



# Operation and Maintenance Manual

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## **C7.1 (XQ230) Rental Generator Set**

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CK2 1-UP (C7.1 (XQ230)  
Generator Set)  
CF8 1-UP (C7.1 (XQ230)  
Package Generator Set)

Language: Original Instructions



Scan to access the latest service information, purchase additional media, and buy genuine Cat® parts.



## Important Safety Information

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

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

**Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.**

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

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



The meaning of this safety alert symbol is as follows:

**Attention! Become Alert! Your Safety is Involved.**

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

A non-exhaustive list of operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

**Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.**

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

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### NOTICE

**When replacement parts are required for this product Caterpillar recommends using original Caterpillar® replacement parts.**

**Other parts may not meet certain original equipment specifications.**

**When replacement parts are installed, the machine owner/user should ensure that the machine remains in compliance with all applicable requirements.**

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

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## Foreword

### California Proposition 65 Warning

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



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

[www.P65Warnings.ca.gov](http://www.P65Warnings.ca.gov)

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



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

[www.P65Warnings.ca.gov](http://www.P65Warnings.ca.gov)

**Wash hands after handling components that may contain lead.**

### Literature Information

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

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

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

### Safety

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

### Operation

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

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

### Maintenance

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

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

Recommended service should be performed at the appropriate intervals as indicated in the Maintenance Interval Schedule. The actual operating environment of the engine also governs the Maintenance Interval Schedule. Therefore, under severe, dusty, wet, or freezing cold operating conditions, more frequent lubrication, and maintenance than is specified in the Maintenance Interval Schedule may be necessary.

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

## **Maintenance Intervals**

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

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

## **Overhaul**

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

## Safety Section

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### Safety Messages

**SMCS Code:** 1000; 7405

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

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

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

 **WARNING**

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

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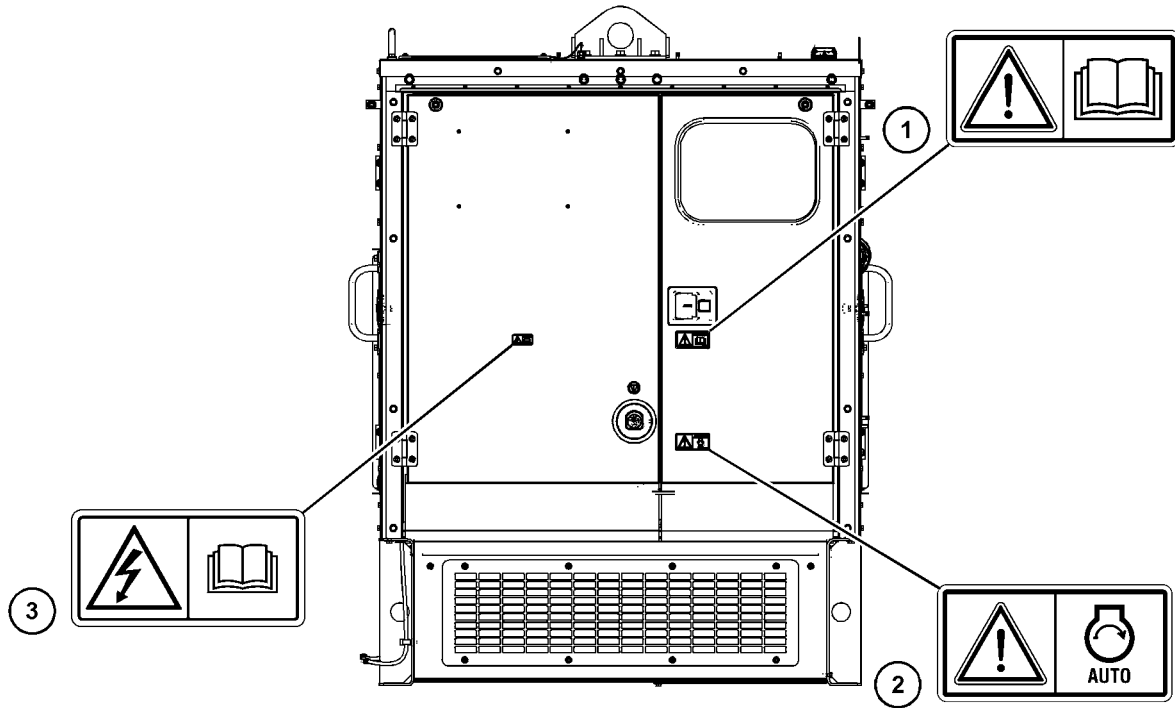


Illustration 1  
Rear view of the enclosure

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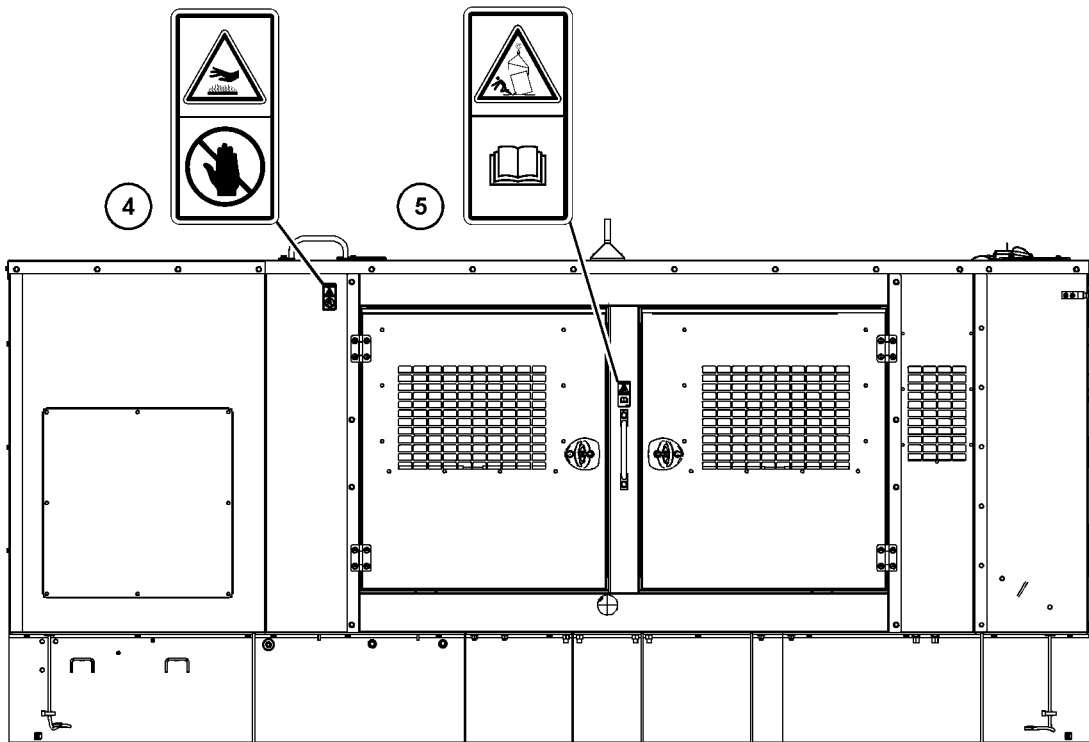


Illustration 2  
Left side view of the enclosure

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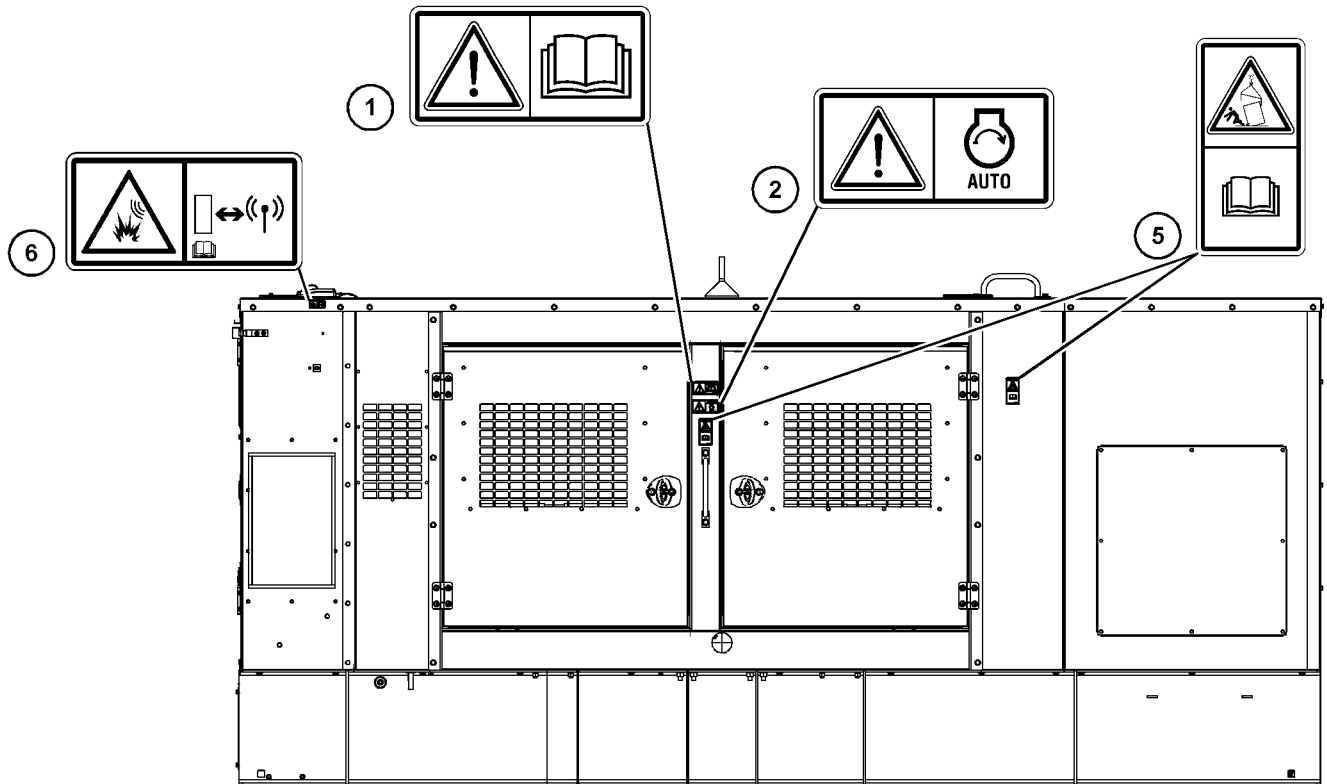


