterpillar Americas Co.
701 Waterford Way, Suite 200
Miami, FL 33126-4670
USA
Phone: 305-476-6800
Fax: 305-476-6801

Europe, Africa, and Middle East
Caterpillar Overseas S.A.
76 Route de Frontenex
P.O. Box 6000
CH-1211 Geneva 6
Switzerland
Phone: 22-849-4444
Fax: 22-849-4544

Far East
Caterpillar Asia Pte. Ltd.
7 Tractor Road
Jurong, Singapore 627968
Republic of Singapore
Phone: 65-662-8333
Fax: 65-662-8302

China
Caterpillar China Ltd.
37/F., The Lee Gardens
33 Hysan Avenue
Causeway Bay
G.P.O. Box 3069
Hong Kong
Phone: 852-2848-0333
Fax: 852-2848-0440

Japan
Shin Caterpillar Mitsubishi Ltd.
SBS Tower
10-1, Yoga 4-Chome
Setagaya-Ku, Tokyo 158-8530
Japan
Phone: 81-3-5717-1150
Fax: 81-3-5717-1177

Japan
Caterpillar Power Systems, Inc.
SBS Tower (14th floor)
4-10-1, Yoga
Setagaya-Ku, Tokyo 158-0097
Phone: 81-3-5797-4300
Fax: 81-3-5797-4359

Australia and New Zealand
Caterpillar of Australia Ltd.
1 Caterpillar Drive
Private Mail Bag 4
Tullamarine, Victoria 3043
Australia
Phone: 03-9953-9333
Fax: 03-9335-3366

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Ordering Replacement Parts

SMCS Code: 7567

⚠ WARNING

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

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

Quality Caterpillar replacement parts are available from Caterpillar dealers throughout the world. Caterpillar dealers' parts inventories are up-to-date. The parts stocks include all of the parts that are normally needed to protect your Caterpillar engine investment.

When you order parts, please specify the following information:

- Part number
- Part name
- Quantity

If there is a question concerning the part number, please provide your dealer with a complete description of the needed item.

When a Caterpillar engine requires maintenance and/or repair, provide the dealer with all the information that is stamped on the Information Plate. This information is described in this Operation and Maintenance Manual (Product Information Section).

Discuss the problem with the dealer. Inform the dealer about the conditions of the problem and the nature of the problem. Inform the dealer about when the problem occurs. This will help the dealer in troubleshooting the problem and solving the problem faster.

Reference Materials

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Reference Material

SMCS Code: 1000

The following literature can be obtained through any Caterpillar dealer.

Coolants

- Data Sheet, PEHJ0067, “Cat ELC (Worldwide Formulation)”
- Data Sheet, PEHP7057, “Coolant Analysis”
- Data Sheet, PEHP9554, “Diesel Engine Antifreeze/Coolant (DEAC)”
- Special Publication, PMEP5027, “Label - ELC Coolant/AntiFreeze Label”
- Special Publication, SEBD0518, “Know Your Cooling System”
- Special Publication, SEBD0970, “Coolant and Your Engine”

Fuels

- Special Publication, LEGT6380, “Understanding Tractor-Trailer Performance: A Guide to Specing and Driving Cat Engines”
- Special Publication, SEBD0717, “Diesel Fuels and Your Engine”
- Special Publication, SENR9620, “Improving Fuel System Durability”

Greases

- Data Sheet, NEHP6010, “Cat Ultra 5Moly Grease”
- Special Instruction, NEHP6011, “Arctic Platinum Grease Spec Sheet”
- Data Sheet, NEHP6012, “Cat Desert Gold Grease”
- Data Sheet, NEHP6015, “Caterpillar Special Purpose Grease”

- Special Publication, PEGJ0035, “Grease Selection Guide”
- Data Sheet, PEHP0002, “Molybdenum Grease Data Sheet”
- Data Sheet, PEHP0088, “Cat Multipurpose Grease”

Lubricants

- Data Sheet, PEHJ0159, “DEO-ULS Data Sheet”
- Special Publication, PEHP6001, “How To Take A Good Oil Sample”
- Special Publication, SEBD0640, “Oil and Your Engine”

S·O·S Services

- Special Publication, NEHP6013, “S·O·S Fluids Analysis Products”
- Special Publication, PEDP7035, “Optimizing Oil Change Intervals”
- Special Publication, PEDP7036, “S·O·S Fluids Analysis Cornerstone”
- Special Publication, PEHP7057, “S·O·S Coolant Analysis”
- Special Instruction, PEHP7058, “S·O·S Trend Analysis Module Data Sheet”
- Special Publication, PEHP7076, “Understanding S·O·S Services Tests”

Miscellaneous

- Special Publication, LEDT2254, “Cat Answers Your Questions About Truck Performance”
- Special Instruction, NEHS0526, “Service Technology Group/Application Guide”
- Special Instruction, NENG2500, “Caterpillar Dealer Service Tool Catalog”
- Special Publication, PECP9067, “One Safe Source”
- Special Instruction, REHS0354, “Charging System Troubleshooting for All Engines”

