CATERPILLAR®

SEBU7695-06
October 2005



Operation and Maintenance Manual

C11, C13, and C15 On-highway Engines

KCA1-Up (Engine)
KCB1-Up (Engine)
JAM1-Up (Engine)
BXS1-Up (Engine)
MXS1-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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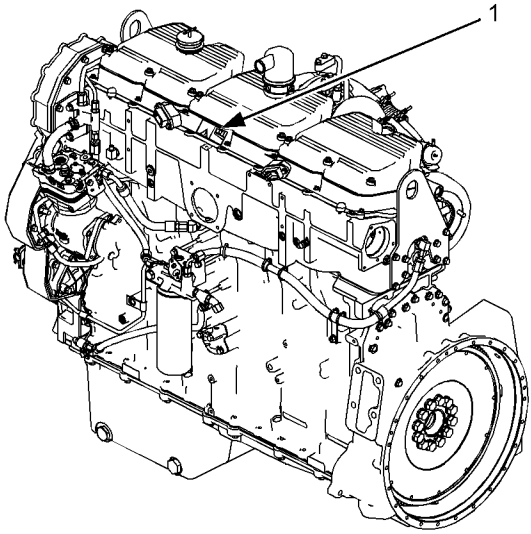
Safety Messages

SMCS Code: 1000; 7405

There may be several specific warning signs on your engine. The exact location and a description of the warning signs are reviewed in this section. Please become familiar with all warning signs.

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

Replace any warning sign that is damaged or missing. If a warning sign is attached to a part of the engine that is replaced, install a new warning sign on the replacement part. Your Caterpillar dealer can provide new warning signs.



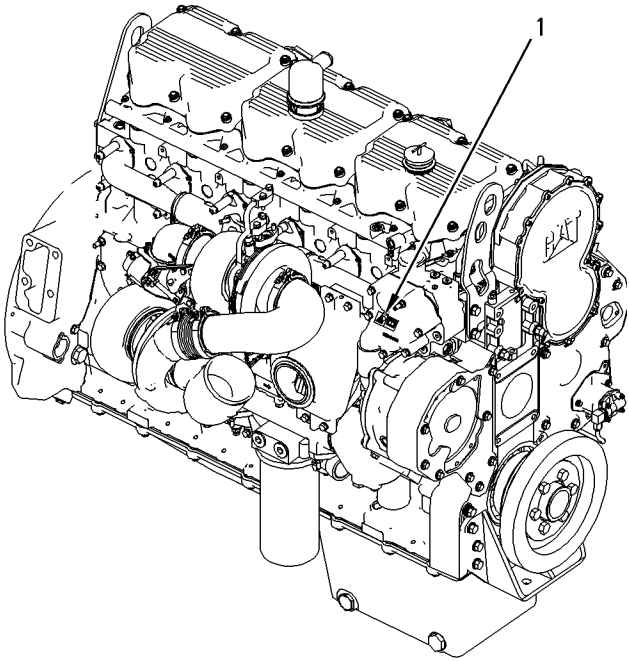
g01017254

Illustration 1

Typical example

C15 is shown.

(1) Universal Warning



g00978799

Illustration 2

Typical example

C15 is shown.

(1) Universal Warning

(1) Universal Warning

⚠ WARNING

Do not operate or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manuals. Failure to follow the instructions or heed the warnings could result in serious injury or death.

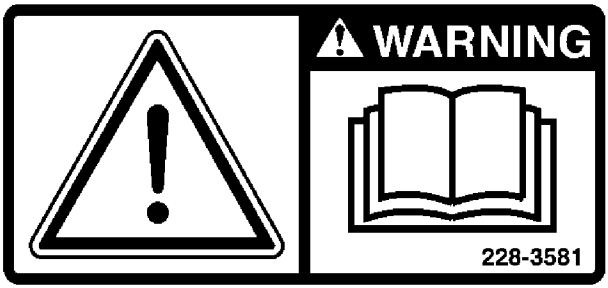


Illustration 3 g00934493

One warning label for the Universal Warning is located on the valve cover base on the left side of the engine. The label is on the fourth flat surface from the rear of the engine.

The other warning label for the Universal Warning is located on the vertical surface of the water temperature regulator housing just below the round boss that is cast into the housing.

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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.

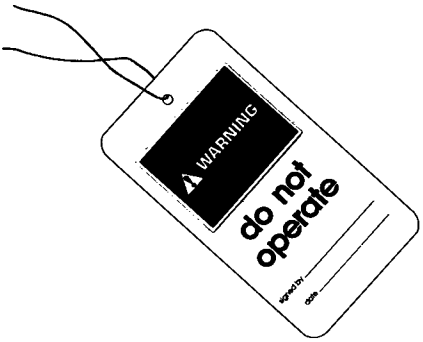


Illustration 4 g00104545

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. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the hydraulic system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings or related items are disconnected.

Coolant

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

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

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

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

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

Oils

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

Batteries

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

i01806909

Fire Prevention and Explosion Prevention

SMCS Code: 1000; 7405



Illustration 5 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.

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 6 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.

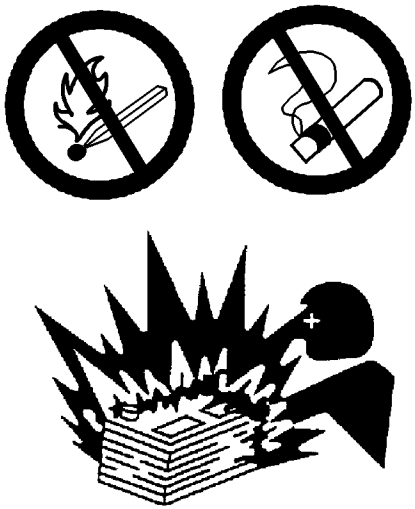


Illustration 7 g00704135

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.

Ether (If Equipped)

Ether is flammable and poisonous.

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

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

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

⚠ 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.

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

Lines, Tubes and Hoses

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

Repair any lines that are loose or damaged. Leaks can cause fires. Consult your 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.

i01359666

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.

i01372247

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.

i00911989

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.

i01807173

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.

Ether (If Equipped)

⚠ 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.

Ether is poisonous and flammable. Do not inhale ether, and do not allow ether to contact the skin. Personal injury could result. Do not smoke while ether cylinders are changed. Use ether in well ventilated areas.

Keep ether cylinders out of the reach of unauthorized persons. Store ether cylinders in authorized storage areas only. Do not store ether cylinders in direct sunlight or at temperatures above 39 °C (102 °F). Discard the ether cylinders in a safe place. Do not puncture the ether cylinders. Do not burn the ether cylinders.

i01462046

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

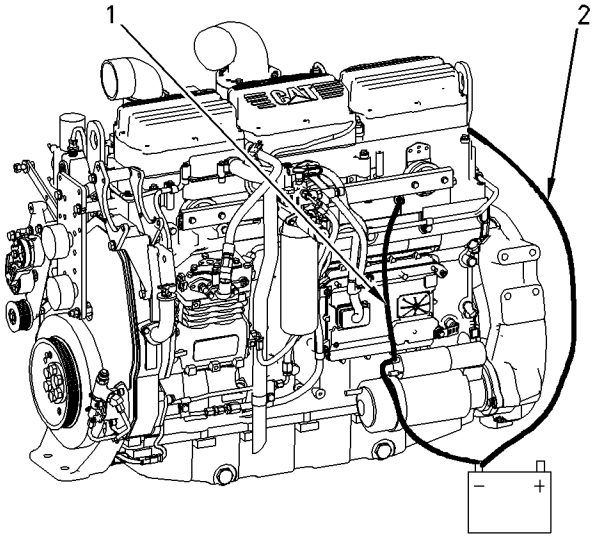
SMCS Code: 1000; 1400

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 Operation and Maintenance Manual, SEBU7729, “Starting the Engine” for specific starting instructions.

Grounding Practices



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Illustration 8

Typical example

Engine ground

(1) Recommended connections
(2) Alternate connections

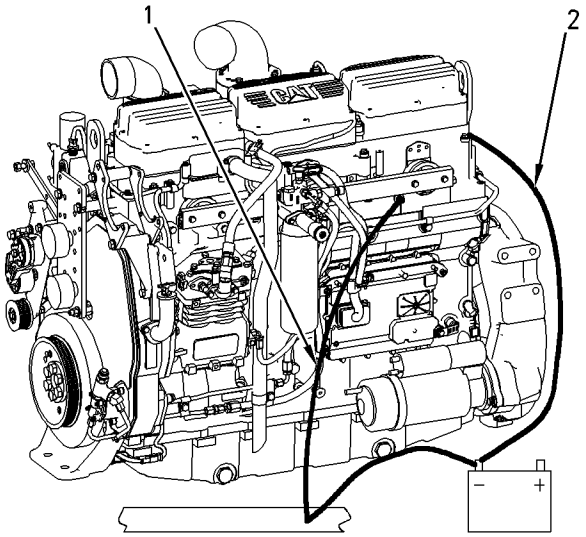


Illustration 9 g00944000

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.

i01563743

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.

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. These 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

i02276735

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.

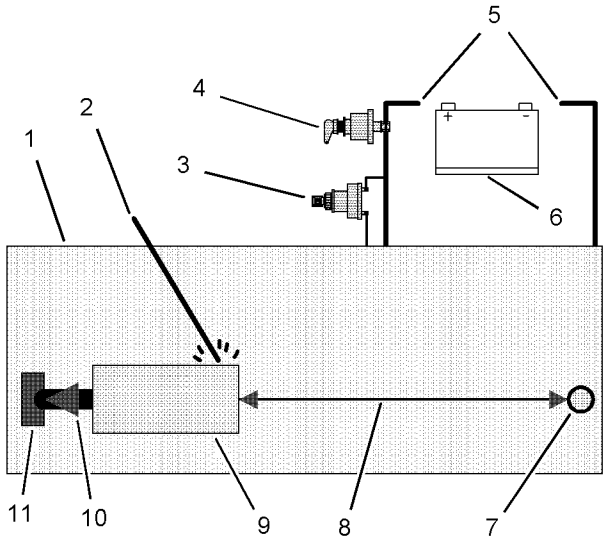


Illustration 10 g01075639

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

i02221806

Model View Illustrations

SMCS Code: 1000

C11 and C13 On-highway Engines

KCA1-UP

KCB1-UP

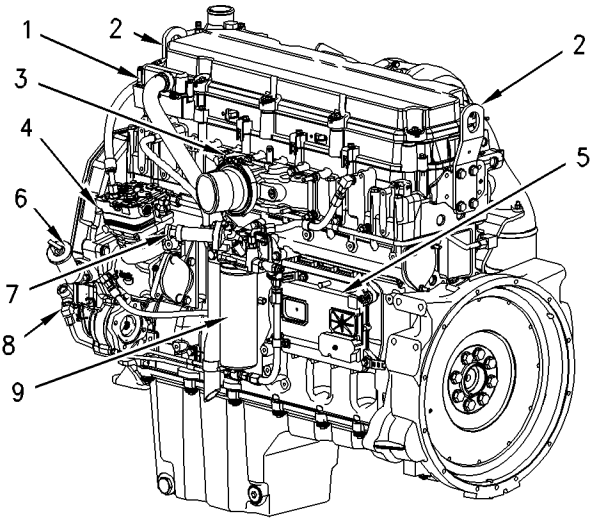


Illustration 11 g00939115

(1) Engine crankcase breather
(2) Lifting eyes
(3) Inlet air manifold
(4) Air compressor
(5) Engine control module (ECM)
(6) Engine oil filler
(7) Fuel priming pump
(8) Fuel transfer pump
(9) Fuel filter

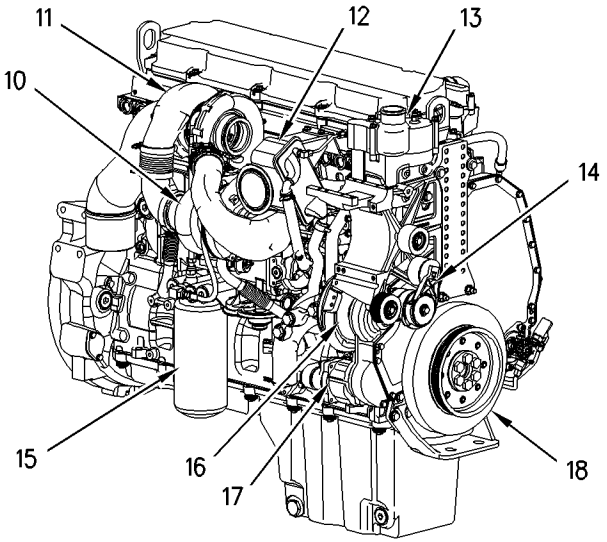
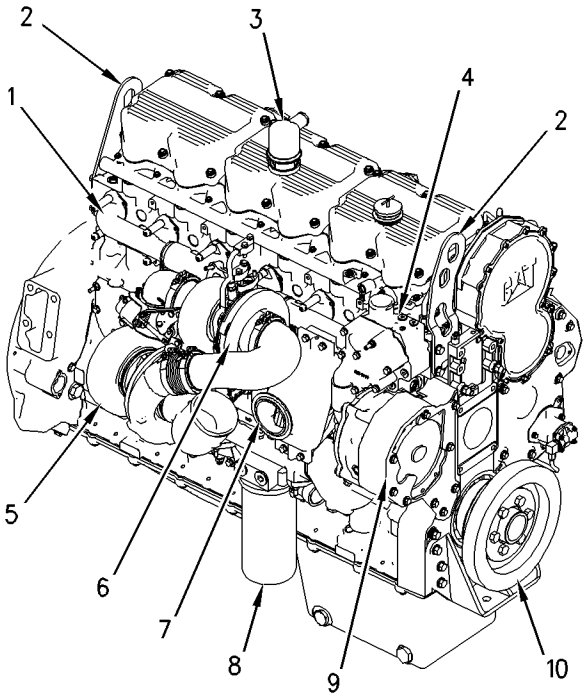


Illustration 12 g00939112

(10) Low pressure turbocharger
(11) High pressure turbocharger
(12) Cooler
(13) Water temperature regulator
(14) Belt tensioner
(15) Engine oil filter
(16) Water pump
(17) Engine oil pump
(18) Vibration damper

C15 On-highway Engines

BXS1-UP



g00947237

Illustration 13

(1) exhaust manifold
(2) Lifting eyes
(3) Engine crankcase breather
(4) Water temperature regulator housing
(5) Low pressure turbocharger
(6) High pressure turbocharger
(7) Cooler
(8) Engine oil filter
(9) Water pump
(10) Vibration damper

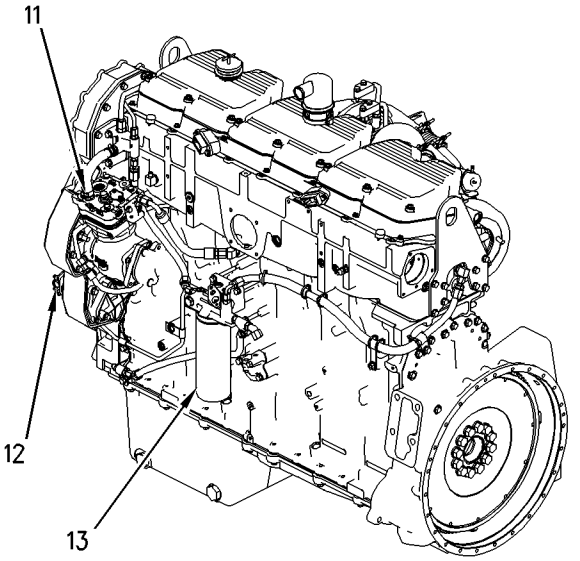


Illustration 14 g00947236

(11) Air compressor (12) Fuel transfer pump (13) Fuel filter

C15 On-highway Engines

MXS1-UP

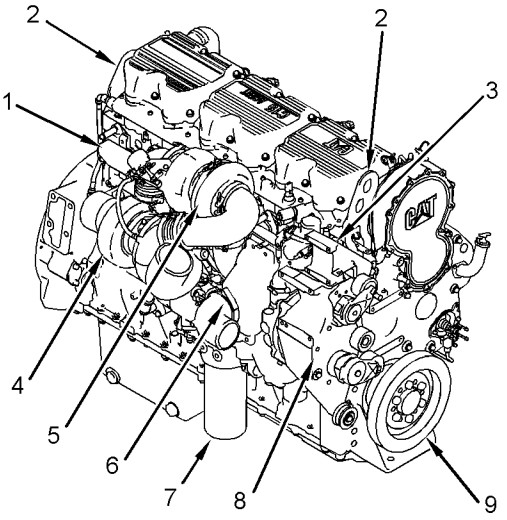


Illustration 15 g01085177

(1) Inlet air manifold
(2) Lifting eyes
(3) Water temperature regulator housing
(4) Low pressure turbocharger
(5) High pressure turbocharger
(6) Cooler
(7) Engine oil filter
(8) Water pump
(9) Vibration damper

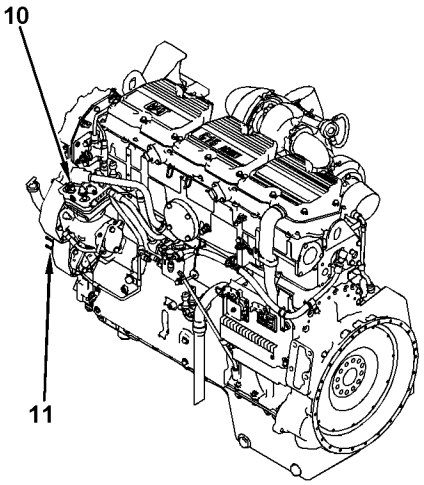


Illustration 16 g01085182

(10) Air compressor (11) Fuel transfer pump

i02176916

Engine Description

SMCS Code: 1000

Table 1

C11 (S/N: KCA) On-highway Engine Specifications	
Cylinders and Arrangement	In-line six cylinder
Bore	130 mm (5.2 inch)
Stroke	140 mm (5.5 inch)
Displacement	11.1 L (677 in^3)
Firing Order	1-5-3-6-2-4
Rotation (flywheel end)	Counterclockwise

Table 2

C13 (S/N: KCB) On-highway Engine Specifications	
Cylinders and Arrangement	In-line six cylinder
Bore	130 mm (5.2 inch)
Stroke	157 mm (6.2 inch)
Displacement	12.5 L (763 in^3)
Firing Order	1-5-3-6-2-4
Rotation (flywheel end)	Counterclockwise

Table 3

C15 (S/N: BXS; MXS) On-highway Engine Specifications	
Cylinders and Arrangement	In-line six cylinder
Bore	137.2 mm (5.4 inch)
Stroke	171.5 mm (6.8 inch)
Displacement	15.2 L (928 in^3)
Firing Order	1-5-3-6-2-4
Rotation (flywheel end)	Counterclockwise

The electronic on-highway engines that are covered by this manual have the following characteristics: direct fuel injection, electronic unit injection that is mechanically actuated, turbocharged, and air-to-air aftercooled (ATAAC).