Illustration 3  
Right side view of the enclosure

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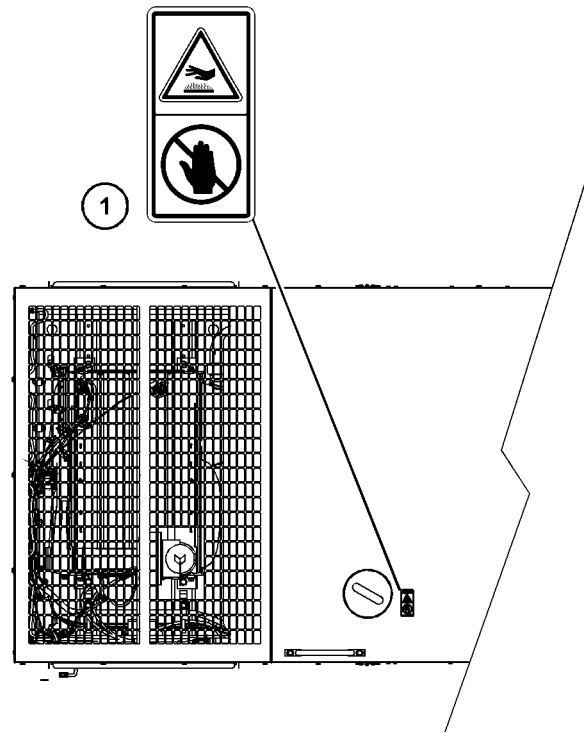


Illustration 4

g06388575

Top view of the enclosure

## Universal Warning (1)

This safety message is on the enclosure for the control panel.



Illustration 5

g01370904

**⚠ WARNING**

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

## Automatic Starting (2)

This safety message is on the sides of the enclosure. This safety message is also located of the enclosure for the control panel.



Illustration 6

g01392484

**⚠ WARNING**

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

## Electrocution (3)

This safety message is on the side of the generator and on the enclosure for the circuit breaker. This safety message is also on the side of the enclosure.

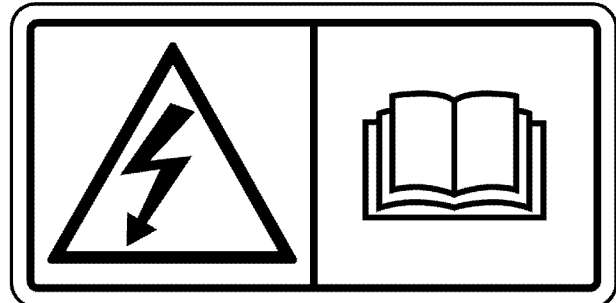


Illustration 7

g03430411

**⚠ DANGER**

**DANGER: Shock/Electrocution Hazard-Do not operate this equipment or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings will result in serious injury or death.**

**⚠ WARNING**

Do not connect generator to a utility electrical distribution system unless it is isolated from the system. Electrical feedback into the distribution system can occur and could cause personal injury or death.

Open and secure main distribution system switch, or if the connection is permanent, install a double throw transfer switch to prevent electrical feedback. Some generators are specifically approved by a utility to run in parallel with the distribution system and isolation may not be required. Always check with your utility as to the applicable circumstances.

**Hot Surface (4)**

This safety message is on the sides and the top of the enclosure for enclosed generator sets.



Illustration 8

g01384734

**⚠ WARNING**

Hot parts or hot components can cause burns or personal injury. Do not allow hot parts or components to contact your skin. Use protective clothing or protective equipment to protect your skin.

**Crush (5)**

This safety message is on the sides of enclosed generator sets. This safety message is also on the base for open generator sets.

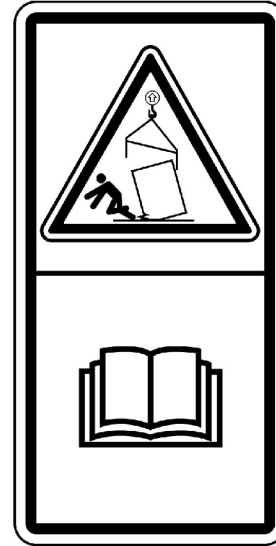


Illustration 9

g01433231

**⚠ WARNING**

Crushing hazard! Read and understand the instructions and warnings in the Operation and Maintenance manual. Failure to follow the instructions or heed the warnings could cause serious injury or death.

**Product Link (6)**

This safety message is on the roof of the enclosure, near the antenna for the Cat® Product Link™ communication device.

**NOTICE**

Before applying (installing battery jumper) battery power, note:

There are a few countries for which Product Link is not certified. Ensure local radio compliance before operation, see [www.Dealer.cat.com/PL/Certification](http://www.Dealer.cat.com/PL/Certification).

Use in blast sites is also restricted. Refer to M0075640 for further details.

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

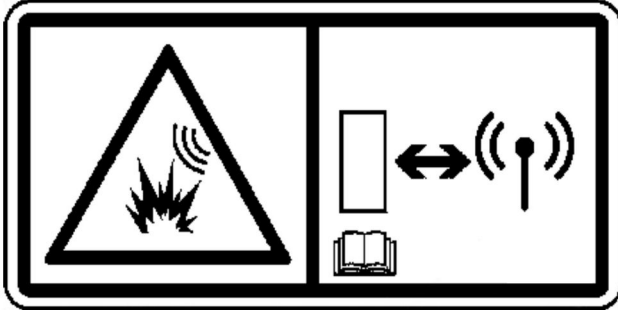


Illustration 10

g06250090

### **WARNING**

This equipment is equipped with a Cat® Product Link communication device. When electric detonators are being used for blasting operations, radio frequency devices can cause interference with electric detonators for blasting operations which can result in serious injury or death. The Product Link communication device should be deactivated within the distance mandated under all applicable national or local regulatory requirements. In the absence of any regulatory requirements Caterpillar recommends the end user perform their own risk assessment to determine safe operating distance.

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## Additional Messages

**SMCS Code:** 1000; 7405

There are several specific messages on these machines. The exact location of the messages and the description of the messages are reviewed in this section. Become familiarized with all messages.

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

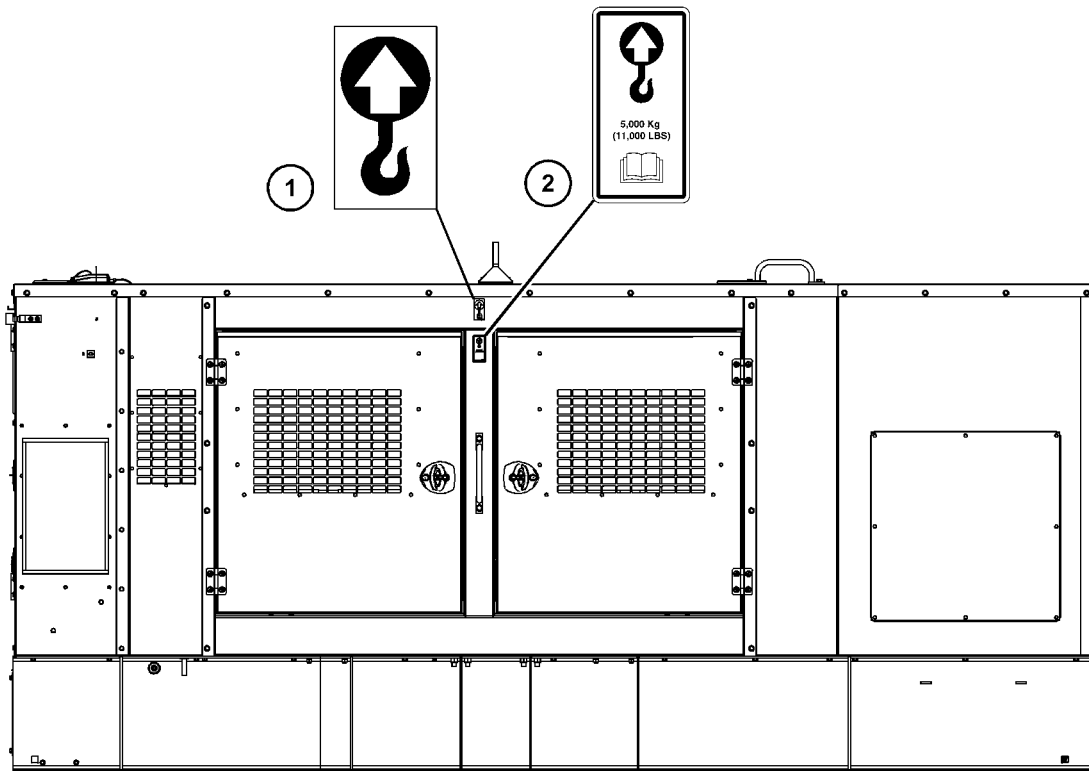


Illustration 11

g06390110

**Lifting point (1)**

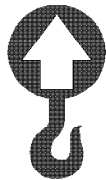


Illustration 12

g01034418

Lift the package from this point. Refer to the following topic:

- Operation and Maintenance Manual, "Product Lifting"

**Rating for lifting equipment (2)**

This message is on the side of the enclosure, on the pillar between the two doors.

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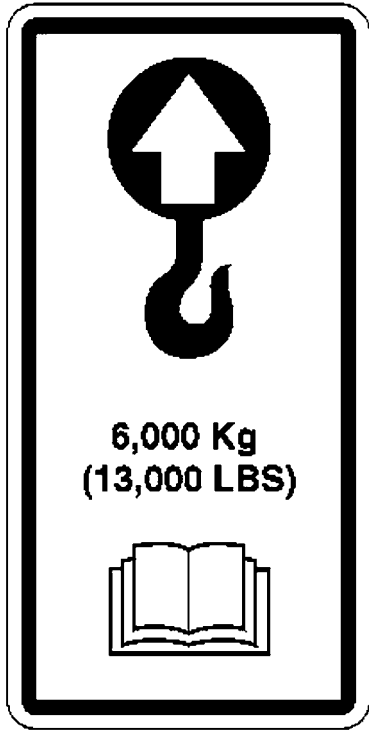


Illustration 13

g06390092

The lifting equipment that is used for lifting this type of generator set must be rated for a total weight of 6000 kg (13,000 lb).