- Special Instruction, REHS0871, “Electronic Installation Guide”.
- Special Instruction, REHS1413, “Installation and Operation of Cat Messenger for On-highway Engines”
- Special Instruction, REHS1807, “Diesel Particulate Filter Installation Guide”
- Service Manual, RENR1282, “Truck Engines Electronic PTO Installation and Applications”
- Service Manual, RENR9805, “C13 On-highway Engine (2007 Emissions)”
- Service Manual, RENR9810, “C15 On-highway Engine (2007 Emissions)”
- Special Publication, SEBF8029, “Index to Guidelines for Reusable Parts and Salvage Operations”
- Special Publication, SEBF8062, “Procedure to Inspect and Clean Air Filters”
- Special Publication, SEBU6385, “Caterpillar On-highway Diesel Engine Fluids Recommendations”
- Special Instruction, SEHS7332, “Warning Tag - Danger Do Not Operate”
- Special Instruction, SEHS7633, “Battery Test Procedure”
- Special Instruction, SEHS8622, “Using the FT-1984 Aftercooler Testing Group”
- Special Instruction, SEHS9031, “Storage Procedure for Caterpillar Products”
- Specifications, SENR3130, “Torque Specifications Module”
- Special Instruction, SMHS7001, “Assembly of Fan Drive Pulley Assemblies”
- Special Publication, “Truck Engine Application and Installation Guide” (See your Caterpillar dealer.)

Additional Reference Material

The “Engine Fluids Data Book” can be obtained from the following locations: local technological society, local library, and local college. If necessary, consult EMA at the following address:

Engine Manufacturers Association
Two North LaSalle Street, Suite 2200
Chicago, Illinois, USA 60602
E-mail: ema@enginemanufacturers.org
(312) 827-8700
Facsimile: (312) 827-8737

The “Society of Automotive Engineers (SAE) Specifications” can be found in your SAE handbook. This publication can also be obtained from the following locations: local technological society, local library, and local college. If necessary, consult SAE at the following address:

SAE International
400 Commonwealth Drive
Warrendale, PA, USA 15096-0001
Telephone: (724) 776-4841

The “American Petroleum Institute Publication No. 1509” can be obtained from the following locations: local technological society, local library, and local college. If necessary, consult API at the following address:

American Petroleum Institute
1220 L St. N.W.
Washington, DC, USA 20005
Telephone: (202) 682-8000

The International Organization for Standardization (ISO) offers information and customer service regarding international standards and standardizing activities. ISO can also supply information on the following subjects that are not controlled by ISO: national standards, regional standards, regulations, certification, and related activities. Consult the member of ISO in your country.

International Organization for Standardization (ISO)
1, rue de Varembé
Case postale 56
CH-1211 Genève 20
Switzerland
Telephone: +41 22 749 01 11
Facsimile: +41 22 733 34 30
E-mail: central@iso.ch
Web site: http://www.iso.ch

European classifications are established by the Counseil International Des Machines a Combustion (CIMAC) (International Council on Combustion Engines).

CIMAC Central Secretariat
Lyoner Strasse 18
60528 Frankfurt
Germany
Telephone: +49 69 6603 1567
Facsimile: +49 69 6603 1566

Emissions Warranty

This engine may be Certified and this engine may be covered by an Emissions Warranty. The engine is certified if the engine has a special label that states that the engine is certified. A Caterpillar dealer can also inform you if the engine is Certified.

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Maintenance Records

SMCS Code: 1000

Caterpillar Inc. recommends the retention of accurate maintenance records. Accurate maintenance records can be used for the following purposes:

- Demonstration of compliance with the required maintenance practices and maintenance intervals
- Determination of operating costs
- Establishment of maintenance schedules for other engines that are operated in the same environment

Maintenance records can be used for a variety of other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is well managed. Accurate maintenance records can help your Caterpillar dealer to fine tune the recommended maintenance intervals in order to meet the specific operating situation. This should result in a lower engine operating cost.

Keep records 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. Keep the following documents as proof of maintenance or repair for warranty:

- Dealer work orders and itemized bills
- Logs of engine performance
- Maintenance logs
- Owner’s repair costs
- Owner’s receipts
- Trend charts

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Maintenance Log

SMCS Code: 1000

Table 16

Engine Model	**Customer Identifier**
Serial Number	**Arrangement Number**

Table 17

Service Hours	**Quantity of Fuel**	**Serviced Item**	**Date**	**Authorization**

(continued)

(Table 17, contd)

Service Hours	Quantity of Fuel	Serviced Item	Date	Authorization

Index

A

B

C

D

E

F

G

H

I

L

M

O

P

R

S

T

V

W

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:	_____	_____	_____

Printed in U.S.A.