The electronic engine control system provides the following functions: electronic governing, automatic air to fuel ratio control, torque rise shaping, injection timing control, and system diagnostics.

Several programmable features are included in the electronic control: cruise control, governing the PTO, vehicle speed limiting, rpm limit for high gears, rpm limit for low gears, top engine limit, idle shutdown timer, and control for the engine retarder (compression brake).

Additional benefits provide engine fuel economy, serviceability, and operator comfort. The additional benefits include the following features: improved cold starting capability, resistance to tampering, diagnostics, progressive shift engine speed control, data link (SAE J1587) for the American Trucking Association (ATA), and optional Engine Monitoring Package.

An electronic governor controls the output of the unit injectors in order to maintain the engine rpm that is desired. The functions of the governor include a programmable low idle and a 20 rpm to 200 rpm governor overrun.

Very high injection pressures are produced by electronically controlled, mechanically actuated unit injectors. The injectors combine the pumping and the electronic fuel metering (duration and timing) during injection. The unit injectors accurately control smoke limiting, white smoke, and engine acceleration rates.

Each cylinder has one unit injector. Individual unit injectors meter the fuel. The individual unit injectors also pump the fuel. The metering and the pumping is done under high pressure. High injection pressures help to reduce fuel consumption and emissions. The use of this type of unit injector provides total electronic control of injection timing. The injection timing varies with engine operating conditions. The engine performance is optimized in the following areas:

- Starting
- Emissions
- Noise
- Fuel consumption
- Driveability

The timing advance is achieved through precise control of the injector firing. Engine speed is controlled by adjusting the firing duration. The information is provided to the Engine Control Module (ECM) by a engine speed/timing sensor. The information is for detection of cylinder position and engine speed.

The engines have built-in diagnostics in order to ensure that all of the components are functioning and operating properly. In the event of a system component deviation from the programmed limits, the operator will be alerted to the condition by a CHECK ENGINE/DIAGNOSTIC lamp that is mounted on the dashboard. An electronic service tool that is provided by Caterpillar or the cruise control switches (if equipped) may be used to read the numerical code of the diagnostic flash code. There are three types of diagnostic codes: ACTIVE, LOGGED, and EVENT. These codes are logged and stored in the ECM. Refer to the Operation and Maintenance Manual, “Engine Diagnostics” for additional information.

The cooling system consists of the following items: a centrifugal pump that is driven by a gear, water temperature regulator, an oil cooler, and an OEM supplied radiator that incorporates a shunt system.

The engine lubricating oil is supplied by a gear type pump. The engine lubricating oil is cooled and filtered. Bypass valves provide unrestricted flow of lubrication oil to the engine parts when the oil viscosity is high or if either the oil cooler or the oil filter elements (paper cartridge) become plugged.

Engine efficiency, efficiency of emission controls, and engine performance depend on adherence to proper operation and maintenance recommendations. This includes the use of recommended fuels, coolants and lubrication oils.

Multitorque Rating (If Equipped)

The Multitorque ratings provide additional torque as engine load increases. This feature provides higher torque levels. This feature also provides better driveability while the truck is only in the top gears. The engine electronics are able to determine when the vehicle is in the top gears by calculating the engine rpm/vehicle speed ratio.

With the additional torque, the following benefits are provided: less shifting in rolling terrain, less wear on drive line components, more responsive, and better engine performance.

Aftermarket Products and Caterpillar Engines

NOTICE

In order to maximize fuel system life and prevent premature wear out from abrasive particles in the fuel, a two micron 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.

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.

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

i01028428

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 Serial Number Plate and the Information Plate that are mounted on the engine.

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

i01858749

Serial Number Plate

SMCS Code: 1000

CATERPILLAR®			CAT®
SERIAL NUMBER		ARRANGE-MENT NUMBER	
ENGINE MODEL			
MADE IN U.S.A	(ALWAYS GIVE ALL NUMBERS)		

Illustration 17 g00880164

C11 and C13 The Serial Number Plate is located on the left side of the cylinder block near the rear of the engine.

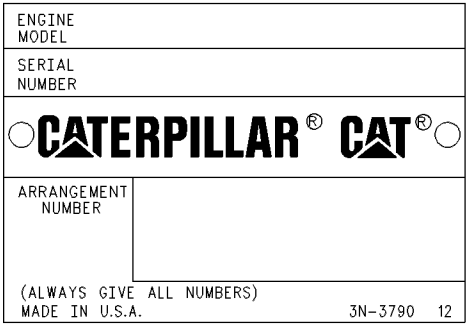


Illustration 18 g00123229

C-15 The Serial Number Plate is located on the right side of the cylinder block near the lower rear corner of the engine.

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

i01858776

Information Plate

SMCS Code: 1000

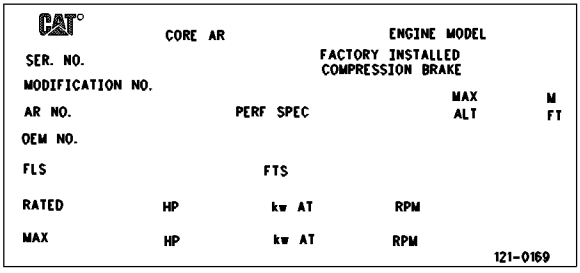


Illustration 19 g00880195

C11 and C13 The Information Plate is located on the right side of the engine. The information plate is on the front half of the inlet manifold.

C15 The Information Plate is located on the front, angled portion of the cylinder head near the section of the inlet manifold.

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. _____

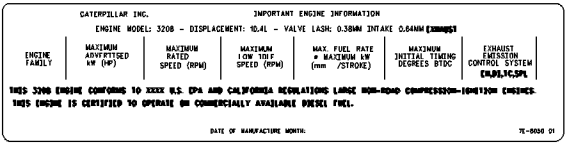
Fan Drive Belt No. _____

Alternator Belt No. _____

i00844066

Emissions Certification Film

SMCS Code: 1000; 7405



g00284658

Illustration 20

EPA Emissions Certification Film

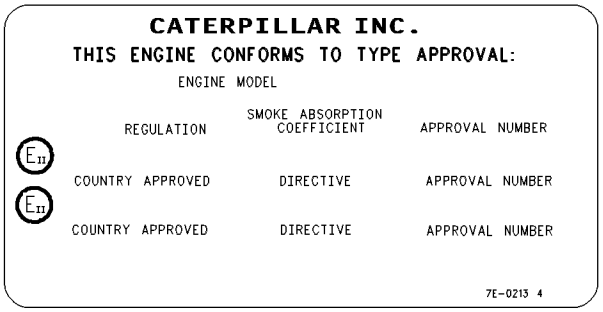


Illustration 21 g00415538

European Emissions Certification Film

The EPA Emissions Certification Film (if equipped) and/or the European Emissions Certification Film (if equipped) is located on the side of the engine.

i01948855

Customer Specified Parameters

SMCS Code: 1000

To record programmed specifications, use the following blanks.

Customer Passwords

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

Selected Engine Rating _____

- “Rating Number” _____
- “Rating Type” _____
- “Multi-torque Ratio” _____
- “Advertised Power” _____

- “Governed Speed” _____
- “Rated Peak Torque” _____
- “Top Engine Speed” _____
- “Test Spec” _____
- “Test Spec with Brake Saver” _____

ECM Identification Parameters _____

- “Vehicle ID” _____
- “Engine Serial Number” _____
- “ECM Serial Number” _____
- “Personality Part Number” _____
- “Personality Module Release Date” _____

Security Parameters _____

- “Total Tattletale” _____
- “Last Tool to Change Customer Parameters” _____
- “Last Tool to Change System Parameters” _____
- “ECM Wireless Communications Enable” _____

Vehicle Speed Parameters

- “Vehicle Speed Calibration” _____ pulses per km or pulses per mile
- “Vehicle Speed Limit” _____ km per hr or miles per hr
- “Vehicle Speed Limit Protection” _____
- “Tachometer Calibration” _____ pulses per revolution
- “Soft Vehicle Speed Limit” _____
- “Low Speed Range Axle Ratio” _____

- “High Speed Range Axle Ratio” _____
- “Vehicle Speed Cal (J1939-Trans)” _____
- “Vehicle Speed Cal (J1939-ABS)” _____

Cruise Control Parameters

- “Low Cruise Control Speed Set Limit” _____ km per hr or miles per hr
- “High Cruise Control Speed Set Limit” _____ km per hr or miles per hr
- “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 Enable” _____

Idle Parameters

- “Idle Vehicle Speed Limit” _____ km per hr or miles per hr
- “Idle RPM Limit” _____
- “Idle/PTO Engine Speed Ramp Rate” _____ rpm/sec
- “Idle/PTO Bump RPM” _____

PTO Parameters

- “PTO Configuration” _____
- “PTO Top Engine Limit” _____

- “PTO Engine RPM Set Speed” _____
- “PTO to Set Speed” _____
- “PTO Cab Controls RPM Limit” _____
- “PTO Kickout Vehicle Speed Limit” _____
- “Torque Limit” _____ N·m or lb ft
- “PTO Shutdown Time” _____
- “PTO Activation of Cooling Fan (If Equipped)” _____
- “PTO Engine RPM Set Speed” _____
- “PTO Engine RPM Set Speed A” _____
- “PTO Engine RPM Set Speed B” _____
- “Maximum PTO Enable Speed” _____
- “PTO Shutdown Timer Maximum rpm” _____

“Engine/Gear Parameters”

- “Lower Gears Engine RPM Limit” _____
- “Lower Gears Turn Off Speed” _____ km per hr or miles per hr
- “Intermediate Gears Engine RPM Limit” _____
- “Intermediate Gears Turn Off Speed” _____ km per hr or miles per hr
- “Gear Down Protection RPM Limit” _____
- “Gear Down Protection Turn On Speed” _____ km per hr or miles per hr
- “Top Engine Limit” _____
- “Top Engine Limit with Droop” _____
- “Low Idle Engine RPM” _____
- “Transmission Style” _____

- “Eaton Top 2 Override with Cruise Switch” _____
- “Top Gear Ratio” _____
- “Top Gear Minus One Ratio” _____
- “Top Gear Minus Two Ratio” _____
- “Governor Type” _____

Smart Idle Parameters

- “Battery Monitor and Engine Control Voltage” _____

Timer Parameters

- “Idle Shutdown Time” _____
- “Idle Shutdown Timer Maximum RPM” _____
- “Idle Shutdown Override Allowance” _____
- “Minimum Idle Shutdown Outside Temp” _____
- “Maximum Idle Shutdown Outside Temp” _____
- “A/C Pressure Switch Fan On - Time (If Equipped)” _____
- “Fan with Engine Retarder in High Mode (If Equipped)” _____
- “Engine Retarder Delay” _____

Engine Monitoring Mode

- “Warning” _____
- “Warning/Derate” _____
- “Warning/Derate/Shutdown” _____
- “Engine Monitoring Lamps” _____
- “Coolant Level Sensor Type” (If Equipped) _____
- “Coolant Temperature Derate” _____

Maintenance Indicator Parameters

- “Maintenance Indicator Mode” _____
- “PM 1 Interval” _____
- “Engine Oil Capacity” _____

Dash Display Access Parameters

- “Fuel Correction Factors” _____
- “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

- “Minimum Idle Time” _____

Driver Reward

- “Driver Reward Enable” _____

Data Link Parameters

- “Powertrain Data Link” _____

Operation Section

Lifting and Storage

i02123539

Product Lifting

SMCS Code: 1000; 1404; 7002

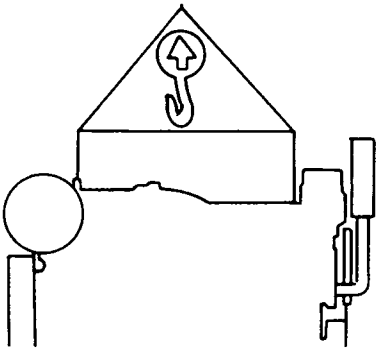


Illustration 22 g00103219

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.

i02068367

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 this Operation and Maintenance Manual, “Refill Capacities and Recommendations” (Maintenance Section).

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

i02433210

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 from 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.

Electronically controlled engines require one lamp in addition to the gauge package that is normally provided.

The “Diagnostic” lamp is yellow or amber. The “Diagnostic” lamp will communicate the status of the engine’s electronic system.

An optional “Warning” lamp is available. This red “Warning” 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 C11. 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 C13, and 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 diagnostic 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).



Engine Oil Temperature – This gauge indicates the engine oil temperature. An oil temperature that is higher than normal indicates a heat problem in the lubrication system and/or the cooling system. This problem can damage the cylinder heads, the cylinder liners, the pistons, and the crankshaft bearings.



Jacket Water Coolant Temperature – Typical temperature range is 87 to 98° C (189 to 208° F). The maximum allowable temperature with the pressurized cooling system is 102° C (216° F) for the C11. The maximum allowable temperature with the pressurized cooling system is 107° C (225° F) for the C13, and C15. 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.



Ammeter – This gauge indicates the amount of a charge or of discharge in the battery charging circuit. Operation of the indicator should be to the right side of “0”(zero). The charging system should be checked for a malfunction if the indicator is constantly to the left side of “0”(zero) or if the indicator shows an excessive charge during normal operation. Correct any problems.



Service Hour Meter – This gauge indicates the total operating hours of the engine. Hours of operation are logged in the ECM. A service tool is needed to retrieve the hours from the ECM. A Service Hour Meter may be installed on the engine.



Fuel Pressure – This gauge indicates fuel pressure to the electronic unit injectors from the fuel filter. The indicator should indicate the “NORMAL” range. A decrease in fuel pressure usually indicates a plugged fuel filter.



Fuel Level – This gauge indicates the level of fuel in the fuel tank. The fuel level gauge registers the fuel level only when the ignition switch is in the ON position.

Features and Controls

i01710090

Monitoring System

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

WARNING

If the Shutdown mode has been selected and the warning indicator activates, engine shutdown may take as little as 20 seconds from the time the warning indicator 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 (if equipped)

Coolant Level Sensor (If Equipped)

Note: The coolant level sensor is an optional feature.

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 injruy.

The engine can be programmed to the following modes:

- “OFF”
- “Warning”
- “Warning/Derate”
- “Warning/Derate/Shutdown”

“Warning”

The “DIAGNOSTIC” lamp and the warning signal (red lamp or buzzer) turn “ON” 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.

“Warning/Derate”

The “DIAGNOSTIC” lamp turns “ON” and the warning signal (red lamp or buzzer) is activated. After the warning, the engine will derate rpm and power. The warning 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.

“Warning/Derate/Shutdown”

The “DIAGNOSTIC” lamp turns “ON” and the warning signal (red lamp or buzzer) is activated. 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.

i01955111

Cold Start Strategy

SMCS Code: 1450; 1456; 1900

These engines use a cold start strategy that limits power until the coolant temperature reaches 28 °C (82 °F). This cold start strategy is called cold mode. The electronic system will automatically idle the C11 and C13 engines at 800 RPM . The electronic system will automatically idle C15 engines at 600 RPM . Cold mode will also vary the fuel injection amount, the timing for the maximum start-up, and the timing for the control of white smoke. Cold mode will provide reduced emissions and reduced warm-up times. Cold mode will be disabled and the engine rpm will drop to the programmed low idle speed if the throttle, the service brake, or the clutch is depressed.

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.

NOTICE

A truck should not be moved until it is out of the cold mode. If the truck is operated while in cold mode, power will be noticeably reduced.

Engine Diagnostics

i01563934

Self-Diagnostics

SMCS Code: 1000; 1900; 1901; 1902

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

- Caterpillar electronic service tools
- “DIAGNOSTIC” lamp

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

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

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

Logged codes represent the following items:

- Intermittent problems
- Recorded events
- Performance history

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

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

i01563946

Diagnostic Lamp

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

The “DIAGNOSTIC” lamp is used to indicate the existence of a fault by flashing codes. The “DIAGNOSTIC” lamp that is on the dashboard is usually “YELLOW”.

When the ignition switch is first turned on, the “DIAGNOSTIC” lamp will go through the following procedure:

- The “DIAGNOSTIC” lamp will illuminate for five seconds.
- The “DIAGNOSTIC” lamp will turn off.

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

The “DIAGNOSTIC” 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 “YELLOW” lamp is flashing. A diagnostic “EVENT” code or Override of the Idle Shutdown Timer will be logged in the ECM.

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Diagnostic Flash Code Retrieval

SMCS Code: 1000; 1900; 1901; 1902

“Diagnostic” Lamp

Use the “DIAGNOSTIC” Lamp or a Caterpillar electronic service tool to determine the diagnostic flash code.

Use the following procedure to retrieve the diagnostic codes if the engine is equipped with a “DIAGNOSTIC” lamp:

1. Turn the cruise control ON/OFF switch to the OFF position.

2. Move the SET/RESUME switch to either position. Hold that position until the “YELLOW” lamp begins to flash.

The “YELLOW” lamp will flash in order to indicate a two digit flash code and the SET/RESUME switch may be released. The sequence of flashes represents the system diagnostic message. Count the first sequence of flashes in order to determine the first digit of the diagnostic code. After a two second pause, the second sequence of flashes will identify the second digit of the diagnostic code.