## General Hazard Information

SMCS Code: 1000; 4450; 7405

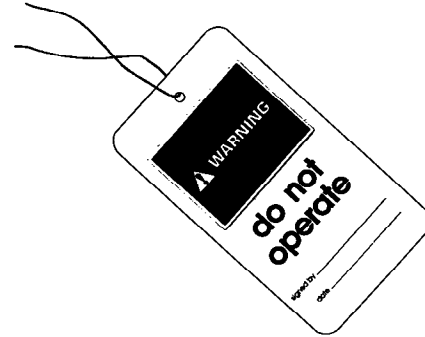


Illustration 14

g00104545

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

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

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

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

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

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

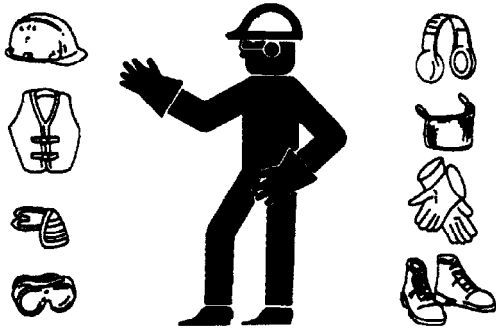


Illustration 15

g00702020

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

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

- The engine is stopped. Ensure that the engine cannot be started.
- The protective locks or the controls are in the applied position.
- Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads to help prevent sparks.
- When starting a new engine or an engine which has not been started since service has been performed, make provisions to stop the engine if an overspeed occurs. Shutting down the engine may be accomplished by shutting off the fuel supply and/or the air supply to the engine.
- Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.

- Start the engine with the operator controls. Never short across the starting motor terminals or the batteries. This method of starting the engine could bypass the engine neutral start system and/or the electrical system could be damaged.

**California Proposition 65 Warning**

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

**Pressurized Air and Water**

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

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

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

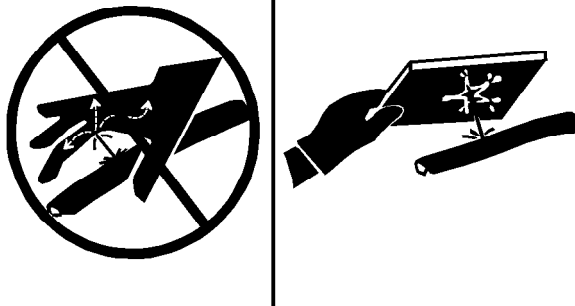


Illustration 16

g00687600

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

## Containing Fluid Spillage

### NOTICE

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

Refer to Special Publication, NENG2500, "Cat Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Cat Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

## Lines, Tubes, and Hoses

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

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

Inspect all lines, tubes, and hoses carefully. Do not use bare hands to check for leaks. Always use a board or cardboard for checking engine components for leaks. Tighten all connections to the recommended torque.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Wire that is exposed in reinforced hose
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

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

## Inhalation

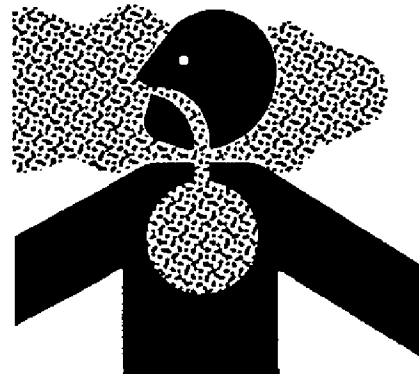


Illustration 17

g02159053

## Exhaust

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

## Asbestos Information

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

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

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

- Never use compressed air for cleaning.
- Avoid brushing materials that contain asbestos.
- Avoid grinding materials that contain asbestos.
- Use a wet method to clean up asbestos materials.
- A vacuum cleaner that is equipped with a high efficiency particulate air filter (HEPA) can also be used.
- Use exhaust ventilation on permanent machining jobs.
- Wear an approved respirator if there is no other way to control the dust.
- Comply with applicable rules and regulations for the work place. In the United States, use Occupational Safety and Health Administration (OSHA) requirements. These OSHA requirements can be found in "29 CFR 1910.1001".
- Obey environmental regulations for the disposal of asbestos.
- Stay away from areas that might have asbestos particles in the air.

## Hexavalent Chromium

Cat equipment and replacement parts comply with applicable regulations and requirements where originally sold. Caterpillar recommends the use of only genuine Cat replacement parts.

Hexavalent chromium has occasionally been detected on exhaust and heat shield systems on Cat engines. Although lab testing is the only accurate way to know if hexavalent chromium is, in fact, present, the presence of a yellow deposit in areas of high heat (for example, exhaust system components or exhaust insulation) may be an indication of the presence of hexavalent chromium.

Use caution if you suspect the presence of hexavalent chromium. Avoid skin contact when handling items that you suspect may contain hexavalent chromium, and avoid inhalation of any dust in the suspect area. Inhalation of, or skin contact with, hexavalent chromium dust may be hazardous to your health.

If such yellow deposits are found on the engine, engine component parts, or associated equipment or packages, Caterpillar recommends following local health and safety regulations and guidelines, utilizing good hygiene, and adhering to safe work practices when handling the equipment or parts. Caterpillar also recommends the following:

- Wear appropriate personal protective equipment (PPE).
- Wash your hands and face with soap and water prior to eating, drinking, or smoking, and also during rest room breaks, to prevent ingestion of any yellow powder.
- Never use compressed air for cleaning areas suspected of containing hexavalent chromium.
- Avoid brushing, grinding, or cutting materials suspected of containing hexavalent chromium.
- Obey environmental regulations for the disposal of all materials that may contain or have come into contact with hexavalent chromium.
- Stay away from areas that might have hexavalent chromium particles in the air.

## Softwrap

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

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

<http://www.catmsds.com>

## Dispose of Waste Properly

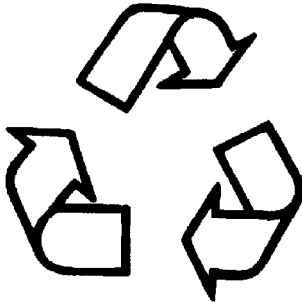


Illustration 18

g00706404

Improperly disposing of waste can threaten the environment. Dispose potentially harmful fluids according to local regulations.

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

i07277507

## Burn Prevention

**SMCS Code:** 1000; 4450; 7405

Do not touch any part of an operating engine system. The engine, the exhaust, and the engine aftertreatment system can exceed 650° C (1202° F) under normal operating conditions.

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

### **WARNING**

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

After the engine has stopped, wait for 10 minutes to allow the fuel pressure to be purged from the high-pressure fuel lines before any service or repair is performed on the engine fuel lines. The 10 minute wait will also allow static charge to dissipate from the low-pressure fuel system.

Allow the pressure to be purged in the air system, in the hydraulic system, in the lubrication system, or in the cooling system before any lines, fittings, or related items are disconnected.

## Induction System

### **WARNING**

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

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

## 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, aftertreatment system 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 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

Skin may be irritated following repeated or prolonged exposure to mineral and synthetic base oils. Refer to your suppliers Material Safety Data Sheets for detailed information. Hot oil and lubricating components can cause personal injury. Do not allow hot oil to contact the skin. Appropriate personal protective equipment should be used.

## Diesel Fuel

Diesel engines have high-pressure fuel systems and the fuel can reach temperatures of over 100° C (212° F). Ensure that the fuel has cooled before any service or repairs are performed.

Diesel may be irritating to the eyes, respiratory system, and skin. Prolonged exposure to diesel may cause various skin conditions. Appropriate personal protective equipment should be used. Refer to supplier Material safety Data sheets for detailed information.

## 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.

## Engine and Aftertreatment System

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

## Aftertreatment System and Diesel Exhaust Fluid

Diesel Exhaust Fluid (DEF) temperatures can reach 65° to 70° C (149.° to 126°F) during normal engine operation. Stop the engine. Wait for 15 minutes to allow the DEF system to be purged and the DEF to cool before service or repair is performed.

i05774818

## Fire Prevention and Explosion Prevention

SMCS Code: 1000; 4450; 7405



Illustration 19

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 15 minutes after an emergency shutdown.

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

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

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

Safety Section  
Fire Prevention and Explosion Prevention

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

Do not expose the engine to any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil or fuel spray in a 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. Ensure that all electrical wires are 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.

**⚠ WARNING**

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

After the engine has stopped, you must wait for 10 minutes in order to allow the fuel pressure to be purged from the high-pressure fuel lines before any service or repair is performed on the engine fuel lines. The 10 minute wait will also allow static charge to dissipate from the low-pressure fuel system.

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

Ensure that the oil filters and fuel filters are properly installed. The filter housings must be tightened to the proper torque.



Illustration 20

g00704059

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

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

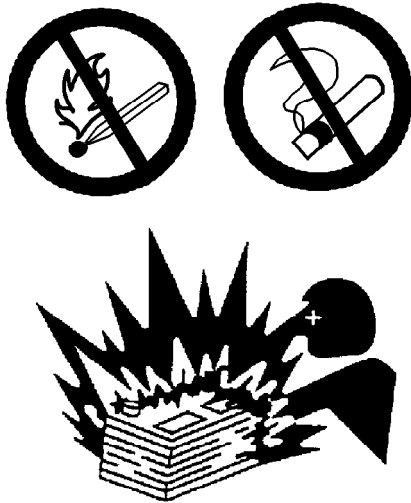


Illustration 21

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. A frozen battery 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

Ether is flammable and poisonous.

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.

## 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:

- High-pressure fuel line or lines are removed.
- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are ballooning.
- Flexible part of the hose is 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, correct installation will help to prevent vibration, rubbing against other parts, and excessive heat.

i08162291

## Crushing Prevention and Cutting Prevention

**SMCS Code:** 1000; 4450; 7405

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

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

## Safety Section

### Mounting and Dismounting

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 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.

i05768982

## Mounting and Dismounting

**SMCS Code:** 1000; 4450; 7405

Do not climb on the engine or the engine aftertreatment system. The engine and aftertreatment system have not been designed with mounting or dismounting locations.

Refer to the OEM for the location of foot and hand holds for your specific application.

i08704512

## Sound Information

**SMCS Code:** 1000

### Sound Level Information for Products Required by the Applicable Regional Regulations

- European Union Countries
- United Kingdom
- Eurasian Economic Union Countries
- Ukraine
- Countries that Adopt the “EU Directives”

The information below applies to only the product configurations that contain regional product marking on or near the Product Identification Plate noted in the “Regional Product Marking” section of this manual.