Any additional diagnostic codes will follow after a pause. The additional diagnostic codes will be displayed in the same manner. Flash Code 55 signals that No Detected Faults have occurred since the ignition key switch has been turned to the ON position.

Refer to the Service Manual or consult an authorized Caterpillar dealer for the following items.

- Further information
- Assistance for repairs
- Troubleshooting

The electronic diagnostic codes are listed and described in Table 4.

Note: Table 4 indicates the potential effect on engine performance with “ACTIVE” flash codes.

Some codes record events or some codes indicate that a mechanical system needs attention rather than indicating a performance problem. Troubleshooting is not required for codes “35”, “41”, “47” and “55”. Code “01” will not flash. Some codes will limit the operation or the performance of the engine.

Table 4 indicates the potential effect on the engine performance with active flash codes. Table 4 also forms a list of Electronic diagnostic codes and descriptions.

Table 4

Diagnostic Flash Code or Engine Performance Relationship								
Diagnostic Flash Code		Effect On Engine Performance[1]				Suggested Action of the Operator		
		Engine Misfire	Low Power	Reduced Engine Speed	Engine Shutdown	Shut Down the Engine[2]	Service[3]	Schedule Service ASAP[4]
01	Idle Shutdown Override							
12	Coolant Level Sensor Fault[5]							X
13	Fuel Temperature Sensor Fault							X
14	Retarder Solenoid Fault							X
21	Sensor Supply Voltage Fault[5][6]		X					X
24	Oil Pressure Sensor Fault[5]							X
25	Boost Pressure Sensor Fault[6]		X					X
26	Barometric Pressure Sensor Fault[6]							X
27	Coolant Temperature Sensor Fault[5][6]							X
28	Accelerator Pedal Position Out of Calibration							X

(continued)

(Table 4, contd)

Diagnostic Flash Code or Engine Performance Relationship								
Diagnostic Flash Code		Effect On Engine Performance[1]				Suggested Action of the Operator		
		Engine Misfire	Low Power	Reduced Engine Speed	Engine Shutdown	Shut Down the Engine[2]	Service[3]	Schedule Service ASAP[4]
29	PTO Throttle Position Sensor Fault			X			X	
31	Loss of Wheel-Based Vehicle Speed Signal			X				X
32	Accelerator Pedal Position Invalid			X			X	
34	Engine RPM Signal Fault	X		X	X		X	
35	Engine Overspeed Warning							
36	Wheel-Based Vehicle Speed Signal Fault			X				X
38	Intake Manifold Air Temperature Sensor Fault[5][6]							X
41	Wheel-Based Vehicle Overspeed Warning							
42	Check Engine Speed Sensor Calibrations		X					X

(continued)

(Table 4, contd)

Diagnostic Flash Code or Engine Performance Relationship								
Diagnostic Flash Code		Effect On Engine Performance[1]				Suggested Action of the Operator		
		Engine Misfire	Low Power	Reduced Engine Speed	Engine Shutdown	Shut Down the Engine[2]	Service[3]	Schedule Service ASAP[4]
46	Low Oil Pressure Warning		X	X	X	X	X	
47	Idle or PTO Shutdown Occurrence				X			
51	Intermittent Battery Power to ECM	X	X		X		X	
55	No Detected Faults							
56	Check Customer or System Parameters		X	X				X
	Check Transmission Customer Parameters							
59	Incorrect Engine Software							X
61	High Coolant Temperature Warning		X		X		X	
62	Low Coolant Level Warning		X		X		X	
64	High Intake Manifold Air Temperature Warning							X

(continued)

(Table 4, contd)

Diagnostic Flash Code or Engine Performance Relationship								
Diagnostic Flash Code		Effect On Engine Performance[1]				Suggested Action of the Operator		
		Engine Misfire	Low Power	Reduced Engine Speed	Engine Shutdown	Shut Down the Engine[2]	Service[3]	Schedule Service ASAP[4]
65	High Fuel Temperature Warning							X
66	Auxiliary Output # 6 Fault							X
67	Auxiliary Output #7 Fault							X
68	Transmission Not Responding							X
69	Multifunction No. 1 Output Fault							X
71	Ignition Keyswitch Fault							X
72	Cylinder 1 or 2 Fault	X	X				X	
73	Cylinder 3 or 4 Fault	X	X				X	
74	Cylinder 5 or 6 Fault	X	X				X	
92	Intake Valve Actuator 1 or 2 Fault						X	
93	Intake Valve Actuator 3 or 4 Fault						X	

(continued)

(Table 4, contd)

Diagnostic Flash Code or Engine Performance Relationship								
Diagnostic Flash Code		Effect On Engine Performance(1)				Suggested Action of the Operator		
		Engine Misfire	Low Power	Reduced Engine Speed	Engine Shutdown	Shut Down the Engine(2)	Service(3)	Schedule Service ASAP(4)
94	Intake Valve Actuator 5 or 6 Fault						X	
95	Intake Valve Actuation Oil Pressure Voltage Fault							X
97	Intake Valve Actuation System Oil Pressure Solenoid Current Fault							X
98	Engine Coolant Diverter Solenoid Fault							X

(1) An “X” indicates that the effect on engine performance may occur, if the code is active. This depends on the exact failure.
(2) Shut Down the Engine: Operate the engine cautiously. Get immediate service. Severe engine damage may result.
(3) Service: The operator should go to the nearest qualified service facility.
(4) Schedule Service: When it is convenient for the operator, the problem should be investigated.
(5) When the diagnostic flash code is active, the effectiveness of the Engine Monitoring feature is reduced.
(6) The system may be affected by these Diagnostic Flash Codes, only under specific environmental conditions. This includes engine start-up at cold temperature, cold weather operation at high altitudes, etc.

For further information or assistance for repair, consult an authorized Caterpillar dealer.

i01174828

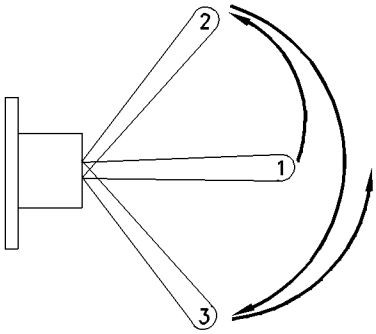
ECM Snapshot

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:



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Illustration 23

(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.

i01463504

Fault Logging

SMCS Code: 1000; 1900; 1901; 1902

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

i01710539

Engine Operation with Active Diagnostic Codes

SMCS Code: 1000; 1900; 1901; 1902

If the diagnostic lamp stays on 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. 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. Refer to Operation and Maintenance Manual, “Diagnostic Flash Code Retrieval” for more information on flash codes.

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 diagnostic lamp will turn off.

Operation of the engine and performance of the engine can be limited as a result of the active diagnostic code that is generated. Acceleration rates may be significantly slower. Refer to the Operation and Maintenance Manual for more information on the relationship between these active diagnostic codes and engine performance.

i01710618

Engine Operation with Intermittent Diagnostic Codes

SMCS Code: 1000; 1900; 1901; 1902

If the diagnostic lamp illuminates during normal engine operation and the diagnostic 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.

- Low power
- Limits of the engine speed
- Excessive smoke, etc

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

i01710630

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 the engine is started. 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 starting the engine. Look for the following items: oil leaks, coolant leaks, loose bolts, and trash buildup. Remove trash buildup and arrange for repairs, as needed.
- Inspect the cooling system hoses for cracks and for loose clamps.
- Inspect the alternator and accessory drive belts for cracks, breaks, and other damage.
- Inspect the wiring for loose connections and for worn wires or frayed wires.
- Check the fuel supply. Drain water from the water separator (if equipped). Open the fuel supply valve.
- Do not start the engine or move any of the controls if there is a “DO NOT OPERATE” warning tag or similar warning tag attached to the start switch or to the controls.

- Ensure that the areas around the rotating parts are clear.
- All of the guards must be put in place. Check for damaged guards or for missing guards. Repair any damaged guards. Replace damaged guards and/or missing guards.
- Disconnect any battery chargers that are not protected against the high current drain that is created when the electric starting motor (if equipped) is engaged. Check electrical cables and check the battery for poor connections and for corrosion.
- Reset 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.
- 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.

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).

Starting the Engine

⚠ WARNING

DO NOT USE ETHER (starting fluids) unless specifically instructed to do so. The use could result in engine damage and/or personal injury.

When using starting fluid, follow the manufacturer's instructions carefully. Use starting fluid sparingly and spray it ONLY WHILE CRANKING THE ENGINE. Excessive ether can cause piston and ring damage. Use ether for cold weather starting purposes only.

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 in cold weather can mean the difference between starting the engine and not starting the engine. Depressing the clutch helps to reduce the battery drain.

2. Turn the ignition key switch to the ON position. The "CHECK ENGINE/DIAGNOSTIC" lamp will illuminate for 5 seconds when the ignition key switch is first turned on. If the lamp fails to illuminate, notify your authorized Caterpillar dealer. If the lamp continues to stay on, the ECM has detected a problem in the system. Refer to the Operation and Maintenance Manual, "Engine Diagnostics" topic (Operation Section).

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 ignition key switch to the START position in order to crank the engine. Do not push the throttle or 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 30 seconds of cranking, release the ignition key switch. Turn the ignition key switch 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 ignition key switch to the ON or RUN position immediately after the engine starts. After the engine starts, 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 low speed.

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

Locate the ECM. Two harness connectors are attached to the ECM. The left connector is the engine harness and the right 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.

i02308903

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

i01955113

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 at 600 rpm.

Avoid excess idling. If the vehicle is parked for more than five minutes, stop the engine. An engine can burn from 2.8 L (.7 US gal) to 5.7 L (1.5 US gal) of fuel per hour while the engine is idling. Excessive idling can cause carbon buildup and/or excessive idling can cause the engine to slobber. 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. The engine is not in Cold Mode.

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”.

Cold Mode Operation

Cold mode is initiated if the coolant temperature is below 28° C (82° F). Engine power is decreased until the coolant temperature reaches the above value. In cold mode, the idle is 800 rpm for the C11 and the C13. In cold mode, the idle is 600 rpm for the C15. The strategy for cold mode provides reduced smoke emission and faster warm-up time.

After the cold mode is completed, the engine should be operated at low rpm and low load until normal operating temperature is reached. The engine will reach normal operating temperature faster when the engine is operated at low rpm and low power demand. This method is faster than trying to reach operating temperature by idling with no load.

NOTICE

It is not recommended that the vehicle be moved until the engine is out of cold mode. Power may be noticeably reduced if the vehicle is operated while the engine is in cold mode. At a speed above 8 km/h (5 mph), the low idle speed will be reduced to the customer programmed low idle speed. The power will still be reduced.

Cold mode is disabled if the throttle, the service brake, or the clutch (if equipped) is depressed. The rpm for cold mode operation drops to the programmed low idle speed in order to allow the transmission to be put into gear.

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 are 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 (.5 mpg) to 0.3 km/L (.7 mpg).

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.

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 feature is available in order to provide the operator with additional control of the gears for the Top 2 transmission. The Throttle Activated Downshift feature 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 Top 2 transmission.

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.

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Auxiliary Engine Brakes

SMCS Code: 1093; 1119; 1129; 1155

⚠ WARNING

If your vehicle is equipped with an auxiliary brake, follow the instructions provide in the auxiliary brake owner's manual. For C11 and C13 engines, follow the compression brake information included in this manual. Failure to follow the instructions during wet or slippery conditions could reduce vehicle control and result in injury or death.

NOTICE

Auxiliary brakes should not be used as a primary or service brake. The vehicle's service brake must be used in order to bring the vehicle to a complete stop.

Certain auxiliary engine braking devices are approved for use on these engines. Refer to the Truck Engine Application and Installation Guide or see your Caterpillar dealer for more information. For information on the specific auxiliary engine brakes on your vehicle, refer to the information that is provided by the OEM of the vehicle.

The anti-lock brake system (ABS) of this vehicle may interrupt the operation of the auxiliary engine brake during the actuation of the ABS. Compression brakes and exhaust brakes are typical examples of auxiliary engine brakes. For information on the operation of the ABS, refer to the literature that is provided by the OEM of the vehicle.

The auxiliary engine brake provides additional braking in order to slow the vehicle on grades and curves. The auxiliary engine brake also helps to control the speed. The auxiliary engine brake is useful when a reduction of speed is necessary, but a long application of the service brake is not desired. Controlling the slowing or downhill speed of a vehicle by using the auxiliary engine brake results in reduced wear on brake linings and brake drums. A reduced wear on these components helps to save the service brakes for emergency stopping requirements.

An auxiliary engine brake generates the maximum retarding effect at the engine's maximum rated rpm. As the engine rpm decreases, the performance of the auxiliary engine brake also decreases. For maximum available retarding, the operator should select a gear which will provide the desired road speed at the highest allowable engine rpm.

On long downhill grades, an operator should establish a "control speed". The "control speed" is present when the force that pushes the vehicle is equal to the retarding that slows the vehicle. The "control speed" is established with little use or no use of the service brake.

To maximize the benefit of the auxiliary engine brake, the auxiliary engine brake should be used when the operator wants to slow the vehicle. The auxiliary engine brake should be kept in the ON position during all normal operating conditions.

The operation of any vehicle under slippery conditions requires caution. This is also true when a vehicle with an auxiliary engine brake is operated. Under slippery conditions as a general rule, start with the auxiliary engine brake in the OFF position. Ensure that the vehicle maintains control through natural retardation. Then activate the auxiliary engine brake at the lowest power setting. Change the power settings as the conditions of the road dictate.

Operating the Auxiliary Engine Brake

The auxiliary engine brake is controlled by a switch on the dashboard. Before starting the engine, ensure that the switch is in the OFF position.

After the engine has reached normal operating temperature, turn the switch to the ON position. The switch may stay in the ON position during engine operation. The auxiliary engine brake will only activate when no fuel is supplied to the engine. The auxiliary engine brake will help to slow the vehicle when no pressure is applied to the throttle pedal or to the clutch pedal.

The auxiliary engine brake may be programmed to one of three modes:

- "COAST"
- "LATCH"
- "MANUAL"

The “COAST” mode and the “LATCH” mode require the Cruise Control switch to be in the ON position. The “COAST” mode and the “LATCH” mode do not require the Cruise Control to be active. In the “COAST” mode or the “LATCH” mode, the auxiliary engine brake is activated by the service brake. Using the service brake will deactivate the Cruise Control. However, the service brake does not turn the Cruise Control to the OFF position.

In the “MANUAL” mode, it is not necessary to depress the service brake in order to activate the auxiliary engine brake.

If the “Cruise Control ON/OFF” switch is in the OFF position, the auxiliary engine brake will activate regardless of the service brake.

“COAST” Mode

If the auxiliary engine brake is programmed to “COAST” and the Cruise Control switch is in the ON position, the auxiliary engine brake will activate when the service brake is depressed. In the “COAST” mode, the braking power is provided by both the service brake and the auxiliary engine brake.

The auxiliary engine brake will deactivate when the service brake is released.

“LATCH” Mode

If the auxiliary engine brake is programmed to “LATCH” and the Cruise Control switch is in the ON position, the auxiliary engine brake will activate when the service brake is depressed.

The auxiliary engine brake remains active when the service brake is released. The auxiliary engine brake remains active until the throttle pedal or the clutch pedal is depressed, or the engine speed drops below 900 rpm.

“MANUAL” Mode

If the auxiliary engine brake is programmed to “MANUAL”, the auxiliary engine brake will activate regardless of the service brake or the position of the Cruise Control switch. The auxiliary engine brake will activate when no pressure is applied to the throttle pedal or to the clutch pedal.

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BrakeSaver

SMCS Code: 1155

Note: The Anti-lock Brake System (ABS) may interrupt the operation of the engine retarder. The interruption may be during the actuation of the ABS. Refer to the literature of the vehicle manufacturer regarding the operation of the ABS. The BrakeSaver should NOT be used as a primary brake or service brake. To stop the vehicle, use the service brakes.

NOTICE

Do not exceed 116°C (240°F) maximum engine oil temperature at any time.

Do not exceed 2300 rpm in any situation. Operation of the engine over 2300 rpm will cause the CHECK ENGINE lamp to activate, indicating engine overspeed. Overspeeding can result in serious damage to your engine.

The BrakeSaver provides auxiliary braking in order to slow the vehicle. The BrakeSaver provides auxiliary braking in order to control speed on grades, on curves, or at any time when the reduction of speed is necessary. Use the BrakeSaver when a long application of the service brake is not desired. Controlling the slowing or downhill speed of a vehicle by using the BrakeSaver results in reduced wear on brake linings and brake drums. The BrakeSaver aids in helping save the service brakes for emergency stopping requirements.

No special skills are required to operate a vehicle that is equipped with the BrakeSaver. No special skills are required to maintain a vehicle that is equipped with the BrakeSaver. However, the operator must observe the engine speed and the oil temperature of the BrakeSaver.

For maximum effectiveness of the BrakeSaver, select the proper gearing in order to keep the engine rpm as close to 2300 rpm as possible without exceeding 2300 rpm. The effectiveness of the BrakeSaver declines as the engine rpm decreases.

Manual operation allows the operator to match the driving conditions to any load or to any hill. Do not control the vehicle speed with the accelerator while the manual control is “ON”. Allow a two second delay for full engagement and full disengagement.

Manual Control

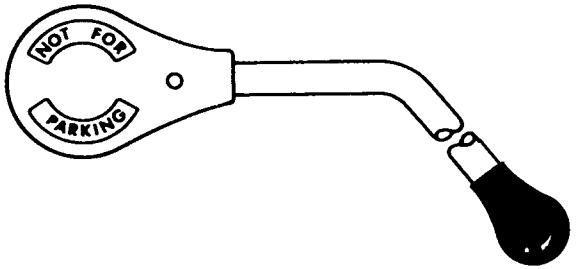


Illustration 24 g00459342

The hand operated manual control lever is usually mounted on the steering column. Move the manual control lever in order to increase the BrakeSaver or decrease the BrakeSaver. Allow a two second delay for full engagement and full disengagement. Actuating the manual Brakesaver control will deactivate the cruise control or the PTO control.

Automatic Control



Illustration 25 g00459407

The mode selector switch must be in the AUTOMATIC /MANUAL position and the Cruise Control ON/OFF switch for the Electronic system must be in the OFF position in order for the automatic control to function. In this mode, the BrakeSaver will automatically be engaged when the clutch pedal is applied and the accelerator pedal is released. The BrakeSaver will automatically shut off when the clutch pedal is released or when the accelerator pedal is pressed. The BrakeSaver will engage when the clutch pedal is applied again and when the accelerator pedal is released.

BrakeSaver Gauges

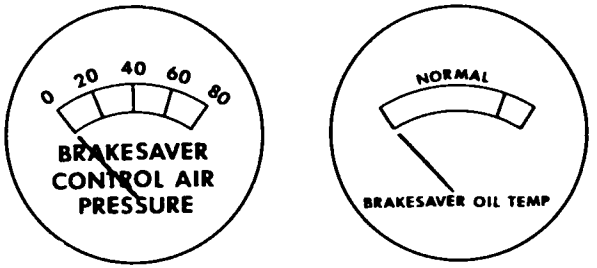


Illustration 26 g00459408

CONTROL AIR PRESSURE should not exceed 390 kPa (55 psi). If the indicator shows little pressure or no pressure, the BrakeSaver may not provide any braking effort. Control the stopping of the vehicle with proper downshifting and service brakes until repairs are made. Stop the vehicle or operate at a reduced speed.

The BrakeSaver oil temperature gauge indicator should remain in the NORMAL (GREEN) range. The normal range is less than 116°C (240°F). If the indicator moves to the RED range, place the BrakeSaver manual control lever to the OFF position. Operate the vehicle with the service brakes only, or stop the vehicle. Allow the engine to idle, until the oil temperature gauge returns to the NORMAL range.

To prevent unnecessary fuel consumption and possible heat buildup, do not leave the BrakeSaver activated while the engine is idling and the vehicle is parked. Place the control selector switch in MANUAL position, and place the manual control lever in the “OFF” position.

i01955119

Compression Brake (If Equipped)

SMCS Code: 1119; 1129

S/N: KCA1-Up

S/N: KCB1-Up

S/N: JAM1-Up

Note: For additional information that relates to compression brakes for the C11 and C13 engines, refer to the Operation and Maintenance Manual, “Auxiliary Engine Brakes”.

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.

i01387704

Compression Brake

SMCS Code: 1119; 1129

S/N: JAM1-Up

S/N: BXS1-Up

S/N: MXS1-Up

Using Your Jacobs Engine Brake (Jake Brake®)

Jake Brake is a registered Trademark of Jacobs Vehicle Systems.

NOTICE
A compression brake is used to slow a vehicle, not to stop a vehicle. A compression brake is not a substitute for the service braking system. The vehicles service brakes must be used to bring the vehicle to a complete stop. Proper use of the compression brake will keep the service brakes cool. This will keep the service brakes ready to provide maximum stopping power.

Driver Controls

It is important to be familiar with the Jake Brake controls in your vehicle. The Jake Brake controls will vary slightly depending on the Jake Brake configuration. The Jake Brake controls will vary depending on the design of the vehicle cab. However, basic operator controls will be similar for all models. The various types of dash switches that may be used in the cab of your vehicle are shown in the illustrations below.

Note: Switches that are supplied by Jacobs Vehicle Systems may be different from the switches that are installed in your vehicle. The physical appearance of the dash switches may vary but the function of the dash switches should not change.

The following information is for a typical in-line six cylinder engine.

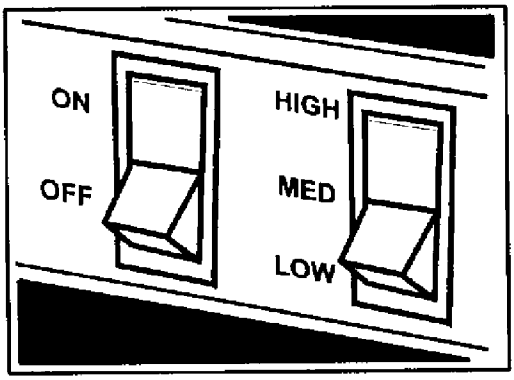


Illustration 27 g00731591

"LOW/MED/HIGH" Switch

The "LOW" setting on the dash switch will activate two cylinders, which will provide approximately one-third of the braking horsepower. The "MED" setting on the dash switch will activate four cylinders, which will provide approximately two-thirds of the braking horsepower. The "HIGH" setting on the dash switch will activate all of the cylinders, which will provide full braking horsepower.

Note: A foot-operated switch may be installed in the cab of the vehicle. The foot-operated switch will control the on/off functions of the compression brake. Some vehicle manufacturers may offer a switch that is mounted on the gear selector for the Jake Brake controls.

Engine Controls

All Jake Brake applications have two additional controls. One control is activated by the position of the clutch pedal and the other control is activated by the position of the accelerator pedal. The two additional controls can provide fully automatic operation of the Jake Brake.

Operation of the Jacobs Engine Brake (Jake Brake®)

NOTICE

The Jake Brake depends on the free flow of engine oil for operation. **Make sure that the engine is at full operating temperature before switching on the Jake Brake.** Normally the Jake Brake is left in the ON position whenever you are driving. The exception is when roads are slippery due to bad weather conditions. Refer to the Slippery Pavement topic in this Manual for specific operating instructions.

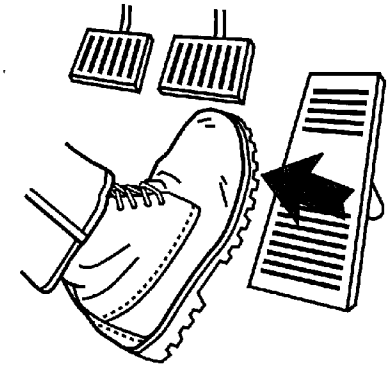


Illustration 28 g00731601

The operation of the Jake Brake is fully automatic once the brake is turned on. When your foot is off of the clutch and you remove your foot completely from the accelerator pedal, the Jake Brake is automatically activated. There are some systems that will activate the Jake Brake only once the brake pedal is depressed.



Illustration 29 g00731603

When you apply pressure to the accelerator pedal, the Jake Brake is deactivated.

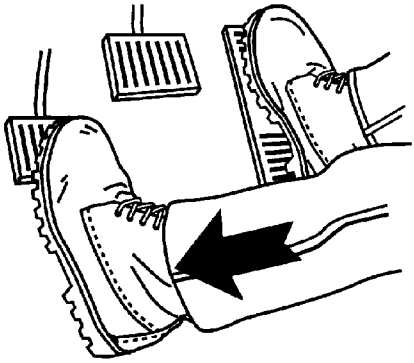


Illustration 30 g00731767

During shifting, the Jake Brake is automatically deactivated when the clutch pedal is depressed.

NOTICE
If the Jake Brake is on, shifting without using the clutch or double-clutching (to use the compression brake to reduce engine rpm--also known as "Jake Shifting") is strongly discouraged. Serious powertrain damage can result.

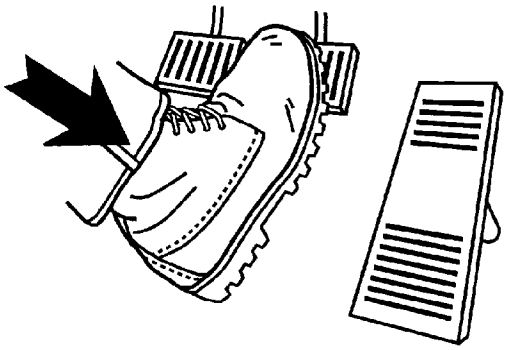


Illustration 31 g00731909

Note: The Jake Brake will remain activated after the brake pedal has been depressed. This function gives the combined power of both the compression brake and the service brakes to the drive wheels.

The ECM on vehicles that are equipped with ABS (Anti-Lock Brake System) has the ability to deactivate the Jake Brake if wheel slippage is detected. The Jake Brake will be automatically reactivated when wheel slippage is no longer detected.

The ECM will deactivate the Jake Brake when engine speed falls below approximately 1000 rpm or when the vehicle slows down to a preset speed. These parameters may vary depending on the vehicle and the engine configuration. This prevents stalling the engine.

NOTICE

Be sure to turn the Jake Brake dash switch to the OFF position when the engine is turned off. This will prevent the switch from being in the ON position at engine cold start.

Automatic Transmissions

Operating the Jake Brake in a vehicle that is equipped with an automatic transmission is similar to operating the Jake Brake in a vehicle that is equipped with a manual transmission. The Jake Brake is activated when you move your foot off the accelerator pedal. The Jake Brake is deactivated when you apply pressure to the accelerator pedal. The ECM will deactivate the Jake Brake when the engine speed falls below approximately 1000 rpm or when the torque converter shifts out of lockup. The torque converter will usually shift out of lockup between 10 and 25 mph. This is dependent on the type of transmission.

Note: With Autoshift transmissions, the Jake Brake may actuate in order to help the transmission upshift. This is done automatically through the transmission control module. This can happen even if the Jake Brake dash switch is in the OFF position.

Cruise Control

There are several types of cruise control systems. The operation of the Jake Brake in vehicles that are equipped with cruise control will depend on the engine and the options that are provided by the OEM. Some cruise controls are specifically designed to operate in conjunction with the Jake Brake. It may be possible to program the activation of the Jake Brake during cruise control operation. When the cruise control is enabled, the ECM will activate the Jake Brake when the vehicle exceeds the set speed of the cruise control. The Jake Brake will operate until the vehicle has slowed to one-half mph above the set speed of the cruise control. For additional information, refer to the “Cruise Control” topic in the Operation and Maintenance Manual, “Engine Operation” section.

Driving With Your Jacobs Engine Brake (Jake Brake®)

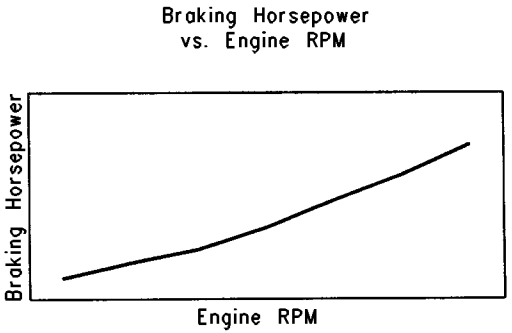


Illustration 32 g00731958

Since the Jake Brake is most effective at higher engine speeds, gear selection is very important. **Maximum retarder performance is obtained when you use the lowest possible gear without exceeding the recommended engine braking speed.** Best retarding performance is obtained at engine speeds between 1800 rpm and rated engine speed. Below 1700 rpm, retarding power may be significantly reduced.

The Jake Brake must be turned ON at the dash switch in order to operate. Once the Jake Brake is turned ON, remove your foot from the accelerator pedal in order to slow your vehicle. Apply the service brakes in order to come to a complete stop. Refer to the sections below for driving procedures for specific conditions.

Flat, Dry Pavement

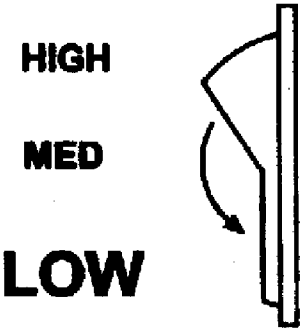


Illustration 33 g00732036

Put the progressive braking switch in the “LOW” position while you are driving on flat, open stretches of road with a light load. During these conditions, more slowing power is not required. If you are still using the service brakes, move the progressive braking switch to a higher position until there is no need for the service brakes to slow the vehicle.

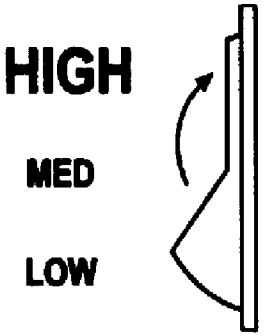


Illustration 34 g00732040

The progressive braking switch should be in the “High” position under the following operating conditions:

- Carrying heavy loads
- Descending a grade

- The pavement is dry.
- The traction is good.

Descending a Grade

Before beginning a long, steep descent, determine if your Jake Brake is operating properly. This can be done by lifting your foot briefly off the accelerator pedal. The Jake Brake is working correctly if the vehicle begins to slow down.

Note: The following road speeds and grades are given as examples only! Actual conditions and retarding performance will vary.

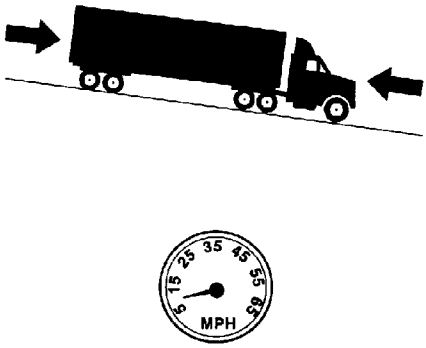


Illustration 35 g00731973

An explanation of control speed is helpful in understanding the use of the Jake Brake while you are descending a grade. Control speed is the constant speed that occurs when the forces that are pushing the vehicle down a grade are equal to the forces that are holding the vehicle back without using the service brakes. In other words, vehicle speed will be maintained without using the service brakes.

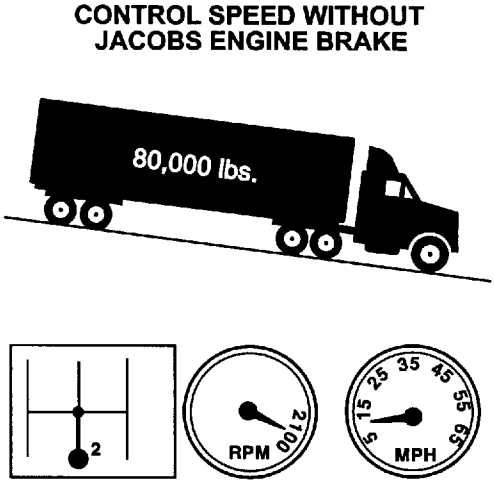


Illustration 36 g00731981

You may be able to safely descend a 6 percent grade at 10 mph without using the service brakes or the Jake Brake. This is dependent on the road conditions and the load that is being carried.

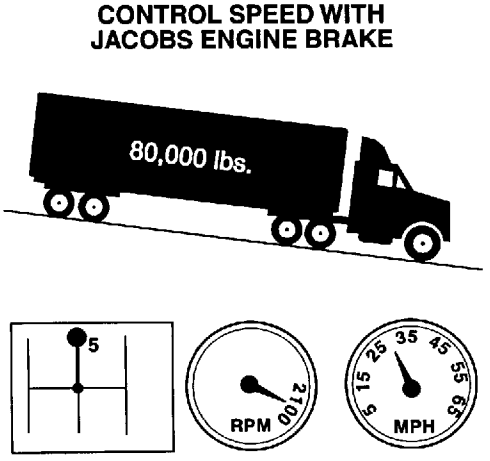


Illustration 37 g00731989

It may be possible to maintain control of the vehicle while descending a 6 percent grade at 25 mph without using the service brakes with the Jake Brake set to the “HIGH” position on the progressive braking switch.

Note: The Jake Brake can be kept on for as long as needed without any risk of engine overheating or damage.

FASTER THAN CONTROL SPEED WITH JACOBS ENGINE BRAKE

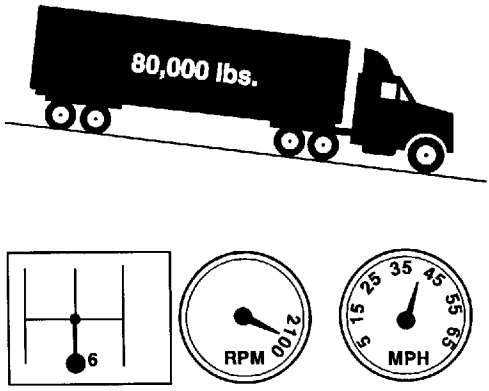


Illustration 38 g00731993

Under some circumstances, you may want to descend a grade at a faster rate than the control speed. This can be done by selecting a higher gear, or a lower position on the progressive braking switch. However, you may need to apply the service brakes intermittently. Applying the service brakes will help prevent engine overspeed. Applying the service brakes will also help keep the vehicle at a safe speed.

NOTICE

Frequent use of the service brakes will cause the service brakes to heat up, reducing the stopping ability of the vehicle. The result can be a dangerous condition called brake fade.

There may be circumstances when you might want to descend a grade at a rate that is slower than the control speed. This is done by selecting a lower gear. Do not select a gear that is low enough to result in an engine overspeed. You may need to apply the service brakes in order to obtain the desired lower speed.

The Jake Brake can be misused. Look at the example of descending the 6 percent grade under control only at 10 mph without a compression brake, but at 25 mph with a compression brake. You could not expect to maintain control of the vehicle on the same grade at 50 mph. Become familiar with the amount of retarding power that can be provided by your Jake Brake. **Never exceed a safe control speed.**

Slippery Pavement

The operation of any vehicle can be unpredictable in slippery conditions. Be careful when you are testing the Jake Brake on slippery roads.

The Jake Brake will not affect the operation of the ABS. The ECM will deactivate the Jake Brake when the ABS senses wheel slippage (loss of traction). The Jake Brake will be reactivated when traction is regained.

Become familiar with the operation of the Jake Brake before attempting to use the Jake Brake on slippery roads until you have some experience with the Jake Brake on dry pavement.

NOTICE
Do not use the Jake Brake when bobtailing or pulling an empty trailer on wet or slippery pavement, especially when operating a single drive axle vehicle.

Driving Procedures for Slippery Pavement

When you are driving in wet conditions or icy conditions, begin with the dash switch in the OFF position. Use the same gear that would normally be used for these conditions.