Table 1

| Sound Level                |              |   |
|----------------------------|--------------|---|
| Region                     | Engine Model | Maximum Guaranteed Value (GV) dB(A) <sup>(1)(2)</sup> |
| EU<br>UK<br>EEU<br>Ukraine | C7.1         | 97  |

<sup>(1)</sup> Measured at 75% rated power per test method ISO 8528-10.

<sup>(2)</sup> Maximum GV for generator set per engine model. Refer to the supplied Declaration of Conformity (DOC) for individual generator set model GV.

The sound levels listed above include both measurement uncertainty and uncertainty due to production variation.

The product sound power level meets the criteria that are specified in the applicable regional regulation. For example:

- “European Directive 2000/14 EC” amended by “2005/88/EC”
- “United Kingdom 2001 No. 1701” amended by “2005 No. 3525”
- “Ukraine Technical Regulation of the Noise Emission in the Environment by Equipment for Use Outdoors”

The criteria are specified on the certificate of the conformance and the accompanying labels.

i07671624

## High Pressure Fuel Lines

**SMCS Code:** 1274

### WARNING

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

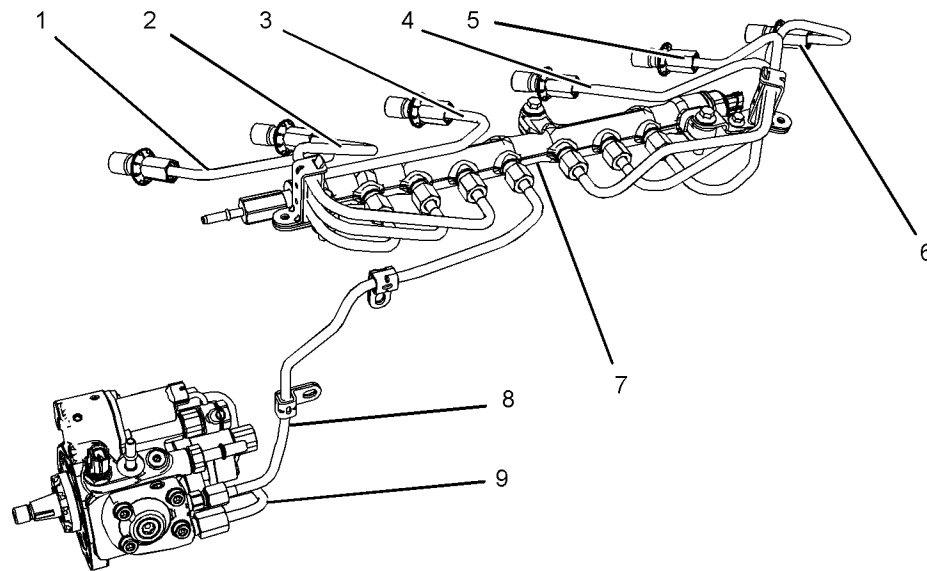


Illustration 22

g01877473

(1) High-pressure line  
(2) High-pressure line  
(3) High-pressure line

(4) High-pressure line  
(5) High-pressure line  
(6) High-pressure line

(7) High-pressure fuel manifold (rail)  
(8) High-pressure line  
(9) Fuel transfer line that is high pressure

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

The differences are as follows:

- The high-pressure fuel lines are constantly charged with high pressure while the engine is in operation and up to 10 minutes after the engine has stopped.
- The internal pressures of the high-pressure fuel lines are higher than other types of fuel system.
- The high-pressure fuel lines are formed to shape and then strengthened by a special process.

Do not step on the high-pressure fuel lines. Do not deform the high-pressure fuel lines. Do not bend or strike the high-pressure fuel lines. Deformation or damage of the high-pressure fuel lines may cause a point of weakness and potential failure.

Do not check the high-pressure fuel lines with the engine or the starting motor in operation. After the engine has stopped, you must wait for 10 minutes to allow the fuel pressure to be purged from the high-pressure fuel lines before any service or repair is performed on the engine fuel lines. The 10 minute wait will also allow static charge to dissipate from the low-pressure fuel system.

Do not loosen the high-pressure fuel lines to remove air from the fuel system. This procedure is not required.

Visually inspect the high-pressure fuel lines before the engine is started. This inspection should be performed each day.

If the engine is inspected whilst in operation, always use the correct inspection procedure to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, "General hazard Information".

- Inspect the high-pressure fuel lines for damage, deformation, a nick, a cut, a crease, or a dent.
- Do not operate the engine with a fuel leak. If there is a leak, do not tighten the connection, to stop the leak. The connection must only be tightened to the recommended torque. Refer to Disassembly and Assembly, "Fuel injection lines - Remove and Fuel injection lines - Install".
- If the high-pressure fuel lines are torqued correctly and the high-pressure fuel lines are leaking, the high-pressure fuel lines must be replaced.
- Ensure that all clips on the high-pressure fuel lines are in place. Do not operate the engine with clips that are damaged, missing, or loose.
- Do not attach any other item to the high-pressure fuel lines.

- Loosened high-pressure fuel lines must be replaced. High-pressure fuel lines that have been removed must be replaced. Refer to Disassembly and assembly manual, "Fuel Injection Lines - Install".

i08614835

i06574642

## Before Starting Engine

SMCS Code: 1000

---

### NOTICE

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

---

### 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.**

---

Inspect the engine for potential hazards.

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.

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

All protective guards and all protective covers must be installed if the engine must be started 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 to help prevent personal injury. The circuits are also provided to help prevent engine damage.

See the Service Manual for repairs and for adjustments.

## Before Starting Engine

SMCS Code: 1000

---

### NOTICE

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

---

### 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.**

---

Inspect the engine for potential hazards.

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

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

If equipped, ensure that the lighting system for the engine is suitable for the conditions. Ensure that all lights work properly, if equipped.

All protective guards and all protective covers must be installed if the engine must be started 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 to help prevent personal injury. The circuits are also provided to help prevent engine damage.

See the Service Manual for repairs and for adjustments.

i02344744

## Engine Starting

SMCS Code: 1000

---

### WARNING

**Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.**

---

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

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

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

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

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

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

**Note:** The engine is equipped with a device for cold starting. If the engine will be operated in very cold conditions, then an extra cold starting aid may be required. Normally, the engine will be equipped with the correct type of starting aid for your region of operation.

These engines are equipped with a glow plug starting aid in each individual cylinder that heats the intake air in order to improve starting.

i02328530

## Engine Stopping

**SMCS Code:** 1000

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

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

On the initial start-up of a new engine or an engine that has been serviced, make provisions to stop the engine if an overspeed condition occurs.

To stop an electronic controlled engine, cut the power to the engine and/or the air supply to the engine.

i07651627

## 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 "-" 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 cable to the engine block.

Check the electrical wires daily for wires that are loose or frayed, or have damaged insulation. Tighten all loose electrical connections before the engine is started. Repair all frayed or damaged electrical wires before the engine is started. See the Operation and Maintenance Manual for specific starting instructions.

## Grounding Practices

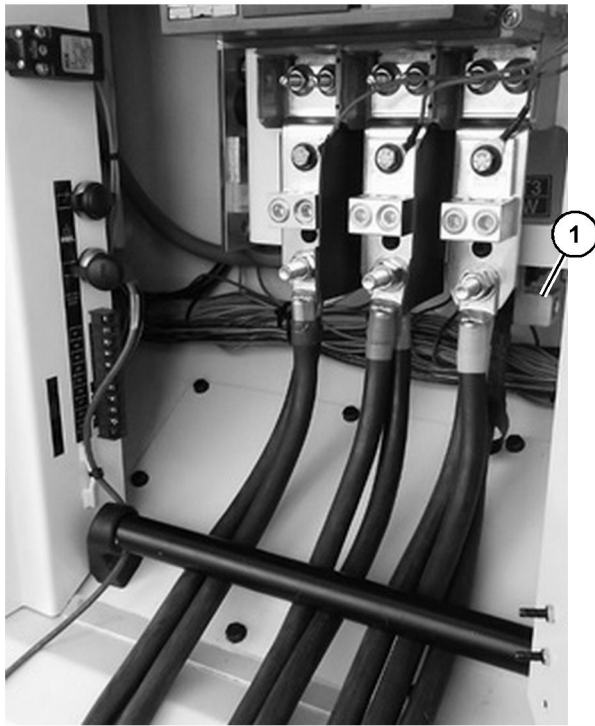


Illustration 23

g06387868

(1) Earth ground connection point

There are two convenient means provided for the earth ground cable connection:

- a mechanical lug with set screw for cables having no ring terminal
- a hole in the ground bar for attaching cables having ring terminal with customer-provided hardware

This connection is the first connection that is made at the installation. This connection is the last connection that should be removed. If the generator set is on flexible pads, or on resilient pads, the ground connection must be flexible. This configuration will avoid possible breakage in later operation. Ground connection cable or ground connection straps should have at least the current carrying capacity of the largest line-lead to the connected load. Joints in cables or in straps must be clean, free of electrical resistance, and protected from possible oxidation. Bolted ground connection joints eventually oxidize. The joints are frequent sources of radio frequency interference (RFI).

Silver soldered joints are electrically, and mechanically sound.

i08292380

## Generator Isolating for Maintenance

SMCS Code: 4450

When you service an electric power generation set or when you repair an electric power generation set, follow the procedure below:

1. Stop the engine.

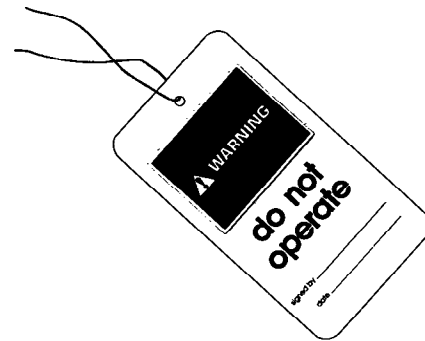


Illustration 24

g00104545

2. Attach a "DO NOT OPERATE" or similar warning tag to the engine prime mover starting circuit. Disconnect the engine starting circuit.
3. Disconnect the generator from the distribution system.
4. Lock out the circuit breaker. Attach a "DO NOT OPERATE" or similar warning tag to the circuit breaker. Refer to the electrical diagram. Verify that all points of possible reverse power flow have been locked out.
5. For the following circuitry, remove the fuses:
  - power
  - sensing
  - control
6. Attach a "DO NOT OPERATE" or similar warning tag to the generator excitation controls.
7. Remove the cover of the generator terminal box.