Before activating the Jake Brake, ensure that the following conditions exist:

- There is adequate distance between your vehicle and other vehicles.
- Traffic conditions are adequate for testing the braking ability of the vehicle.
- The vehicle is able to maintain traction and stability during deceleration without the use of the Jake Brake.

If there is any loss of traction during deceleration without the use of the Jake Brake, do not attempt to use the Jake Brake until road conditions improve.

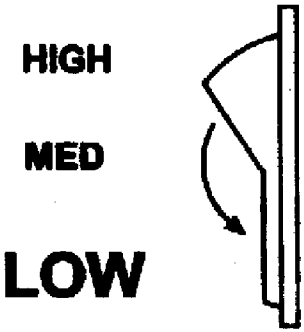


Illustration 39 g00732036

If the vehicle is maintaining traction, activate the Jake Brake by turning the progressive braking switch to the “LOW” position.

If the drive wheels begin to lock or the rear of the trailer begins to move, immediately turn the dash switch to the OFF position. Do not turn the Jake Brake to the ON position until road conditions improve.

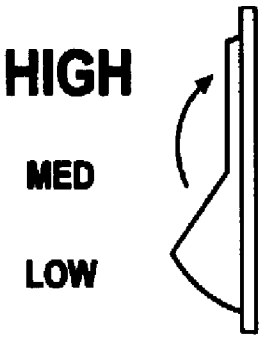


Illustration 40 g00732040

If there is no tendency for the drive wheels to lose traction and you desire greater braking performance, move the progressive braking switch to the next highest position.

If the drive wheels begin to lock or the rear of the trailer begins to move, immediately move the dash switch back to the original position. Do not attempt to use a higher position until road conditions improve.

Note: Check your progressive braking switch for the proper position often. Road conditions can change rapidly. Remember: In slippery road conditions, never skip a step when you are operating the progressive braking switch. Always begin with the switch in the LOW position. Continue moving the switch to the next highest position as the road conditions improve.

On single trailers or combinations, a light application of the trailer brakes may be necessary to help keep the trailer in line with the tractor. Follow the manufacturer's recommended operating procedure when using your trailer brakes.

If the tractor is equipped with tandem axles and a power divider, the Jake Brake will not change the normal usage of this equipment on slippery roads. See the manufacturer's recommendations for the proper use of this equipment.

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Caterpillar Driver Information Display (Messenger)

SMCS Code: 7490

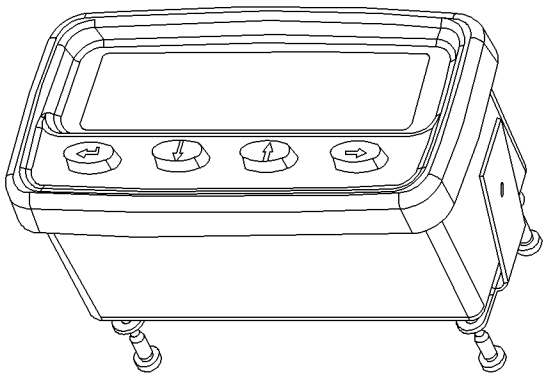


Illustration 41 g00916428

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. Refer to the Operation and Maintenance Manual, “Diagnostic Flash Code Retrieval” for additional information.

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.

Vehicle Trip Information

The Messenger display provides information concerning 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.

Fuel Correction Adjustment

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.

Driver ID Entry

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

i00948324

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 key switch 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.

NOTICE
Only use antifreeze/coolant mixtures recommended in the Coolant Specifications that are in the Operation and Maintenance Manual. Failure to do so can cause engine damage.

- Allow the engine to cool. Check the coolant level. 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

i01502338

Radiator Restrictions

SMCS Code: 1353; 1396

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

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

Shutters can be properly used for parking overnight, very cold temperatures, and high winds. In those particular cases, the coolant temperature and the inlet manifold temperature must be carefully monitored and controlled.

NOTICE
Failure to open the winter fronts in the morning could cause engine damage and/or loss of fuel economy.

i02118561

Fuel and the Effect from Cold Weather

SMCS Code: 1000; 1250

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

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

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

Note: Engines that are equipped with a Diesel Particulate Filter (DPF) are required to use Ultra Low Sulfur Diesel (ULSD) diesel fuel. ULSD fuel contains less than 15 ppm sulfur using ASTM D 2622 or DIN 51400. The use of higher sulfur diesel fuel in an engine with a DPF will cause the engine to produce emissions that are not in compliance with emissions standards and deactivation of the catalyst within the DPF. The use of a blend of No.1 and No.2 fuel is allowed in an engine that is equipped with a DPF, if both of the base fuels meet the ULSD standard.

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

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

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

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

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

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

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

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

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

For more information about fuel, refer to Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluids Recommendations”.

i01502354

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 so that the fuel is 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.

The following fuel heaters are recommended for use with Caterpillar engines:

- 7C-3557 Fuel Heater Group
- 7C-3558 Heater Kit

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

Maintenance Section

Refill Capacities

i02176924

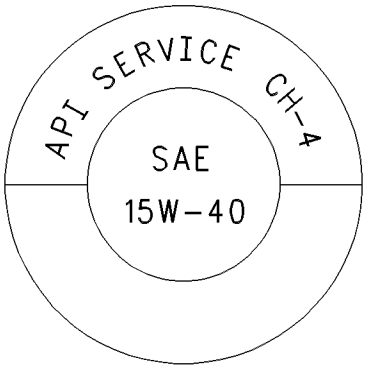
Refill Capacities and Recommendations

SMCS Code: 1348; 1395; 7560

Engine Oil

API Oils

The Engine Oil Licensing and Certification System by the American Petroleum Institute (API) is recognized by Caterpillar. For detailed information about this system, see the latest edition of the “API publication No. 1509”. Engine oils that bear the API symbol are authorized by API.



g00546535

Illustration 42

Typical API symbol

Diesel engine oils CC, CD, CD-2, and CE have not been API authorized classifications since 1 January 1996. Table 5 summarizes the status of the classifications.

Table 5

API Classifications	
Current	**Obsolete**
CI-4[1]CH-4[1], CG-4[2], CF-4[3]	CE
CF [4]	CC, CD
CF-2[5]	CD-2[5]

(1) **API CH-4 and CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met. CH-4 and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.**

(2) API CG-4 oils are acceptable for all Caterpillar diesel engines. When the API CG-4 oils are used, the oil drain interval should not exceed 75 Percent of the standard oil drain interval for your engine.

(3) API CF-4 oils are no longer recommended for Caterpillar on-highway diesel engines.

(4) API CF oils are not recommended for Caterpillar on-highway diesel engines.

(5) API CF-2 and CD-2 oils are classifications for two-cycle diesel engines. Caterpillar does not sell engines that utilize the CD-2 and the API CF-2 oils.

Caterpillar Diesel Engine Oil (DEO)

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. These oils are offered by Caterpillar dealers for continued use when the engine oil is changed. Consult your Caterpillar dealer for more information on these oils.

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

- **Caterpillar Diesel Engine Oil (DEO) (10W-30)**
- **Caterpillar Diesel Engine Oil (DEO) (15W-40)**

Commercial Oils

Engine Crankcase Fluid Recommendations for all current and noncurrent Caterpillar On-highway Diesel Truck Engines:

- API CH-4 oils and API CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met. CH-4 oils and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.
- API CG-4 oils are acceptable for all Caterpillar diesel engines. When the API CG-4 oils are used, the oil drain interval should not exceed 75 Percent of the standard oil drain interval for your engine.
- API CF-4 oils are no longer recommended.

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

In order to make the proper choice of a commercial oil, refer to the following explanations:

API CI-4 – API CI-4 oils were developed in order to meet the requirements of high performance diesel engines that use cooled Exhaust Gas Recirculation (EGR). API CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met.

API CH-4 – API CH-4 oils were developed in order to protect low emissions diesel engines that use a 0.05 percent level of fuel sulfur. However, API CH-4 oils may be used with higher sulfur fuels. API CH-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met.

Note: CH-4 oils and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.

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

Note: Refer to Special Publication, SEBU6385, "Caterpillar On-highway Diesel Truck Engine Fluids Recommendations" for additional information that relates to lubrication for your engine.

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

Refer to Table 6 (maximum temperature) in order to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

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

If ambient temperature conditions at engine start-up require the use of multigrade SAE 0W oil, SAE 0W-40 viscosity grade is preferred over SAE 0W-20 or SAE 0W-30.

Note: SAE 10W-30 is the preferred viscosity grade for the following diesel engines when the ambient temperature is above −18 °C (0 °F) and below 40 °C (104 °F).

Table 6

Engine Oil Viscosities for Ambient Temperatures		
	Ambient Temperature	
Viscosity Grade	Minimum	Maximum
SAE 0W-20	−40 °C (−40 °F)	10 °C (50 °F)
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 Oil Analysis

Caterpillar has developed a tool for maintenance management that evaluates oil degradation and the tool 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 three categories:

- Wear Analysis
- Oil condition
- Additional tests

The wear analysis monitors metal particles, some oil additives, and some contaminants.

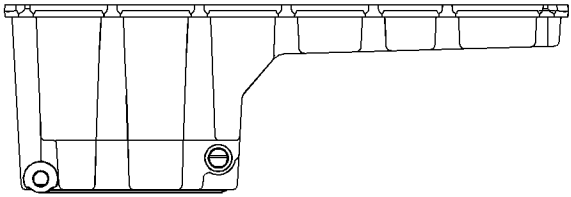
Oil condition uses infrared (IR) analysis to evaluate the chemistry of the oil. Infrared analysis is also used to detect certain types of contamination.

Additional tests are used to measure contamination levels from water, fuel, or coolant. Oil viscosity and corrosion protection can be evaluated, as needed.

Refer to Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluids Recommendations” or contact your local Caterpillar dealer for additional information concerning the S·O·S 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.



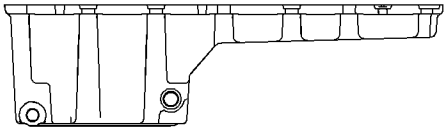
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Illustration 43

C11 and C13

210-1745 Oil Pan (Deep-Standard)

This pan has an overall height of 335 mm (13.2 inch).



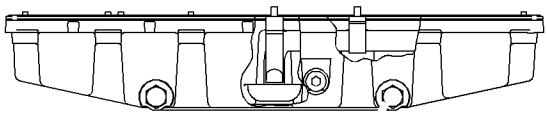
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Illustration 44

C11 and C13

240-3277 Oil Pan(Shallow-Optional)

This pan has an overall height of 278 mm (10.9 inch).



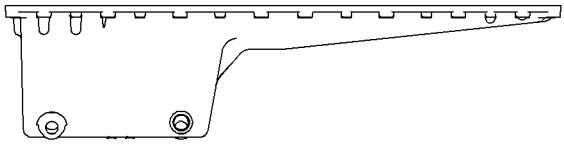
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Illustration 45

C11 and C13

251-9356 Pan(Shallow-Optional)

This pan has an overall height of 167.5 (6.6 inch).



g01016726

Illustration 46

C15

227-3004 Pan

This pan has an overall height of 278.5 mm (11 inch).

Table 7

Approximate Refill Capacities of the Engine Lubrication System		
Compartment or System	**C11 and C13**	**C15**
Deep-Standard Oil Sump(1)	40 L (42 qt)	38 L (40 qt)
Shallow Oil Sump(1)	34 L (36 qt)	N/A
Capacity of the Auxiliary Oil Filter System(2)		
Total Capacity of the Lubrication System(3)		

(1) Approximate sump capacity of the crankcase includes standard oil filters that are factory installed. 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.

Lubricating Grease

Caterpillar provides a range of moderate greases to extremely high performance greases in order to service the entire line of Caterpillar products that operate throughout the wide variety of climates. From this variety of Caterpillar grease products, you will find at least one of the Caterpillar greases that will meet or exceed the performance requirements for any machine or equipment application.

Before selecting a grease for any application, the performance requirements must be determined. Consult the grease recommendations that are made by the OEM for the equipment when the equipment is operated in the expected conditions. Then, consult with your Caterpillar dealer for a list of greases and the following related characteristics.

- Performance specifications
- Available sizes of containers
- Part numbers

Always choose a 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. Keep in mind that products that barely meet the minimum performance requirements can be expected to barely produce the minimum life of the parts. It is false economy to use grease that was purchased based on the lowest cost per pound. Instead, use the grease that yields the lowest total operating cost based on an analysis that includes the costs of parts, labor, and downtime, as well as the cost of the amount of grease that is actually used.

Note: Because some greases are not chemically compatible, it is generally recommended to purge all of the old grease from the joint when switching from one type of grease to another, and/or from one supplier to another. Consult your supplier in order to determine if the greases are compatible.

If in doubt, Purge!

Note: All Caterpillar brand of greases are compatible with each other.

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

Fuel

Distillate Diesel Fuel

Caterpillar recommends that all distillate diesel fuel, including ULSD fuel (fuel ≤ 15 ppm sulfur using ASTM D 2622 or DIN 51400) meet the requirements of the Caterpillar Specifications for Distillate Diesel Fuel.

In North America, diesel fuel that is identified as No. 1-D or No. 2-D in "ASTM D975" generally meet the specifications. Caterpillar recommends diesel fuels that are distilled from crude oil. Diesel fuels from other sources could exhibit detrimental properties that are not defined or controlled by this specification.

Note: Caterpillar recommends that the fuel be filtered through a fuel filter with a rating of less than five (5) microns absolute at the point at which the fuel is dispensed into the vehicle.

NOTICE
Operating with fuels that do not meet Caterpillar's recommendations can cause the following effects: starting difficulty, poor combustion, deposits in the fuel injectors, reduced service life of the fuel system, deposits in the combustion chamber, and reduced service life of the engine.

Note: Refer to Special Publication, SEBU6385, "Caterpillar On-highway Diesel Truck Engine Fluids Recommendations" for the Caterpillar Specification for distillate fuel and for additional information that relates to fuel for your engine.

Refill Capacities (Fuel System)

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

Coolant

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

The following two coolants are used in Caterpillar diesel engines:

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

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

Note: Caterpillar DEAC does not require a treatment with an SCA at the initial fill. A commercial heavy-duty coolant/antifreeze that meets “ASTM D4985” or “ASTM D6210” specifications MAY require a treatment with an SCA at the initial fill. These coolants WILL require a treatment with an SCA on a maintenance basis.

Table 8

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

(1) Whichever comes 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 stated kilometers/miles that are recommended, or base the coolant service life on the stated hours. Engine hours of operation are reported in the ECM (Electronic Control Module). Two examples of engines that experience excessive idle time are engines that are normally operated in city pickup and delivery applications, and over the road truck applications in which the engines are kept running in order to provide heat and/or air conditioning while the driver sleeps. 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.

Note: These drain intervals are only possible with annual Level 2 coolant analysis.

Glycol

Glycol in the coolant helps to provide protection against the following conditions:

- Boiling
- Freezing
- Cavitation of the water pump and cylinder liners

For optimum performance, Caterpillar recommends a 1:1 mixture of a water/glycol solution.

Note: Use a mixture that will provide protection against the lowest ambient temperature.

Note: 100 percent pure glycol will freeze at a temperature of −23 °C (−9 °F).

Refer to tables 9 and 10for additional information.

Most conventional heavy-duty coolant/antifreezes use ethylene glycol. Propylene glycol may also be used. In a 1:1 mixture with water, ethylene and propylene glycol provide similar protection against freezing and boiling. Refer to tables 9 and 10 for additional information.

Table 9

Ethylene Glycol		
Concentration	**Freeze Protection**	**Boil Protection**
50 Percent	−37 °C (−34 °F)	106 °C (223 °F)
60 Percent	−51 °C (−60 °F)	111 °C (232 °F)

NOTICE
Do not use propylene glycol in concentrations that exceed 50 percent glycol because of propylene glycol's reduced heat transfer capability. Use ethylene glycol in conditions that require additional protection against boiling or freezing.

Table 10

Propylene Glycol		
Concentration	**Freeze Protection**	**Boil Protection**
50 Percent	−32 °C (−26 °F)	106 °C (223 °F)

To check the concentration of glycol, use the 1U-7298 Coolant/Battery Tester (Degree Celsius) or use the 1U-7297 Coolant/Battery Tester (Degree Fahrenheit). The testers give readings that are immediate and accurate. The testers can be used with ethylene or propylene glycol.

Note: Propylene glycol coolant used in Caterpillar Diesel Engine cooling systems must meet "ASTM D6211-98a "Fully-Formulated Propylene Glycol-Based Engine Coolant for Heavy-Duty Engines". When Propylene glycol is used in heavy-duty diesel engines, the regular addition of Supplemental Coolant Additive (SCA) is required for protection against liner cavitation. Consult your Caterpillar dealer for more information.

S·O·S Coolant Analysis

Table 11

Recommended Interval		
Type of Coolant	**Level 1**	**Level 2**
DEAC	Every 250 Hours	Yearly(1)
ELC	Not Required	Yearly

(1) The Level 2 Coolant Analysis should be performed sooner if a problem is identified by a Level 1 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 Coolant Analysis can be done 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.

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

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 12

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.

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

i02424053

Maintenance Interval Schedule (C11 , C13 , and C15 Engines with Standard (Deep) Oil Sumps)

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 replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Use mileage, fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance.

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

When Required

Battery - Replace 152
Battery or Battery Cable - Disconnect 155
Cooling System Coolant Sample (Level 1) - Obtain 173
Cooling System Coolant Sample (Level 2) - Obtain 175
Engine Air Cleaner Element - Clean/Replace 186
Engine Oil Level Gauge - Calibrate 197
Engine Oil Level Gauge - Calibrate 199
Fuel System - Prime 214
Severe Service Application - Check 235

Daily

Cooling System Coolant Level - Check 172
Engine Air Cleaner Service Indicator - Inspect 186
Engine Oil Level - Check 192
Fuel System Primary Filter/Water Separator - Drain 225

Fuel System Water Separator - Drain 228
Walk-Around Inspection 237

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

Air Compressor Filter - Clean/Replace 151
Alternator - Inspect 151
Battery Electrolyte Level - Check 153
Belt - Inspect 155
Belt Tensioner - Inspect 158
Cooling System Supplemental Coolant Additive (SCA) - Test/Add 175
Cylinder Head Grounding Stud - Inspect/Clean/Tighten 181
Engine Crankcase Breather - Clean 189
Engine Crankcase Breather - Clean 190
Engine Oil Sample - Obtain 201
Engine Oil and Filter - Change 203
Fuel System Primary Filter - Clean/Replace 223
Fuel System Secondary Filter - Replace 226
Fuel Tank Water and Sediment - Drain 230
Hoses and Clamps - Inspect/Replace 231

Between 24 000 and 96 000 km (15 000 and 60 000 miles)

Compression Brake - Inspect/Adjust 159
Electronic Unit Injector - Inspect/Adjust 184
Engine Valve Lash - Inspect/Adjust 211
Valve Actuators - Inspect/Adjust 237

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

Aftercooler Core - Clean/Test 149
Cooling System Coolant (DEAC) - Change 163
Cooling System Water Temperature Regulator - Replace 178
Fan Drive Bearing - Lubricate 213
Radiator - Clean 234

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

Air Compressor - Inspect 149
Compression Brake - Inspect/Adjust/Replace 161
Crankshaft Vibration Damper - Inspect 180
Electronic Unit Injector - Inspect/Adjust 184
Engine - Clean 185

Engine Valve Lash - Inspect/Adjust 211
Turbocharger - Inspect 236
Valve Actuators - Inspect/Adjust 237

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

Cooling System Coolant Extender (ELC) - Add 170

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

Cooling System Coolant (ELC) - Change 167

PM Level 4 - Every 966 000 km (600 000 miles) or 380 000 L (100 000 US gal) of Fuel or 12 000 Service Hours or 6 Years

Compression Brake - Inspect/Adjust/Replace 161

i02424074

Maintenance Interval Schedule (C11 and C13 Engines with Optional Shallow Sumps)

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 replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Use mileage, fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance.

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

When Required

Battery - Replace 152
Battery or Battery Cable - Disconnect 155
Cooling System Coolant Sample (Level 1) - Obtain 173
Cooling System Coolant Sample (Level 2) - Obtain 175
Engine Air Cleaner Element - Clean/Replace 186
Engine Oil Level Gauge - Calibrate 194
Fuel System - Prime 214
Severe Service Application - Check 235

Daily

Cooling System Coolant Level - Check 172
Engine Air Cleaner Service Indicator - Inspect 186
Engine Oil Level - Check 192
Fuel System Primary Filter/Water Separator - Drain 225
Fuel System Water Separator - Drain 228

Walk-Around Inspection 237

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

Engine Oil and Filter - Change 203

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

Air Compressor Filter - Clean/Replace 151
Alternator - Inspect 151
Battery Electrolyte Level - Check 153
Belt - Inspect 155
Belt Tensioner - Inspect 158
Engine Oil Sample - Obtain 201
Fuel System Primary Filter - Clean/Replace 223
Fuel System Secondary Filter - Replace 226
Fuel Tank Water and Sediment - Drain 230
Hoses and Clamps - Inspect/Replace 231

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

Air Compressor Filter - Clean/Replace 151
Alternator - Inspect 151
Battery Electrolyte Level - Check 153
Belt - Inspect 155
Belt Tensioner - Inspect 158
Cooling System Supplemental Coolant Additive (SCA) - Test/Add 175
Cylinder Head Grounding Stud - Inspect/Clean/Tighten 181
Engine Crankcase Breather - Clean 189
Engine Crankcase Breather - Clean 190
Engine Oil Sample - Obtain 201
Fuel System Primary Filter - Clean/Replace 223
Fuel System Secondary Filter - Replace 226
Fuel Tank Water and Sediment - Drain 230
Hoses and Clamps - Inspect/Replace 231

Between 24 000 and 96 000 km (15 000 and 60 000 miles)

Electronic Unit Injector - Inspect/Adjust 184
Engine Valve Lash - Inspect/Adjust 211
Valve Actuators - Inspect/Adjust 237

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

Aftercooler Core - Clean/Test 149
Cooling System Coolant (DEAC) - Change 163
Cooling System Water Temperature Regulator - Replace 178
Fan Drive Bearing - Lubricate 213
Radiator - Clean 234

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

Air Compressor - Inspect 149
Crankshaft Vibration Damper - Inspect 180
Electronic Unit Injector - Inspect/Adjust 184
Engine - Clean 185
Engine Valve Lash - Inspect/Adjust 211
Turbocharger - Inspect 236
Valve Actuators - Inspect/Adjust 237

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

Cooling System Coolant Extender (ELC) - Add 170

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

Cooling System Coolant (ELC) - Change 167

i02424042

Maintenance Interval Schedule (C11 and C13 Engines with 500 HP Field Up-rate and 525 HP RV Ratings with Optional Shallow Oil Sumps)

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 replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Use mileage, fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance.

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

When Required

Battery - Replace 152
Battery or Battery Cable - Disconnect 155
Cooling System Coolant Sample (Level 1) - Obtain 173
Cooling System Coolant Sample (Level 2) - Obtain 175
Engine Air Cleaner Element - Clean/Replace 186
Engine Oil Level Gauge - Calibrate 194
Fuel System - Prime 214
Severe Service Application - Check 235

Daily

Cooling System Coolant Level - Check 172
Engine Air Cleaner Service Indicator - Inspect 186
Engine Oil Level - Check 192
Fuel System Water Separator - Drain 228

Walk-Around Inspection 237

Every 24 140 km (15 000 miles) or 7950 L (2100 US gal) of Fuel or 230 Service Hours

Engine Oil and Filter - Change 203

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

Air Compressor Filter - Clean/Replace 151
Alternator - Inspect 151
Battery Electrolyte Level - Check 153
Belt - Inspect 155
Belt Tensioner - Inspect 158
Cooling System Supplemental Coolant Additive (SCA) - Test/Add 175
Cylinder Head Grounding Stud - Inspect/Clean/Tighten 181
Engine Crankcase Breather - Clean 189
Engine Oil Sample - Obtain 201
Fuel System Primary Filter - Clean/Replace 223
Fuel System Secondary Filter - Replace 226
Fuel Tank Water and Sediment - Drain 230
Hoses and Clamps - Inspect/Replace 231

Between 24 000 and 96 000 km (15 000 and 60 000 miles)

Electronic Unit Injector - Inspect/Adjust 184
Engine Valve Lash - Inspect/Adjust 211
Valve Actuators - Inspect/Adjust 237

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

Aftercooler Core - Clean/Test 149
Cooling System Coolant (DEAC) - Change 163
Cooling System Water Temperature Regulator - Replace 178
Fan Drive Bearing - Lubricate 213
Radiator - Clean 234

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

Air Compressor - Inspect 149
Crankshaft Vibration Damper - Inspect 180
Electronic Unit Injector - Inspect/Adjust 184
Engine - Clean 185

Engine Valve Lash - Inspect/Adjust 211
Turbocharger - Inspect 236
Valve Actuators - Inspect/Adjust 237

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

Cooling System Coolant Extender (ELC) - Add 170

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

Cooling System Coolant (ELC) - Change 167

i02424024

Maintenance Interval Schedule (C11 and C13 Engines with 500 HP Field Up-rate and 525 HP RV Ratings with Standard (Deep) Oil Sumps)

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 replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Use mileage, fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance.

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

Note: Some maintenance items are for optional equipment.

When Required

Battery - Replace 152
Battery or Battery Cable - Disconnect 155
Cooling System Coolant Sample (Level 1) - Obtain 173
Cooling System Coolant Sample (Level 2) - Obtain 175
Engine Air Cleaner Element - Clean/Replace 186
Engine Oil Level Gauge - Calibrate 197
Fuel System - Prime 214
Severe Service Application - Check 235

Daily

Cooling System Coolant Level - Check 172
Engine Air Cleaner Service Indicator - Inspect 186

Engine Oil Level - Check 192
Fuel System Water Separator - Drain 228
Walk-Around Inspection 237

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

Engine Oil and Filter - Change 203

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

Air Compressor Filter - Clean/Replace 151
Alternator - Inspect 151
Battery Electrolyte Level - Check 153
Belt - Inspect 155
Belt Tensioner - Inspect 158
Cooling System Supplemental Coolant Additive (SCA) - Test/Add 175
Cylinder Head Grounding Stud - Inspect/Clean/Tighten 181
Engine Crankcase Breather - Clean 189
Engine Oil Sample - Obtain 201
Fuel System Primary Filter - Clean/Replace 223
Fuel System Secondary Filter - Replace 226
Fuel Tank Water and Sediment - Drain 230
Hoses and Clamps - Inspect/Replace 231

Between 24 000 and 96 000 km (15 000 and 60 000 miles)

Electronic Unit Injector - Inspect/Adjust 184
Engine Valve Lash - Inspect/Adjust 211
Valve Actuators - Inspect/Adjust 237

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

Aftercooler Core - Clean/Test 149
Cooling System Coolant (DEAC) - Change 163
Cooling System Water Temperature Regulator - Replace 178
Fan Drive Bearing - Lubricate 213
Radiator - Clean 234

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

Air Compressor - Inspect 149
Crankshaft Vibration Damper - Inspect 180

Electronic Unit Injector - Inspect/Adjust 184
Engine - Clean 185
Engine Valve Lash - Inspect/Adjust 211
Turbocharger - Inspect 236
Valve Actuators - Inspect/Adjust 237

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

Cooling System Coolant Extender (ELC) - Add 170

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

Cooling System Coolant (ELC) - Change 167

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.

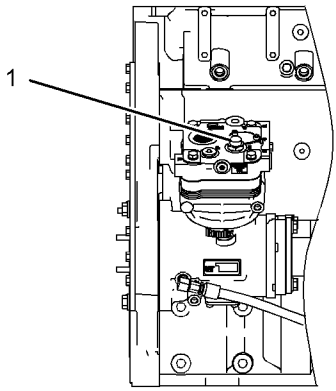
i02413116

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.



g01206109

Illustration 47

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.

i01544231

Air Compressor Filter - Clean/Replace (If Equipped)

SMCS Code: 1803-070-FQ; 1803-510-FQ

One of the single most important aspects of preventive maintenance for the air compressor is the induction of clean air. The type of maintenance that is required for the air compressor and the maintenance interval depends on the type of air induction system that is used. Operating conditions (dust, dirt and debris) may require more frequent service.

Refer to the Service Manual for the type of air compressor that is installed on the engine. Follow the maintenance recommendations that are provided by the OEM of the air compressor. Some engines use boost air pressure so the engine air cleaner will require servicing.

i00072207

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. Refer to the Service Manual.

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.

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.

i02340858

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. If batteries are properly charged, ammeter reading should be very near zero, when the engine is in operation.

⚠ 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.

i02126625

Belt - Inspect

SMCS Code: 1357-040; 1357; 1397-040; 1397

Inspection

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

After the initial check, the belt tension should be checked at Every PM Level 1 or Three Months.

To maximize the engine performance, inspect the belts for wear and for cracking. Replace belts that are worn or damaged.

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

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

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

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

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

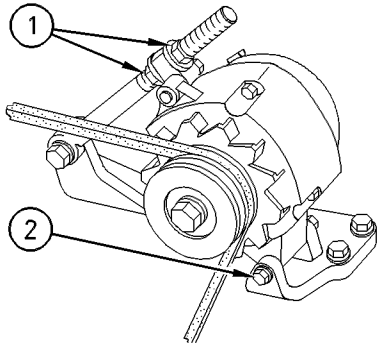
If the belt does not require replacement or adjustment, install the belt guard. If the belt requires adjustment or replacement, perform the following procedure to adjust the belt tension.

- If the engine is equipped with a refrigerant compressor (air conditioner), the belt for the fan drive, the alternator, and the accessories will have an automatic belt tensioner.

- If the engine is not equipped with a refrigerant compressor, the alternator is used to adjust the belt tension.

Adjustment

Alternator Belt



g00485289

Illustration 48

Typical alternator mounting

(1) Adjusting nuts
(2) Mounting bolts

1. Slightly loosen mounting bolt (2) and adjusting nut (1).
2. Move the pulley in order to adjust the belt tension.
3. Tighten adjusting nuts (1) and mounting bolts (2). Refer to the Specifications, SENR3130 in order to locate the proper torques.
4. Install the belt guard.

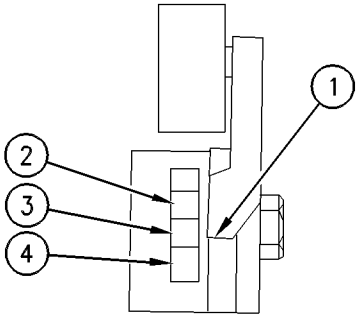
If new belts are installed, check the belt tension again after 30 minutes of engine operation at the rated rpm.

i00924440

Belt Tensioner - Inspect

SMCS Code: 1358-040

It is essential to check the position of the belt tightener in order to maintain the proper belt tension. A film (decal) is located on the side of the belt tightener. The decal indicates when the belts have stretched beyond the belt tightener's ability.



g00472130

Illustration 49

Side view of the belt tensioner

(1) Indicator
(2) Upper red zone
(3) Green zone
(4) Lower red zone

If the pointer (1) is in green zone (3), the belt tension is correct. If the pointer (1) is in the upper red zone (2), the belt has stretched. The tension must be adjusted or the belt must be replaced. If the pointer (1) is in the lower red zone (4), the belt is too short. The belt must be replaced.

i01406684

Compression Brake - Inspect/Adjust

SMCS Code: 1119-025; 1119-040

S/N: JAM1-Up

S/N: BXS1-Up

S/N: MXS1-Up

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 13

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

S/N: JAM1-Up

S/N: BXS1-Up

S/N: MXS1-Up

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 14

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 15 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 15

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.

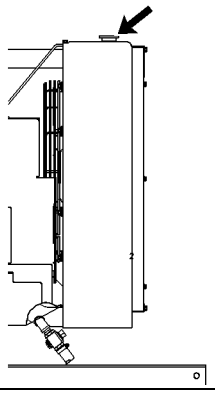


Illustration 50 g00285520

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.

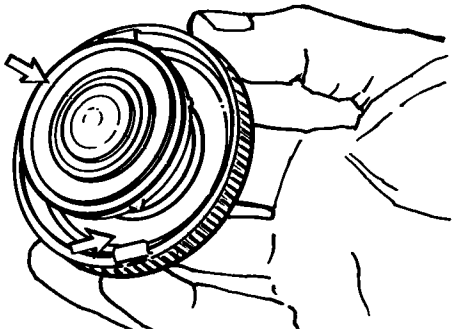


Illustration 51 g00103639
Typical filler cap gaskets

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.

i02185306

Cooling System Coolant Sample (Level 1) - 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.

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

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

Use the following guidelines for proper sampling of the coolant:

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

Submit the sample for Level 1 analysis.

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

i00912898

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 the Service Manual 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:

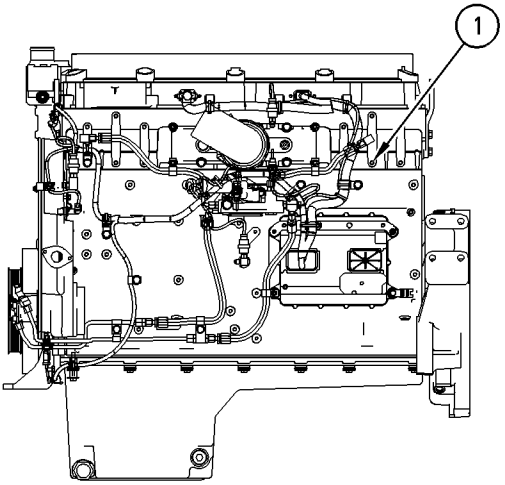
- The damper is dented, cracked, or leaking.
- The paint on the damper is discolored from heat.
- The engine has had a failure because of a broken crankshaft.
- Analysis of the oil has revealed that the front main bearing is badly worn.
- There is a large amount of gear train wear that is not caused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

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

i01823226

Cylinder Head Grounding Stud - Inspect/Clean/Tighten

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



g00931100

Illustration 52

C11 and C13 engines

(1) Cylinder head grounding stud

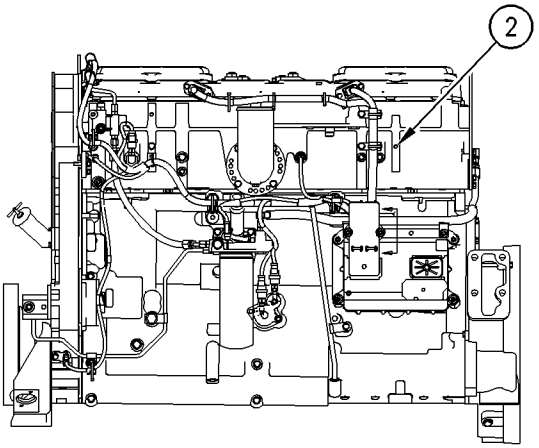


Illustration 53 g00931103

C15 Engine

(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.

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.

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.