8. Use an audio/visual proximity tester to verify that the generator is de-energized. This tester must be insulated for the proper voltage rating. Follow all guidelines to verify that the tester is operational.
9. Determine that the generator is in a de-energized condition. Add ground straps to the conductors or terminals. During the entire work period, these ground straps must remain connected to the conductors and to the terminals.

## Product Information Section

## General Information

i04329752

## Model View Illustrations

SMCS Code: 1000

C7.1 Illustrations are to be added.

i07576558

## Product Description

SMCS Code: 1000; 4450; 4491

### C7.1 Generator Set Engine

The Cat C7.1 Generator Set Engine has the following characteristics:

- In-line six-cylinder
- Four-stroke cycle
- Turbocharged aftercooled

### Engine Specifications

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

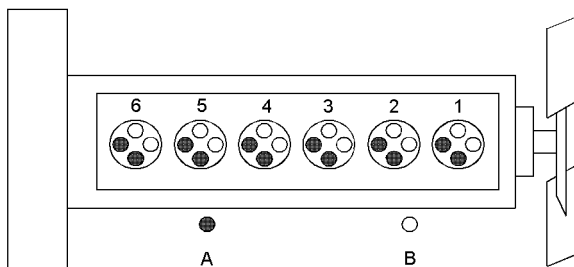


Illustration 25

g01127295

### Cylinder and valve location

- (A) Exhaust valves  
(B) Inlet valves

Table 2

| C7.1 Engine Specifications |                               |
|----------------------------|-------------------------------|
| Operating Range (rpm)      | 900 to 1800 <sup>(1)</sup>    |
| Number of Cylinders        | 6 In-Line                     |
| Bore                       | 105 mm (4.13 inch)            |
| Stroke                     | 135 mm (5.31495 inch)         |
| Power                      | 200 kW (268 hp)               |
| Aspiration                 | Turbocharged charge cooled    |
| Compression Ratio          | 16.5:1                        |
| Displacement               | 7.01 L (428 in <sup>3</sup> ) |
| Firing Order               | 1-5-3-6-2-4                   |
| Rotation (flywheel end)    | Counterclockwise              |

<sup>(1)</sup> The operating rpm depends on the engine rating, the application, and the configuration of the throttle.

### Electronic Engine Features

The engine operating conditions are monitored. The Electronic Control Module (ECM) controls the response of the engine to these conditions and to the demands of the operator. These conditions and operator demands determine the precise control of fuel injection by the ECM. The electronic engine control system provides the following features:

- Engine monitoring
- Engine speed governing
- Control of the injection pressure
- Cold start strategy
- Automatic air/fuel ratio control
- Torque rise shaping
- Injection timing control
- System diagnostics

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

### Engine Diagnostics

The engine has built-in diagnostics to ensure that the engine systems are functioning correctly. The operator will be alerted to the condition by a "Stop or Warning" lamp. Under certain conditions, the engine horsepower may be limited. The electronic service tool may be used to display the diagnostic codes.

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

Most of the diagnostic codes are logged and stored in the ECM. For additional information, refer to the Troubleshooting Manual, "Diagnostic Code Cross Reference" topic.

The ECM provides an electronic governor that controls the injector output to maintain the desired engine rpm.

## Engine Cooling and Lubrication

The cooling system consists of the following components:

- Gear-driven centrifugal water pump
- Water temperature regulator which regulates the engine coolant temperature
- Gear-driven rotor type oil pump
- Oil cooler

The engine lubricating oil is supplied by a rotor type oil pump. The engine lubricating oil is cooled and the engine lubricating oil is filtered. The bypass valve can provide unrestricted flow of lubrication oil to the engine if the oil filter element should become plugged.

Engine efficiency, efficiency of emission controls, and engine performance depend on adherence to proper operation and maintenance recommendations. Engine performance and efficiency also depend on the use of recommended fuels, lubrication oils, and coolants. Refer to this Operation and Maintenance Manual, "Maintenance Interval Schedule" for more information on maintenance items.

## Generator

The Series LC generator has the following characteristics:

- Single phase or three-phase alternating current
- Single bearing
- Brushless type
- Random wound
- Four-pole design
- 12 wire generator stator
- Main stator is 2/3 pitch
- Class H insulation
- Interference suppression conforming to standard EN 55011, group 1, class B

## Product Identification Information

i08704519

### Plate Locations and Film Locations

SMCS Code: 1000; 4450

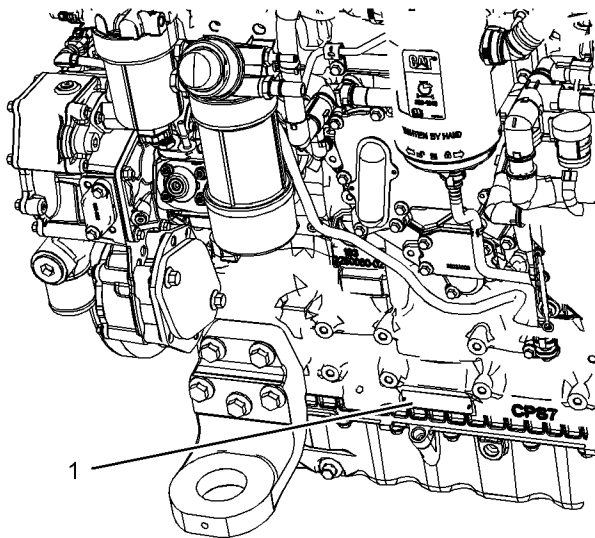


Illustration 26

g01877975

Location of the serial number plate

### Serial Number Plate (1)

The engine serial number plate is on the left side of the cylinder block to the rear of the front engine mounting.

Cat dealers need all these numbers to determine the components that were included with the engine. These numbers will permit accurate identification of replacement part numbers.

### Engine Aftertreatment System

|                     |  |             |  |
|---------------------|--|-------------|--|
| <b>CATERPILLAR®</b> |  | <b>CAT®</b> |  |
| ARRANGEMENT NUMBER  |  | SALES MODEL |  |
| ○                   |  | ○           |  |
| SERIAL NUMBER       |  |             |  |
| MADE IN UK          |  |             |  |

Illustration 27

g01332986

Typical example

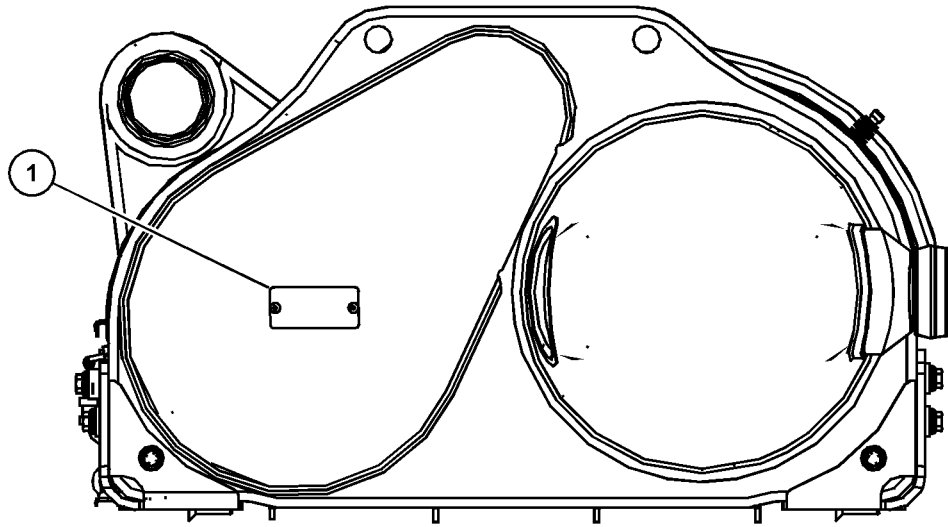


Illustration 28

g06387920

Typical example

The module arrangement exhaust plate is installed on the mounting plate (1). The location of the arrangement plate mounting plate can alter depending on the application.

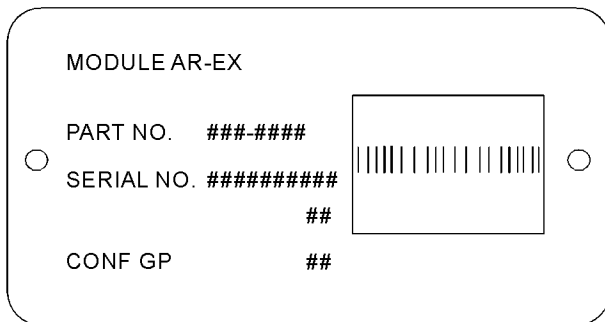


Illustration 29

g02109493

Module Arrangement Exhaust Plate

Record the information that is on the plate. This information identifies the engine aftertreatment system. This information will be required by your Cat dealer.

### Rating Plate

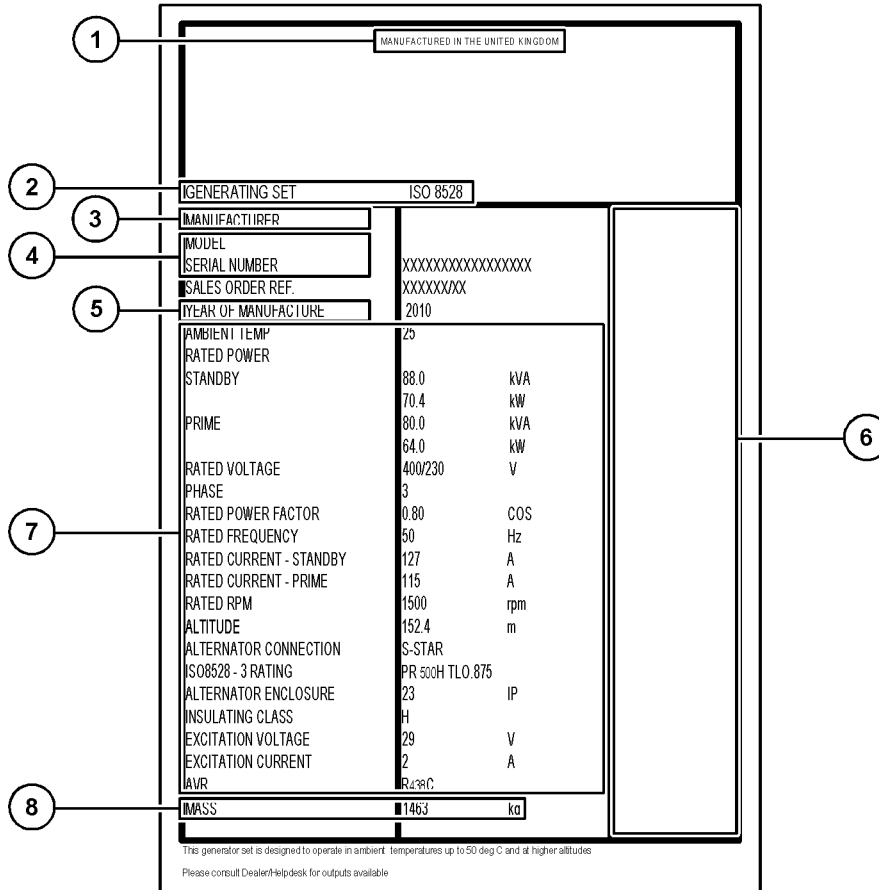


Illustration 30

g06696484

- (1) Country of Origin
- (2) Name/designation
- (3) Manufacturer name
- (4) Model and serial number