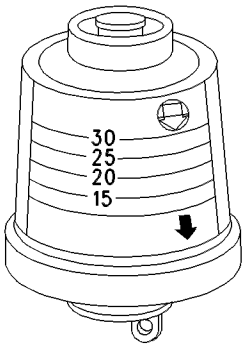


Illustration 54 g00103777

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).

i01848984

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

S/N: KCA1-Up

S/N: KCB1-Up

S/N: JAM1-Up

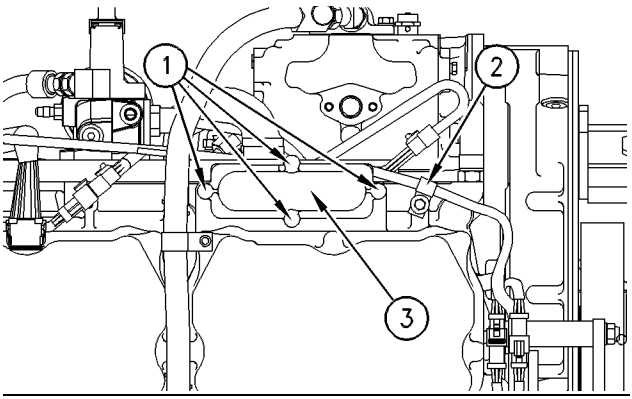


Illustration 55 g00485291

(1) Bolts. (2) Hose clamp. (3) Breather cover.

NOTICE
Perform this maintenance with the engine stopped.

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

1. Loosen hose clamp (2) and remove the hose from breather cover (3).

2. Loosen four bolts (1) for the breather cover and remove breather cover (3).

3. Remove the breather element and wash the breather element in solvent that is clean and nonflammable. Allow the breather element to dry.

4. Install a breather element that is clean and dry. Install breather cover (3) and install bolts (1). Refer to the Specifications, SENR3130 in order to locate the proper torques.

5. Install the hose. Install hose clamp (2). Refer to the Specifications, SENR3130 in order to locate the proper torques.

i02263740

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

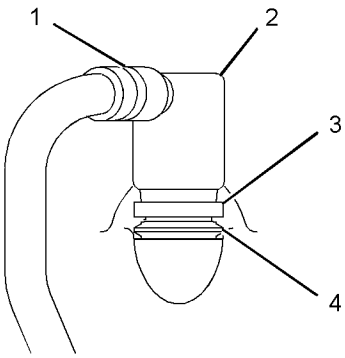
S/N: JAM1-Up

S/N: BXS1-Up

S/N: MXS1-Up

NOTICE
Perform this maintenance with the engine stopped.

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



g01136454

Illustration 56

Typical example

(1) Hose clamp
(2) Breather assembly
(3) Retaining clamp
(4) Seal

1. Loosen hose clamp (1) and remove the hose from breather assembly (2).

2. Loosen retaining clamp (3). Remove the breather assembly and seal (4).

3. Wash the breather element in solvent that is clean and nonflammable. Allow the breather element to dry before installation.

4. Install a breather element that is clean and dry. Install the seal, the breather assembly, and the clamp. Refer to the Specifications, SENR3130 in order to locate the proper torques.

5. Install the hose. Install the hose clamp. Refer to the Specifications, SENR3130 in order to locate the proper torques.

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.

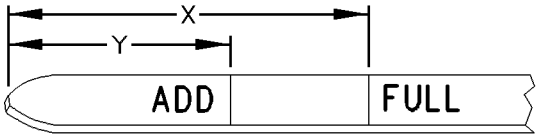


Illustration 57 g00110310

(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.

i02174164

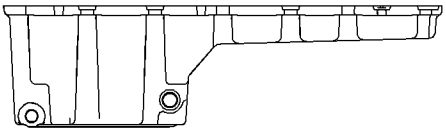
Engine Oil Level Gauge - Calibrate (C11 and C13 Engines with Optional-Shallow Oil Pans)

SMCS Code: 1326-524

S/N: KCA1-Up

S/N: KCB1-Up

S/N: JAM1-Up



g01011620

Illustration 58

C11 and C13

This pan has an overall height of 278 mm (10.9 inch).

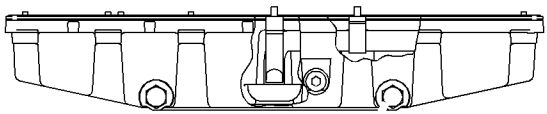


Illustration 59 g01101651

C11 and C13

This pan has an overall height of 167.5 mm (6.59 inch).

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. Pour 26 L (28 qt) of oil 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 4 L (4 qt) of oil 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 an additional 4 L (4 qt) of oil into the crankcase. 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 added. The additional oil and the 34 L (36 qt) of oil that was in the crankcase is the oil capacity of the lubrication system. Record the oil capacity of the lubrication system for future oil changes.

i02179971

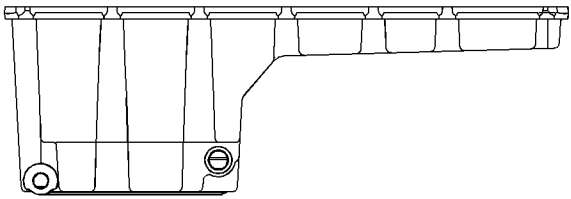
Engine Oil Level Gauge - Calibrate (C11 and C13 Engines with Standard-Deep Oil Pans)

SMCS Code: 1326-524

S/N: KCA1-Up

S/N: KCB1-Up

S/N: JAM1-Up



g01011683

Illustration 60

C11 and C13

210 - 1745 Pan (Standard-Deep)

This pan has an overall height of 335 mm (13.2 inch).

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. Pour 32 L (34 qt) of oil 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 4 L (4 qt) of oil 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 an additional 4 L (4 qt) of oil into the crankcase. 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 added. The additional oil and the 40 L (42 qt) of oil that was in the crankcase is the oil capacity of the lubrication system. Record the oil capacity of the lubrication system for future oil changes.

i02180007

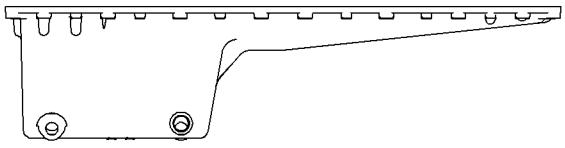
Engine Oil Level Gauge - Calibrate (C15 Engines)

SMCS Code: 1326-524

S/N: JAM1-Up

S/N: BXS1-Up

S/N: MXS1-Up



g01016726

Illustration 61

C15

227-3004 Pan

This pan has an overall height of 278.5 mm (11 inch).

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. Pour 26.6 L (28 qt) of oil 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 5.7 L (6 qt) of oil 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 an additional 5.7 L (6 qt) of oil into the crankcase. 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 added. The additional oil and the 38 L (40 qt) of oil that was in the crankcase is the oil capacity of the lubrication system. Record the oil capacity of the lubrication system for future oil changes.

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.

i02174645

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.

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. Use one of the following methods to drain the engine crankcase oil:

⚠ 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.

- If the engine is equipped with a drain valve, turn the drain valve knob counterclockwise in order to drain the engine oil. After the engine oil has drained, turn the drain valve knob clockwise in order to close the drain valve.
- If the engine is not equipped with a drain valve, remove the oil drain plug in order to allow the engine oil to drain. If the engine is equipped with a shallow sump, remove the bottom oil drain plugs from both ends of the engine oil pan.

After the engine oil has drained, the oil drain plugs should be cleaned and installed. Tighten the oil drain plugs to the proper torque. Refer to the Specifications Module, “Engine Oil Pan” topic for additional information.

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.
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 62 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 (Maintenance Section) for more information. Fill the crankcase with the proper amount of engine oil. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic (Maintenance Section) for more information.

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

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

2. Start the engine and run the engine at “LOW IDLE” for 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. Remove 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.

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: premium API CH-4 multigrade oil, oil analysis at 16,100 km (10,000 miles), and premium oil filters.

Proper oil change intervals are important for maintaining engine service life and engine performance and fully utilizing the lubricant. The engine oil must be able to control the following items: corrosion, oxidation, soot, and wear metals. The engine oil must be able to control the conditions during the time between oil changes. In some severe service applications, reducing the oil change interval may be necessary in order to maintain the integrity of the engine lubricant.

Fuel consumption and oil consumption are the most important factors that are used in order to calculate an oil change interval.

The rate of fuel consumption is a direct result of the load factor of the engine. An engine with a high fuel consumption rate is working harder than an identical engine with a lower fuel consumption rate.

Tables for Extended Oil Change Intervals

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.

The following requirements must be met in order to use Tables 16, 17, and 18:

- Use premium API CH-4 or API CI-4 multigrade oil only. API CH-4 and CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met. CH-4 and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.
- DEO Caterpillar multigrade oil is recommended.
- S·O·S Oil analysis is taken at 16,100 km (10,000 mile) intervals and all oil change intervals. The oil analysis must evaluate oil condition, wear metals and soot. Caterpillar's Oil Analysis is preferred. Caterpillar's Oil Analysis is the only oil analysis program with wear tables and limits for soot and oxidation, that are approved by Caterpillar.
- Use premium oil filter(s). Caterpillar 1R-0716 Oil Filter or an oil filter with equivalent performance and durability is recommended.
- Use North American low sulfer diesel fuel (0.05% sulfer).

Note: Caterpillar cannot guarantee the performance of lubricants or filters that are not sold by Caterpillar. The performance guarantee of any commercially available lubricant is the responsibility of that oil company. The performance guarantee of any commercially available filter is the responsibility of the filter manufacturer.

Table 16

Maximum Permissible Oil Change Intervals for On-highway C11 and C13 Engines with Shallow Sumps (Optional) and 500 HP Field Up Rate and 525 HP RV			
	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 80,000 lb	80,000 lb or less	80,000 lb or less
Minimum Oil Sump Capacity(1)	34 L (36 qt)	34 L (36 qt)	34 L (36 qt)
Idle Time	More than 40%	20% to 40%	Less than 20%
Oil Classification	API CH-4 or API CI-4(2)		
Kilometers (Miles)	24,150 kilometers (15,000 miles)	32,200 kilometers (20,000 miles)	40,250 kilometers (25,000 miles)

(1) If the oil sump capacity is greater than the oil sump capacity that is listed in Table 17, the oil change interval can be extended 1600 kilometers (1000 miles) for every 2 L (2 qt) increase in oil sump capacity.

(2) **API CH-4 and CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met. CH-4 and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.**

Table 17

Maximum Permissible Oil Change Intervals for On-highway C11 and C13 Engines with Deep Sumps (Standard)			
	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 80,000 lb	80,000 lb or less	80,000 lb or less
Minimum Oil Sump Capacity(1)	40 L (42 qt)	40 L (42 qt)	40 L (42 qt)
Idle Time	More than 40%	20% to 40%	Less than 20%
Oil Classification	API CH-4 or API CI-4(2)		
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 17, the oil change interval can be extended 1600 kilometers (1000 miles) for every 2 L (2 qt) increase in oil sump capacity.

(2) **API CH-4 and CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met. CH-4 and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.**

Table 18

Maximum Permissible Oil Change Intervals for On-highway C15 Engines with Deep Sumps (Standard)			
	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 80,000 lb	80,000 lb or less	80,000 lb or less
Minimum Oil Sump Capacity(1)	38 L (40 qt)	38 L (40 qt)	38 L (40 qt)
Idle Time	More than 40%	20% to 40%	Less than 20%
Oil Classification	API CH-4 or API CI-4(2)		
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 17, the oil change interval can be extended 1600 kilometers (1000 miles) for every 2 L (2 qt) increase in oil sump capacity.

(2) **API CH-4 and CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met. CH-4 and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.**

i01849001

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

The initial valve lash adjustment on new engines, rebuilt engines, or remanufactured engines is recommended at the first scheduled oil change. The adjustment is necessary due to the initial wear of the valve train components and to the seating of the valve train components.

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

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.

⚠ 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.

Ensure that the engine is stopped before measuring the valve lash. 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 the Service Manual for more information.

i01771215

Fan Drive Bearing - Lubricate

SMCS Code: 1359-086-BD

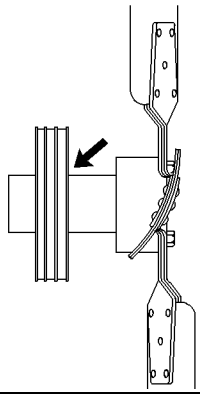


Illustration 63 g00746166

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.

i01957767

Fuel System - Prime

SMCS Code: 1258-548

C11 and C13 On-highway Engines

The Secondary Fuel Filter Has Been Replaced

⚠ 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.

Note: Refer to Operation and Maintenance Manual, “Fuel System Secondary Filter - Replace” for information on replacing the filter.

1. Turn the ignition switch to the “OFF” position.

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.

2. Start the engine. Operate the engine at 1000 to 1200 rpm until the engine runs smoothly in order to remove the residual air from the fuel system.

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

Note: You may use the hand priming pump for the fuel filter (IF EQUIPPED) instead of starting the engine and running the engine. Perform the following procedure when the hand priming pump is used:

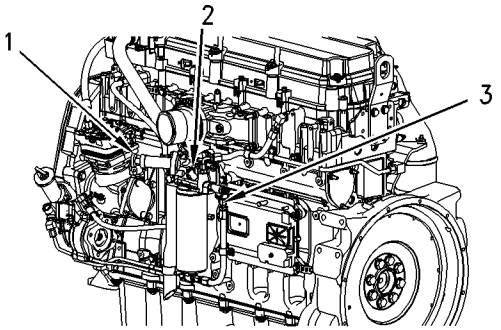


Illustration 64 g00985847

(1) Fuel priming pump
(2) Air purge screw
(3) Priming valve (If Equipped)

a. Turn the priming valve (3) (If Equipped) to the “Closed (Prime)” position in order to prime the fuel system.

b. Open the air purge screw (2) for the fuel filter by three full turns. Do not remove the air purge screw.

c. While you operate the hand priming pump (1), observe air purge screw (2). When a small drop of fuel appears at the threads of the air purge screw, close and tighten air purge screw (2).

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

d. Clean any residual fuel from the engine components.

e. Continue to operate the fuel priming pump (1) 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 (1).

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

f. 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 or smoke, further priming is necessary.

g. After the engine has operated smoothly for 30 seconds, turn the priming valve (3) to the “Open (Run)” position.

Note: Shortened injector life may occur if the priming valve (3) is left in the “Closed (Prime)” position.

The Engine Has Been Run Out of Fuel

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.

1. Turn the ignition switch to the “OFF” position.

2. Fill the fuel tank(s) with clean diesel fuel.

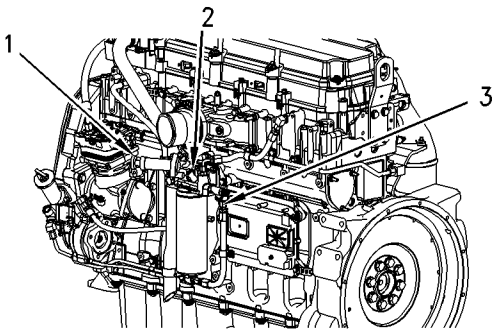


Illustration 65 g00985847

(1) Fuel priming pump
(2) Air purge screw
(3) Priming valve (If Equipped)

3. Turn the priming valve (3) (If Equipped) to the “Closed (Prime)” position in order to prime the fuel system.

4. Open air purge screw (2) for the fuel filter by three full turns. Do not remove the air purge screw.

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.

5. Crank the engine for 30 seconds. Use a suitable container to catch the fuel while you crank the engine. Allow the starter motor to cool for 2 minutes.

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

6. Crank the engine for 30 seconds. Allow the starter motor to cool for 2 minutes.

7. Repeat Step 6 until the engine starts and runs. If the engine runs rough, continue to operate the engine at low idle until the engine runs smoothly.

8. Observe air purge screw (2). When a small drop of fuel appears at the threads of the air purge screw, close and tighten air purge screw (2).

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

9. After the engine has operated smoothly for 30 seconds, turn the priming valve (3) to the “Open (Run)” position.

Note: Shortened injector life may occur if the priming valve (3) is left in the “Closed (Prime)” position.

10. Clean any residual fuel from the engine components.

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

Note: You may use the hand priming pump for the fuel filter (IF EQUIPPED) instead of starting the engine and running the engine. Perform the following procedure when the hand priming pump is used:

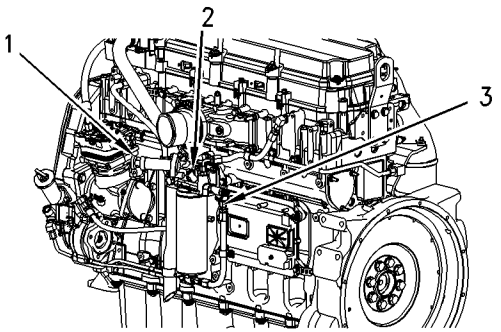


Illustration 66 g00985847

(1) Fuel priming pump
(2) Air purge screw
(3) Priming valve (If Equipped)

a. Turn the priming valve (3) (If Equipped) to the “Closed (Prime)” position in order to prime the fuel system.

b. Open air purge screw (2) for the fuel filter by three full turns. Do not remove the air purge screw.

c. While you operate the hand priming pump (1), observe air purge screw (2). When a small drop of fuel appears at the threads of the air purge screw, close and tighten air purge screw (2).

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

d. Clean any residual fuel from the engine components.

e. Continue to operate the fuel priming pump (1) 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 (1).

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

f. 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 or smoke, further priming is necessary.

g. After the engine has operated smoothly for 30 seconds, turn the priming valve (3) to the “Open (Run)” position.

Note: Shortened injector life may occur if the priming valve (3) is left in the “Closed (Prime)” position.

C15 On-highway Engines

The Secondary Fuel Filter Has Been Replaced

⚠ 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.

Note: Refer to Operation and Maintenance Manual, “Fuel System Secondary Filter - Replace” for information on replacing the filter.

1. Turn the ignition switch to the “OFF” position.

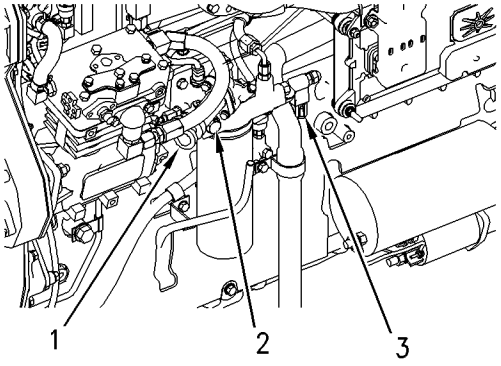


Illustration 67 g00975199

(1) Fuel priming pump
(2) Air purge screw
(3) Priming valve (If Equipped)

2. Turn the priming valve (3) (If Equipped) to the “Closed (Prime)” position in order to prime the fuel system.

3. Open air purge screw (2) for the fuel filter by three full turns. Do not remove the air purge screw.

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. Start the engine. The engine should start and the engine should run smoothly.

Note: You may use the fuel priming pump for the fuel filter (IF EQUIPPED) instead of starting the engine and running the engine.

5. While the engine is running, observe air purge screw (2). When a small drop of fuel appears at the threads of the air purge screw, close and tighten air purge screw (2).

Note: There may be a noticeable change in the sound of the running engine when the air purge screw is tightened. The change in the sound of the engine is normal.

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

6. Clean any residual fuel from the engine components.

7. After the engine has operated smoothly for 30 seconds, turn the priming valve (3) to the “Open (Run)” position.

Note: Shortened injector life may occur if the priming valve (3) is left in the “Closed (Prime)” position.

The Engine Has Been Run Out of Fuel

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.

1. Turn the ignition switch to the “OFF” position.

2. Fill the fuel tank(s) with clean diesel fuel.

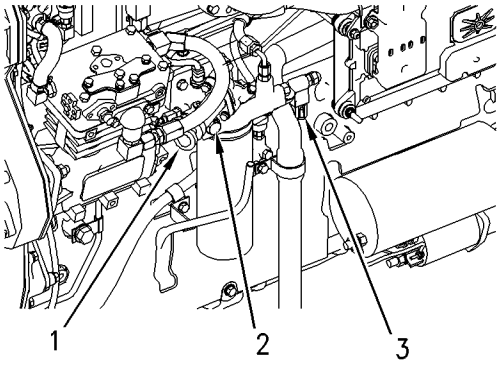


Illustration 68 g00975199

(1) Fuel priming pump
(2) Air purge screw
(3) Priming valve (If Equipped)

3. Turn the priming valve (3) (If Equipped) to the “Closed (Prime)” position in order to prime the fuel system.

4. Open air purge screw (2) for the fuel filter by three full turns. Do not remove the air purge screw.

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.

5. Crank the engine for 30 seconds. Use a suitable container to catch the fuel while you crank the engine. Allow the starter motor to cool for 2 minutes.

Note: You may use the fuel priming pump (1) (IF EQUIPPED) for the fuel filter instead of cranking the engine.

6. Crank the engine for 30 seconds. Allow the starter motor to cool for 2 minutes.

7. Repeat Step 6 until the engine starts and the engine runs.

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

8. After the engine has operated smoothly for 30 seconds, turn the priming valve (3) to the “Open (Run)” position.

Note: Shortened injector life may occur if the priming valve (3) is left in the “Closed (Prime)” position.

9. Clean any residual fuel from the engine components.

i00951418

Fuel System Primary Filter - Clean/Replace

SMCS Code: 1260-070; 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.

1. Stop the engine.

2. Turn the start switch to the “OFF” position. Disconnect the battery.

3. Shut off the fuel tank supply valve to the engine.

4. If the primary fuel filter is equipped with a drain valve, open the drain valve in order to drain any fuel from the filter case. Close the drain valve.

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

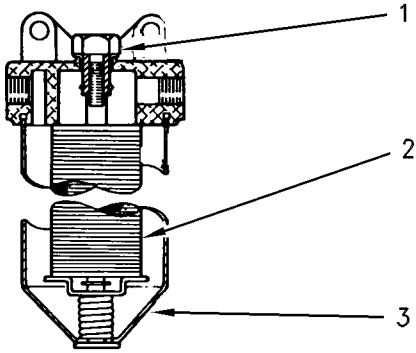


Illustration 69 g00485293

(1) Bolt
(2) Element
(3) Case

5. Loosen the bolt (1) that is on the filter housing. Remove the filter case (3).

6. Remove the element (2) and wash the element in clean, nonflammable solvent.

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

7. Install the element (2) and the filter case (3). Tighten the bolt (1) to a torque of 24 ± 4 N·m (18 ± 3 lb ft).

i01341997

Fuel System Primary Filter/Water Separator - Drain

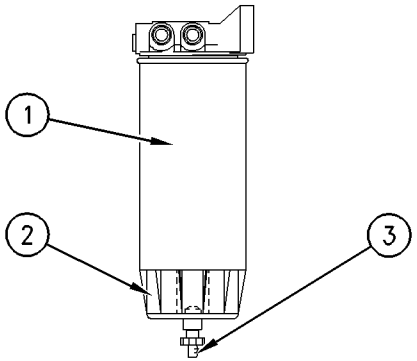
SMCS Code: 1260-543; 1263-543

⚠ WARNING

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

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.



g00709596

Illustration 70

(1) Element
(2) Bowl
(3) Drain

Bowl (2) should be monitored daily for signs of water. If water is present, drain the water from the bowl.

1. Open drain (3). The drain is a self-ventilated drain. Catch the draining water in a suitable container. Dispose of the water properly.

2. Close drain (3).

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

i01503750

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).

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

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

4. Apply clean diesel fuel to the new fuel filter gasket.

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

NOTICE
In order to maximize fuel system life and prevent premature wear out from abrasive particles in the fuel, a two micron 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.

5. Install the new fuel filter. Spin the fuel filter onto the fuel filter base until the gasket contacts the base. Use the rotation index marks on the filters as a guide for proper tightening. Tighten the filter for an additional one turn (360 degrees) by hand. Do not overtighten the filter.

6. Open the fuel supply valve. 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.

Note: There should be enough residual fuel in the cylinder head in order to start the engine. If the engine stops after starting, do not crank the engine for more than 30 seconds. Then allow the starting motor to cool for two minutes. Repeat this procedure until the engine starts and the engine operates.

i02112513

Fuel System Water Separator - Drain

SMCS Code: 1263-543

⚠ WARNING

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

NOTICE

The water separator is not a filter. It separates water from the fuel.

The engine should never be allowed to run with the water level in the separator more than 1/2 full or engine damage may result.

A water separator is recommended. The water separator should be installed between the fuel tank and the engine fuel inlet. Drain the water and sediment from the water separator on a daily basis.

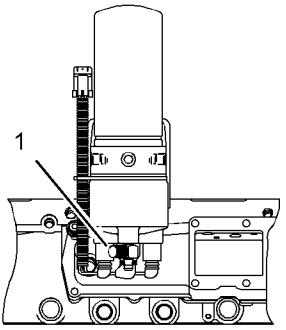


Illustration 71 g01076474

(1) Drain

1. Open drain (1). Catch the draining water in a suitable container. Dispose of the water properly.

NOTICE

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

2. Close drain (1).

i02394978

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.

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.

i02121526

Hoses and Clamps - Inspect/Replace

SMCS Code: 7554-040; 7554-510

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

- Cracking
- Softness
- Loose clamps

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

NOTICE

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

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

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

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

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

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

Replace the Hoses and the Clamps

⚠ WARNING

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

1. Stop the engine. Allow the engine to cool.
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.

i01604510

Radiator - Clean

SMCS Code: 1353-070

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

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

⚠ WARNING

Personal injury can result from air pressure.

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

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

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

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

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

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

Inspect the fins for damage. Bent fins may be opened with a "comb". Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, refer to Special Publication, SEBD0518, “Know Your Cooling System”.

i01357879

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 level of maintenance is crucial to the service life of the engine. Other major factors that affect service life are operating speed and loads.

The conditions that follow can indicate severe service operation:

- Operation above 36,320 kg (80,000 lb) gross vehicle weight (GVW) and other high load factor operations (such as off-highway)
- Frequent high altitude operation above 1525 m (5000 ft)
- Extended operation at low idle
- Arctic operation (regular cold starts at temperatures below −18 °C (0 °F))
- Extending maintenance beyond the recommended maintenance intervals
- Frequent hot shutdowns (minimum five minute cool down periods after high load factor operation)
- Use of fuels that are NOT recommended by Caterpillar in the Fuel Specifications
- 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.)

i01894393

Turbocharger - Inspect

SMCS Code: 1052-040; 1052

Periodic inspection and cleaning is recommended for the turbocharger compressor housing (inlet side).

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.

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.

A periodic inspection of the turbocharger can minimize unscheduled downtime and the chance for potential damage to other engine parts.

Note: Turbocharger components require precision clearances with proper balancing in order to support high operating speeds. Severe Service Applications can accelerate component wear. Therefore, more frequent inspections of the cartridge are required.

Removal and Installation

For options regarding the inspection, removal, installation, repair and replacement, consult your authorized Caterpillar service center. Refer to the Service Manual for this engine for the procedure and specifications.

i01848805

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.

i01185304

Walk-Around Inspection

SMCS Code: 1000-040

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections and trash buildup. Make repairs, as needed:

- The guards must be in the proper place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

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

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

- Ensure that the cooling lines are properly clamped and that the cooling lines are tight. Check for leaks. Check the condition of all pipes.
- Inspect the water pumps for coolant leaks.

Note: The water pump seal is lubricated by coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of water pumps and the installation of water pumps and/or seals, refer to the Service Manual for the engine or consult your Caterpillar dealer.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the valve cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps or for loose fuel line tie-wraps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps. Ensure that hoses and tubes are not contacting other hoses, tubes, wiring harnesses, etc.
- Inspect the alternator belt and the accessory drive belts for cracks, breaks or other damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt is replaced, the belt will carry more load than the belts that are not replaced. The older belts are stretched. The additional load on the new belt could cause the belt to break.

- Drain the water and the sediment from fuel tanks on a daily basis in order to ensure that only clean fuel enters the fuel system.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Inspect the ECM to the cylinder head ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges that are cracked. Replace any gauge that can not be calibrated.

Warranty Section

Warranty Information

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Federal Emission Control Warranty

SMCS Code: 1000

Emissions Warranty

New Heavy Duty Engines Powering On-highway Vehicles-10.3 liter up to and including 18.1 liter.

Caterpillar Inc. warrants to the initial owner and to the 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 United States Environmental Protection Agency (EPA).

2. Caterpillar Inc. or any of its subsidiaries (Caterpillar) warrants new 10.3 liter up to and including 18.3 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, 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 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.

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.

- 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 2003 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 10.3 liter up to and including 18.3 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, 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) in order to comply with exhaust emission standards and gaseous emission standards that are prescribed by Federal laws 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 devices are sensitive to the type of fuel used and the operating schedule. Poor quality fuel may cause increases in exhaust back pressure or clogging resulting in loss of power. An authorized Caterpillar truck engine dealer can determine if the aftertreatment device needs service.

UNIT INJECTORS – Unit injectors are subject to tip 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 unit injector should be inspected, tested and replaced, if necessary. Unit injectors can be tested by an authorized Caterpillar truck engine dealer.

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

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 an engine or concerning the service of an engine, the problem will normally be managed by the dealer in your area.

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

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.

Note: The information that is found in this publication and the information that is found in the publications that are listed below may be changed without notice.

S·O·S Information

- Special Publications, PEDP7036, “S·O·S Fluids Analysis Cornerstone”
- Special Publication, PEHP7057, “Data Sheet - S·O·S Coolant Analysis”
- Special Publication, NEHP6013, “S·O·S Fluids Analysis Products”
- Special Publication, PEHP7076, “Understanding S·O·S Services Tests”

Lubricants

- Special Publication, PEHP6001, “How To Take A Good Oil Sample”
- Special Publication, SEBD0640, “Oil and Your Engine”
- Special Publication, PEDP7035, “Optimizing Oil Change Intervals”
- Special Publication, PELJ0179, “Caterpillar Engine Crankcase Fluid-1 Specifications” All International Markets
- Data Sheet, PEHJ0021, “Product Data Sheet for Cat DEO (Diesel Engine Oil) APD, EAME, LACD Only ”
- Data Sheet, PEHP7062, “Full Synthetic Diesel Engine Oil Data Sheet”
- Data Sheet, PEHJ0008, “Cat Arctic DEO SYN”
- Data Sheet, PEHJ0059, “Cat DEO (for North America)”

- Data Sheet, PEHJ0072, “Cat DEO (Brazil only)”
- Data Sheet, PEHJ0091, “Cat DEO (Egypt and Saudi Arabia)”

Greases

- Data Sheet, NEHP6015, “Caterpillar Special Purpose Grease”
- Special Publication, NEHP5621, “How To Select The Right Grease For Any Job”
- Special Publication, PEHP0002, “Data Sheet - Multipurpose Lithium Complex Grease with Molybdenum (MPGM)”
- Special Instruction, NEHP6011, “Arctic Platinum Grease Spec Sheet”
- Data Sheet, PEHP0088, “Cat MultiPurpose Grease”

Fuels

- Special Publication, SEBD0717, “Diesel Fuels and Your Engine”
- Special Publication, SENR9620, “Improving Fuel System Durability”

Coolants

- Special Publication, SEBD0518, “Know Your Cooling System”
- Special Publication, PEEP5027, “Label - ELC Radiator Label”
- Special Publication, PELJ0176, “Cat ELC (Extended Life Coolant)223-9116 Coolant Test Kit”
- Special Publication, PEHJ0067, “Cat ELC (Worldwide Formulation)”

Miscellaneous

- Service Manual, NENG2500, “Cat Dealer Service Tool Catalog”
- Service Manual, SENR9700, “C11 and C13 On-highway Engine”
- Service Manual, SENR9695, “C15 and C18 On-highway Engine”

- Special Publication, LEWT5622, “Maintenance Products Application Chart for Cat Truck Engines”
- Special Instruction, SMHS7001, “Assembly of Fan Drive Pulley Assemblies”
- Special Instruction, SEHS7633, “Battery Test Procedure”
- Special Instruction, LEDT2254, “Cat Answers Your Questions About Truck Performance”
- Special Publication, PEDP0026, “Power Analysis Report”
- Special Publication, SEBU6385, “Cat On-Highway Truck Engine Fluids Recommendations”
- Special Publication, SEBF8062, “Guideline for Reusable Parts - Procedure to Inspect and Clean Air Filters”
- Special Publication, SEBF8029, “Index to Guidelines for Reusable Parts and Salvage Operations”
- Special Publication, NEHS0526, “Service Technology Application Guide”
- Special Instruction, SEHS9031, “Storage Procedure for Caterpillar Products”
- Specifications, SENR3130, “Torque Specifications Module”
- Special Instruction, SEHS8742, “Using the 8T-8697 Electronic Control Analyzer Programmer (ECAP)”
- Special Instruction, SEHS8622, “Using the FT-1984 Aftercooler Testing Group”
- Special Instruction, SEHS7332, “Warning Tag - Danger Do Not Operate”
- Special Instruction, REHS0871, “Electronic Installation Guide”.
- Special Publication, “Truck Engine Application and Installation Guide” (See your Caterpillar dealer.)
- Special Publication, PECP9067, “One Safe Source” English Language for use in NACD

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 Associaton
Two North LaSalle Street, Suite 2200
Chicago, IL, USA 60602
E-mail: ema@enginemanufacturers.org
(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
E-mail: www.sae.org
(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
E-mail: www.api.org
(202) 682-8000

For information regarding “Technology and Maintenance Council (TMC) Specifications”, refer to the following address:

Technology and Maintenance Council
American Trucking Association
2200 Mill Road
Alexandria, VA, USA 22314
E-mail: www.trucking.org/cc/councils/tmc
(703) 838-1763

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Engine Protection Plans

SMCS Code: 1000

Extended Warranties and Service Contracts

A wide variety of protection plans are available for Caterpillar On-Highway Truck Engines. Consult your authorized Caterpillar Truck Engine dealer for information on the following plans which is best suited for your needs.

- ESC (Extended Service Coverage)
- OPT (Overhaul Protection for Trucks)
- Remanufactured Extended Coverage

Consult your authorized Caterpillar Truck Engine dealer for more detailed information on specific programs and coverage that is available. Ask for the Sales Manager for the Engine Protection Plan.

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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:

- Determine operating costs.
- Establish maintenance schedules for other engines that are operated in the same environment.
- Show compliance with the required maintenance practices and maintenance intervals.

Maintenance records can be used for a variety of other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is well managed. Accurate maintenance records can help your Caterpillar dealer to fine tune the recommended maintenance intervals in order to meet the specific operating situation. This should result in a lower engine operating cost.

Records should be kept for the following items:

Fuel Consumption – A record of fuel consumption is essential in order to determine when the load sensitive components should be inspected or repaired. Fuel consumption also determines overhaul intervals.

Service Hours – A record of service hours is essential to determine when the speed sensitive components should be inspected or repaired.

Documents – These items should be easy to obtain, and these items should be kept in the engine history file. All of the documents should show this information: date, service hours, fuel consumption, unit number, and engine serial number. The following types of documents should be kept as proof of maintenance or repair for warranty:

Keep the following types of documents as proof of maintenance for warranty. Also, keep these types of documents as proof of repair for warranty:

- Dealer work orders and itemized bills
- Owner’s repair costs
- Owner’s receipts
- Maintenance log

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Maintenance Log

SMCS Code: 1000

Table 19

Engine Model	**Customer Identifier**
Serial Number	**Arrangement Number**

Table 20

Service Hours	**Quantity of Fuel**	**Serviced Item**	**Date**	**Authorization**

(continued)

(Table 20, contd)

Service Hours	Quantity of Fuel	Serviced Item	Date	Authorization

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Product and Dealer Information

Note: For product identification plate locations, see the section “Product Identification Information” in the Operation and Maintenance Manual.

Delivery Date: _____

Product Information

Model: _____

Product Identification Number: _____

Engine Serial Number: _____

Transmission Serial Number: _____

Generator Serial Number: _____

Attachment Serial Numbers: _____

Attachment Information: _____

Customer Equipment Number: _____

Dealer Equipment Number: _____

Dealer Information

Name: _____ Branch: _____

Address: _____

_____

_____

	Dealer Contact	Phone Number	Hours
Sales:	_____	_____	_____
Parts:	_____	_____	_____
Service:	_____	_____	_____

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