- (5) Month and Year of Manufacture
- (6) Eurasian Economic Union Member national language
- (7) Basic parameters/features

- (8) Mass

## Regional Product Marking (If Equipped)

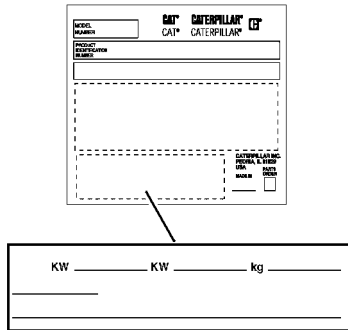


Illustration 31 g06650998  
Regional marking plate

This plate is positioned on the bottom-left side of the identification plate.

**Note:** The regional marking plate is on generator sets that are certified to the applicable requirements that were effective then.

Regional product marking may include one or more of the following:

-  **CE mark**
-  **UKCA mark**
-  **EAC mark**
-  **Gulf Standardization Organization (GSO) mark**
-  **Ukraine mark**

The following information may be stamped onto the regional marking plate. For quick reference, record this information in the spaces that are provided below.

- Engine Power Primary Engine (kW) \_\_\_\_\_
- Engine Power for other Engine (If Equipped)  
\_\_\_\_\_
- Typical Generator Set Operating Weight (kg) \_\_\_\_\_

- Year of Construction \_\_\_\_\_
- Generator Set Type \_\_\_\_\_

## Eurasian Economic Union

The rating plate is placed on generator sets certified to the Eurasian Economic Union requirements effective at the time of market entry.

The Month and Year of Manufacture are on the identification plate.

### Manufacturer Information

Manufacturer:

Caterpillar Inc.,  
100 N.E. Adams Street  
Peoria, Illinois 61629, USA

Entity authorized by the manufacturer at the territory of Eurasian Economic Union:

Caterpillar Eurasia LLC  
75, Sadovnicheskaya Emb.  
Moscow 115035, Russia

## Sound Certification

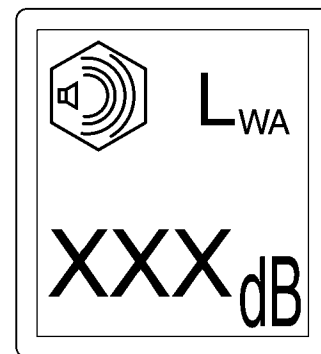


Illustration 32 g06675270  
Sound certification film

A typical example of this film is shown.

A certification film is used to verify the environmental sound certification on generator sets that are certified to the regional requirements. A film installed on your generator set will have a value. The value that is listed on the film indicates the guaranteed exterior sound power level ( $L_{wa}$ ) at the time of manufacture for the conditions that are specified in the following sound test procedures:

- "ISO 6395"
- "European Union 2000/14/EC amended by 2005/88/EC"

Product Information Section  
Plate Locations and Film Locations

---

- “United Kingdom 2001 No. 1701 amended by 2005 No. 3525”

# Declaration of Conformity (Great Britain)

**SMCS Code:** 1000

Table 3

A Declaration of Conformity document was provided with the generator set if the product was manufactured to comply with specific requirements for the Great Britain. To determine the details of the applicable legislation, review the complete Declaration of Conformity provided with the product. The extract shown below from a Great Britain Declaration of Conformity for generator sets that are declared compliant to 2008 No. 1597 applies only to those generator sets originally "UKCA" marked by the manufacturer listed and which have not since been modified.

## DECLARATION OF CONFORMITY

**Manufacturer:** Caterpillar Inc., 100 N.E. Adams Street, Peoria, Illinois 61629, USA

**Person authorized to compile the Technical File and to communicate relevant part (s) of the Technical File to the Authorities on request:**

Standards & Regulations Manager Caterpillar France SAS  
40 Avenue Leon-Blum 38000 Grenoble, France

**I, the undersigned, \_\_\_\_\_, hereby certify that the construction equipment specified hereunder**

|              |                       |                            |
|--------------|-----------------------|----------------------------|
| Description: | Generic Denomination: | Power Generation Equipment |
|              | Function:             | Powered Generator          |
|              | Model/Type:           | C7.1                       |
|              | Serial Number:        |                            |
|              | Commercial Name:      | Caterpillar                |

Fulfills all the relevant provisions of these regulations and/or other enactments as listed below:

| Legislation                                      | UK Approved Body | Document No. |
|--|------------------|--------------|
| 2008 No. 1597                                    |                  |              |
| 2016 No. 1091                                    |                  |              |
| 2001 No. 1701 amended by 2005 No. 3525, Note (1) | Note (2)         |              |

Note (1) Schedule-\_\_\_\_ Guaranteed Sound Power Level - \_\_\_\_ dB (A)  
 Representative Equipment Type Sound Power Level - \_\_\_\_ dB (A)  
 Engine Power per \_\_\_\_-\_\_\_\_ kW Rated engine speed - \_\_\_\_ rpm  
 Technical Documentation accessible through person listed above authorized to compile the Technical File

Note (2) If applicable, information related to Approved Body.

**Done at:**

**Signature**

**Date:**

**Name/Position**

**Note:** The above information was correct as of May 2021, but may be subject to change. Refer to the individual declaration of conformity issued with the machine for exact details.

## Declaration of Conformity (European Union)

**SMCS Code:** 1000

Table 4

An EU Declaration of Conformity document was provided with the machine if the machine was manufactured to comply with specific requirements for the European Union. To determine the details of the applicable Directives, review the complete EU Declaration of Conformity provided with the machine. The extract shown below from an EU Declaration of Conformity for machines that are declared compliant to "2006/42/EC" applies only to those machines originally "CE" marked by the manufacturer listed and which have not since been modified.

### ORIGINAL EU DECLARATION OF CONFORMITY

**Manufacturer:** CATERPILLAR INC. 100 N.E. ADAMS STREET PEORIA, IL 61629 USA

**Person authorized to compile the Technical File and to communicate relevant part (s) of the Technical File to the Authorities on request:**

Standards & Regulations Manager, Caterpillar France S.A.S,  
40 Avenue Leon-Blum 38000 Grenoble, France

**I, the undersigned, \_\_\_\_\_, hereby certify that the construction equipment specified hereunder**

|              |                       |                            |
|--------------|-----------------------|----------------------------|
| Description: | Generic Denomination: | Power Generation Equipment |
|              | Function:             | Power Generator            |
|              | Model/Type:           | C7.1                       |
|              | Serial Number:        |                            |
|              | Commercial Name:      | Caterpillar                |

Fulfills all the relevant provisions of the following Directives

| Directives                                 | Notified Body | Document No. |
|--|---------------|--------------|
| 2006/42/EC                                 | N/A           |              |
| 2014/30/EU                                 | N/A           |              |
| 2000/14/EC amended by 2005/88/EC, Note (1) | Note (2)      |              |

Note (1) Annex - \_\_\_\_ Guaranteed Sound Power Level - \_\_\_\_ dB (A)  
 Representative Equipment Type Sound Power Level - \_\_\_\_ dB (A)  
 Engine Power per \_\_\_\_ - \_\_\_\_ kW Rated engine speed - \_\_\_\_ rpm  
 Technical Documentation accessible through person listed above authorized to compile the Technical File

Note (2) Notified body name and address

**Done at:**

**Signature**

**Date:**

**Name/Position**

**Note:** The above information was correct as of August 2021, but may be subject to change. Refer to the individual declaration of conformity issued with the product for exact details.

i08085827

## Emissions Certification Film

**SMCS Code:** 1000; 7405

Consult your Cat dealer for an Emission Control Warranty Statement.

The emission certification film is on the engine.

i04330671

## Reference Information

**SMCS Code:** 1000; 4450

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

## Record for Reference

Table 5

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

(Table 5, contd)

|  |  |
|--|--|
| Total lubrication system capacity      |  |
| Total cooling system capacity          |  |
| Engine air cleaner element part number |  |
| Fan drive belt part number             |  |
| Alternator belt part number            |  |
| Generator serial number                |  |
| Generator model number                 |  |
| Generator rating                       |  |
| Aftertreatment module part number      |  |
| Aftertreatment module serial number    |  |

(continued)

## Operation Section

## Lifting and Storage

### Product Lifting

SMCS Code: 7000; 7002

i07668511

#### NOTICE

Lifting eyes not intended for use shall be shielded with the appropriate lifting eye shield. Each shield shall display a "Do Not Lift" label. Refer to illustration 33 .



Illustration 33

g01948016

#### **WARNING**

**Do not approach the package while the package is being lifted. The package is extremely heavy. If the package is dropped or collided with, serious injury or death may occur.**

### Lifting the Enclosure

1. Place the trailer package on stable, level ground.  
Secure the trailer package by chocking the wheels and setting the parking brake.
2. Disconnect the lights for the trailer. There are two electrical connectors on the left side of the enclosure that must be unplugged.

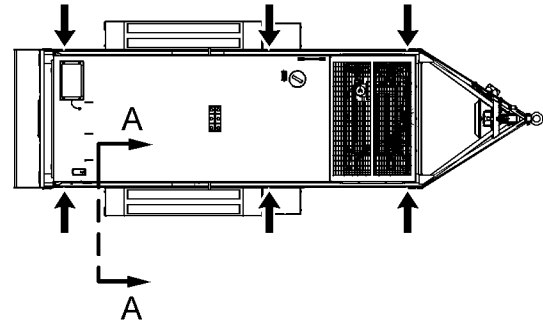


Illustration 34

g06388900

Top view of the package

Bolt locations

There are 6 bolts that fasten the generator set to the trailer.

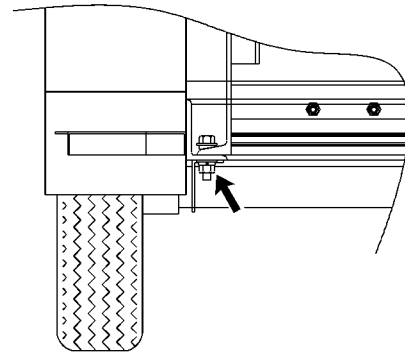


Illustration 35

g01192141

Section A-A

End view of the package

Location of bolts on the side of the trailer

The bolts are located between the frame of the generator and the frame of the trailer.

3. Refer to Illustration 35 . Remove 6 bolts from the frame. There are 3 bolts on each side of the frame.

#### **WARNING**

**Do not approach the package while the package is being lifted. The package is extremely heavy. If the package is dropped or collided with, serious injury or death may occur.**

4. Remove the generator enclosure assembly from the trailer. Use the lifting eye to lift the package.

## Engine Lifting

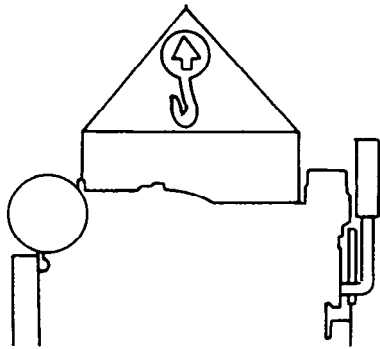


Illustration 36

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 fixtures to obtain proper balance. Lifting fixtures also help to provide safety.

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

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

## Installing the Generator Enclosure Assembly onto the Trailer

When you install the generator enclosure assembly on the trailer, reverse the removal procedure.

Reconnect the lights for the trailer. Inspect the lights and brakes before towing.

## Lifting the Clean Emission Module (CEM)

### 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 CEM. 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 may require lifting the fixtures to obtain proper balance and safety.

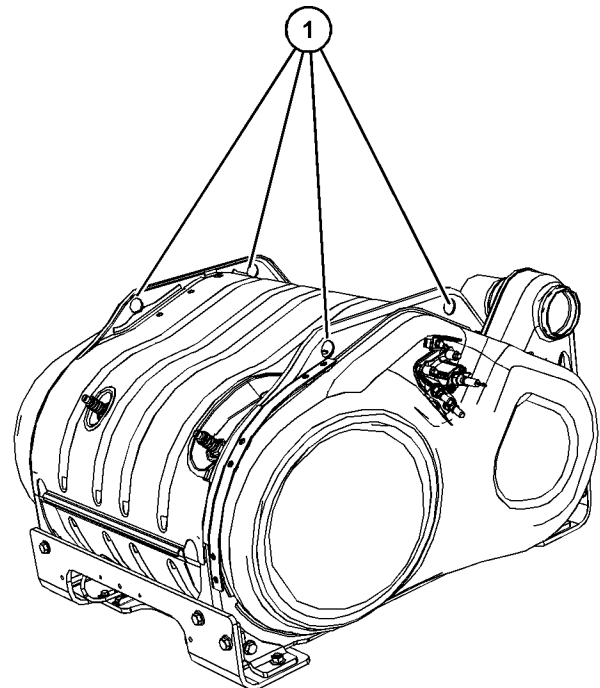


Illustration 37

g06388981

To remove the CEM, use lifting eyes (1). Lifting eyes are designed and installed for the specific CEM arrangement. Do not use the lifting eyes for any other purpose than lifting the CEM.

Alterations to the lifting eyes or the aftertreatment make the lifting eyes and the lifting fixtures obsolete. If alterations are made, ensure that proper lifting devices are provided. Consult your Cat dealer for information regarding fixtures for proper aftertreatment lifting.

i06595394

## Product Storage

**SMCS Code:** 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, which will increase engine wear which can reduce engine service life.

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

- Complete all 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 1 month, a complete protection procedure is recommended.

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

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

## Generator Storage

Store the generator set in a dry area to minimize condensation on the windings. Use space heaters to keep the windings dry, when possible. Wrap the genset in plastic with bags of desiccant for extended storage. Test the insulation of the generator when the generator is removed from storage. Refer to this Special Instruction, SEHS9124, "Winding Insulation Maintenance and Cleaning and Drying of the Generators - "Insulation Resistance Tests"". Dry the generator if the insulation is not acceptable. Refer to this Special Instruction, SEHS9124, "Winding Insulation Maintenance and Cleaning and Drying of the Generators - "Drying"".

# Features and Controls

i07692532

## Alarms and Shutoffs

**SMCS Code:** 7400

### Shutoffs

The shutoffs are electrically operated or mechanically operated. The electrically operated shutoffs are controlled by the ECM.

Shutoffs are set at critical levels for the following items:

- Operating temperature
- Operating pressure
- Operating level
- Operating rpm

The particular shutoff may need to be reset before the engine will start.

---

#### NOTICE

Always determine the cause of the engine shutdown. Make necessary repairs before attempting to restart the engine.

---

Be familiar with the following items:

- Types and locations of shutoff
- Conditions which cause each shutoff to function
- The resetting procedure that is required to restart the engine

### Alarms

The alarms are electrically operated. The operations of the alarms are controlled by the ECM.

The alarm is operated by a sensor or by a switch. When the sensor or the switch is activated, a signal is sent to the ECM. An event code is created by the ECM. The ECM will send a signal to illuminate the lamp.

Your engine may be equipped with the following sensors or switches:

**Coolant temperature** – The coolant temperature sensor indicates high jacket water coolant temperature.

**Intake manifold air temperature** – The intake manifold air temperature sensor indicates high intake air temperature.

**Intake manifold pressure** – The intake manifold pressure sensor checks the rated pressure in the engine manifold.

**Fuel rail pressure** – The fuel rail pressure sensor measures the high pressure or low pressure in the fuel rail. The ECM will Check the pressure.

**Engine oil pressure** – The engine oil pressure sensor indicates when oil pressure drops below rated system pressure, at a set engine speed.

**Engine overspeed** – If the engine rpm exceeds the overspeed setting, the alarm will be activated.

**Air filter restriction** – The switch checks the air filter when the engine is operating.

**User-defined switch** – This switch can shut down the engine remotely.

**Water in fuel switch** – This switch checks for water in the primary fuel filter when the engine is operating.

**Fuel temperature** – The fuel temperature sensor monitors the pressurized fuel in the high-pressure fuel pump.

**Note:** The sensing element of the coolant temperature switch must be submerged in coolant to operate.

Engines may be equipped with alarms to alert the operator when undesirable operating conditions occur.

---

#### NOTICE

When an alarm is activated, corrective measures must be taken before the situation becomes an emergency in order to avoid possible engine damage.

---

If corrective measures are not taken within a reasonable time, engine damage could result. The alarm will continue until the condition is corrected. The alarm may need to be reset.

**Note:** If installed, the coolant level switch and the oil level switch are indicators. Both switches operate when the application is on level ground and the engine RPM at zero.

### Clean Emission Module (CEM)

- Diesel Oxidation Catalyst \_\_\_\_\_(DOC)
- Selective Catalyst Reduction \_\_\_\_\_(SCR)

**Soot Sensors** – The soot sensors monitor the soot level within the CEM

**NOx Sensors** – Two NOx sensors monitor the NOx concentration within the exhaust gas before and after the selective catalyst reduction module.

**Temperature Sensors** – A temperature sensor after the engine exhaust gas exit, after the DOC and

before the SCR module monitor the temperatures within the system.

## Pump Electronics Tank Unit (PETU) Alarms and Shutoff

**Diesel Exhaust Fluid (DEF) Level Sensor** – The DEF level sensor monitors the volume of fluid in the tank and signals the ECM if the level drops below a given point.

**Dosing Control Unit (DCU)** – The DCU controls the injection of the DEF and will signal the ECM if the injection has been interrupted.

i07670421

## Control Panel

SMCS Code: 7451

### Electronic Modular Control Panel (EMCP) 4.2B (if equipped)

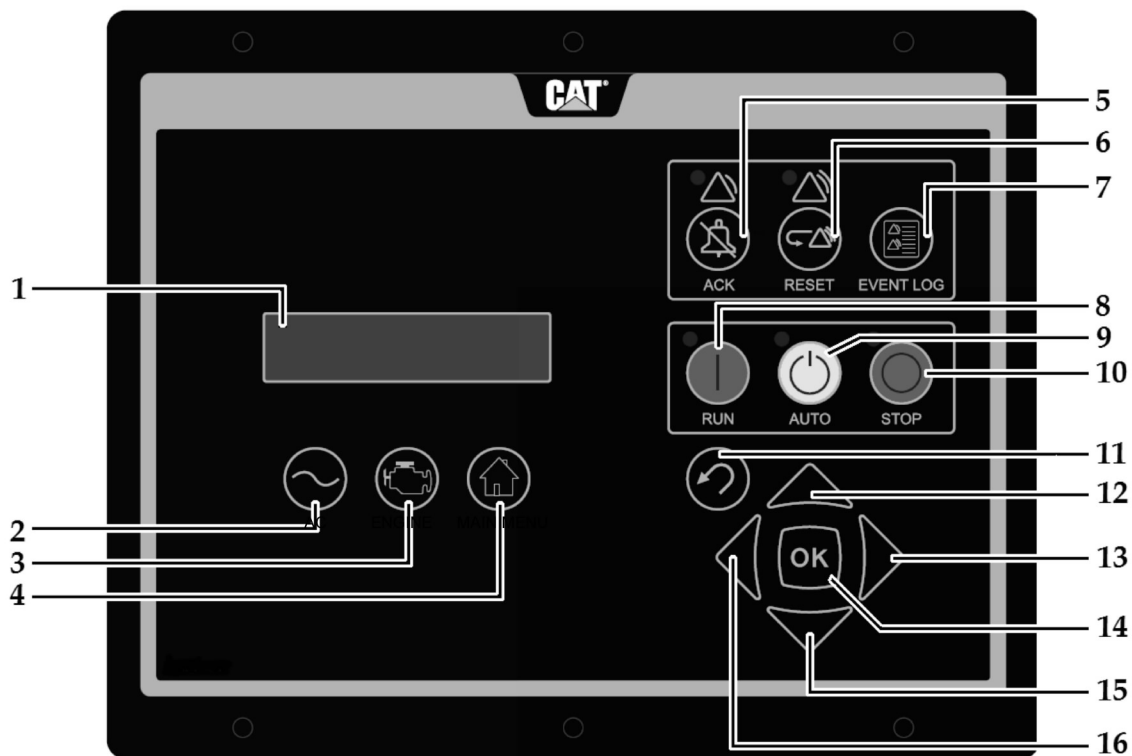


Illustration 38

### EMCP 4 Control System Panel

g02082653

- |                            |                         |
|----------------------------|-------------------------|
| (1) Display screen         | (6) Reset shut down Key |
| (2) AC overview key        | (7) Event log           |
| (3) Engine overview key    | (8) Run key             |
| (4) Main menu key          | (9) Auto key            |
| (5) Alarms acknowledge key | (10) Stop key           |

(11) Escape key  
(12) Up key

(13) Right key  
(14) OK key

(15) Down key  
(16) Left key

## Navigation Keys

**AC Overview (2)** – The “AC OVERVIEW” key will navigate the display to the first screen of AC information. The “AC OVERVIEW” information contains various AC parameters that summarize the electrical operation of the generator set.

**Engine Overview (3)** – The “ENGINE OVERVIEW” key will navigate the display to the first screen of engine information. The “ENGINE OVERVIEW” information contains various engine parameters that summarize the operation of the generator set.

**Main Menu Key (4)** – The “MAIN MENU” key will navigate the display to the main menu directly without having to navigate out of menus.

**Acknowledge Key(5)** – Pressing the “ACKNOWLEDGE” key will cause the horn relay to turn off. The horn relay being turned off will silence the horn. Pressing the “ACKNOWLEDGE” key will also cause any red or yellow flashing lights to either turn off or to come on continuously. The “ACKNOWLEDGE” key may also be configured to send out a global alarm silence signal on the J1939 Data Link. Sending out a global alarm silence signal on the J1939 Data Link will silence the horns on the annunciators.

**Reset Key (6)** – Pressing the “RESET” key will reset various events.

**Event Log Key (7)** – Pressing the “EVENT LOG” key will navigate the display to the event log.

**RUN Key (8)** – Pressing the “RUN” key will start the engine.

**AUTO Key (9)** – Pressing the “AUTO” key will cause the engine to enter the “AUTO” mode. The engine will start if the module receives a start command from a remote source.

**STOP Key (10)** – Pressing the “STOP” key will stop the engine.

**Escape Key (11)** – The “ESCAPE” key is used to navigate through the menus. When the key is pressed, the user moves backward or the user moves upward through the menus. The “ESCAPE” key is also used to exit out of entering data when the user is programming the setpoints. If the “ESCAPE” key is pressed while the user is programming the setpoints, changes made on the screen will not be saved to memory.

**Up Key (12)** – The “UP” key is used to navigate through the various menus and monitoring screens. The “UP” key is also used when a setpoint is entered. When entering numeric data, the “UP” key is used to increment the digits (0-9). If the setpoint requires selection from a list, the “UP” key is used to navigate UP through the list.

**Right Key (13)** – The “RIGHT” key is used during setpoint adjustment. The “RIGHT” key is used to select which digit is edited while entering numeric data. The “RIGHT” key is also used during some setpoint adjustments to select or to unselect a check box. If a check box has a check mark, the function has been enabled. Pressing the “RIGHT” key will disable the function. Pressing the “RIGHT” key will also cause the check mark to disappear. If the check box does not have a check mark, the function is disabled. Pressing the “RIGHT” key will enable the function. Pressing the “RIGHT” key will also cause a check mark to appear.

**Enter Key (14)** – The “ENTER” key is used to navigate through the menus. When the key is pressed, the user moves forward or the user moves downward through the menus. The “ENTER” key is also used to save any changes while the setpoints are being programmed. Pressing the “OK” key during programming the setpoints causes the changes to be saved to memory.

**Down Key (15)** – The “DOWN” key is used to navigate downward through the various menus or screens. The “DOWN” key is also used to program the setpoints. The “DOWN” key is used to decrease the digits when entering numeric data. If the setpoint requires selection from a list, the “DOWN” key is used to navigate DOWN through the list.

**Left Key (16)** – The “LEFT” key is used during setpoint adjustment. The “LEFT” key is used to select the digit that is edited during the entry of numeric data. The “LEFT” key is also used during some of the setpoint adjustments to select a check box. The key is also used to unselect a check box. If a check box has a check mark, pressing the “LEFT” key will disable the function. Pressing the key will also remove the check mark. Pressing the “LEFT” key will also cause the check mark to disappear. If the check box does not have a check mark, pressing the “LEFT” key will enable the function. Pressing the “LEFT” key will also cause a check mark to appear.

## Alarm Indicators

**Yellow Warning Lamp** – A yellow warning lamp is located above the “ACKNOWLEDGE” key. A flashing yellow light indicates that there are active warnings that have not been acknowledged. A continuous yellow light indicates that there are acknowledged warnings that are active. If there are any active warnings, the yellow light will change from flashing yellow to continuous yellow after the “ACKNOWLEDGE” key is pressed. If there are no longer any active warnings, the yellow light will turn off after the “ACKNOWLEDGE” key is pressed.

**Red Shutdown Lamp** – A red shutdown lamp is located above the “RESET” key. A flashing red light indicates that there are active shutdowns that have

Operation Section  
Control Panel

not been acknowledged. A continuous red light indicates that there are active shutdowns that have been acknowledged. If there are any active shutdowns, the red light will change from flashing red to continuous red after the "ACKNOWLEDGE" key is pressed. Any condition that has caused a shutdown must be manually reset. If there are no longer any active shutdowns, the red light will turn off.

## EMCP 4.4 (if equipped)

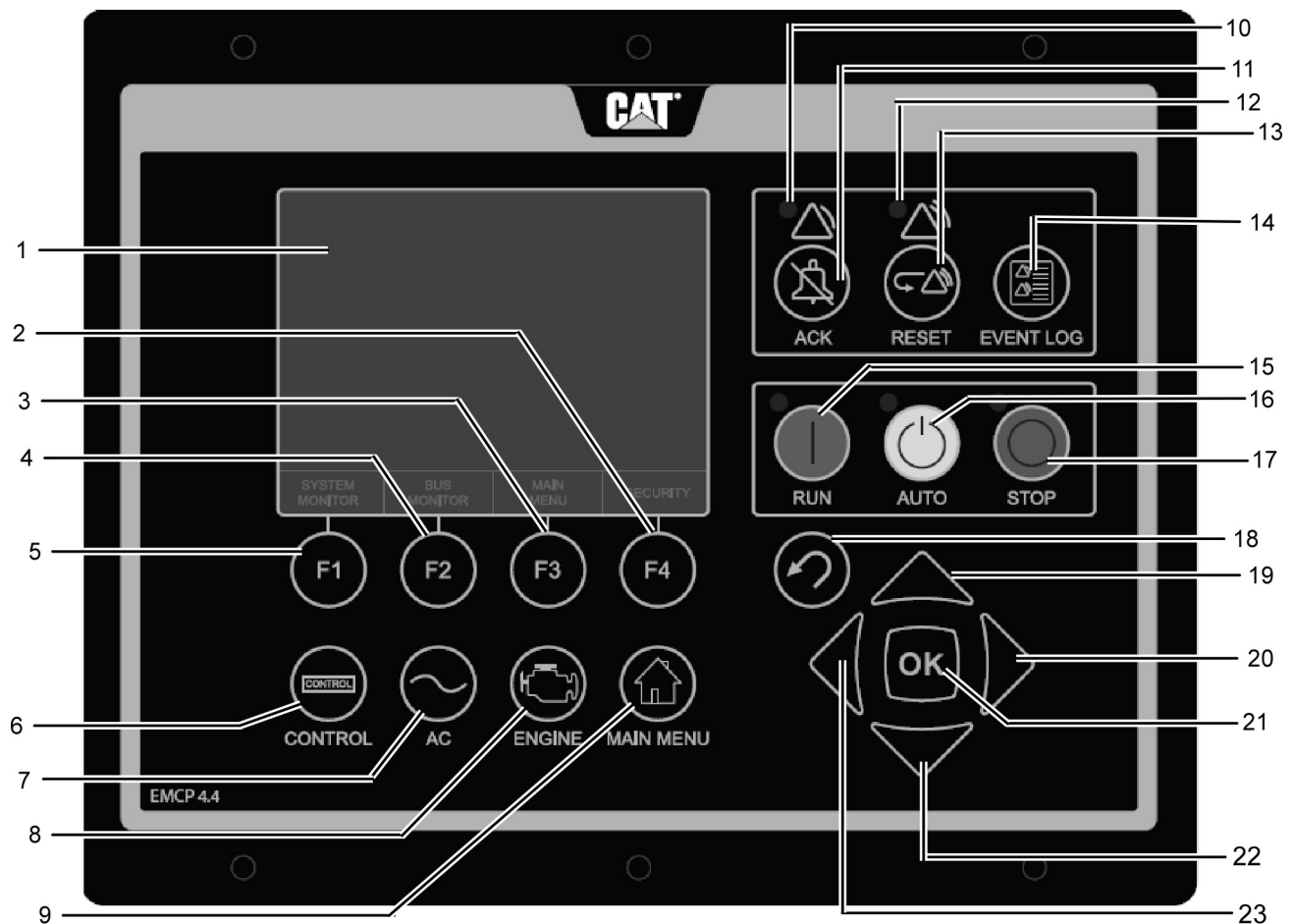


Illustration 39

g02118437

- |                         |   |                 |
|-------------------------|---|-----------------|
| (1) Display screen      | (9) Main menu                               | (16) Auto key   |
| (2) F4 Soft key         | (10) Warning Indicator lamp (yellow)        | (17) Stop key   |
| (3) F3 Soft key         | (11) Alarms acknowledge key and silence key | (18) Escape key |
| (4) F2 Soft key         | (12) Shutdown Indicator lamp (red)          | (19) Up key     |
| (5) F1 Soft key         | (13) Event reset key                        | (20) Right key  |
| (6) Control key         | (14) Event log key                          | (21) OK key     |
| (7) AC overview key     | (15) Run key                                | (22) Down key   |
| (8) Engine overview key |   | (23) Left key   |

## General Information

The main component of the Electronic Modular Control Panel 4.4 (EMCP 4.4) is the electronic control module (ECM). This section discusses the display, keys, and indicators on the control system panel of the ECM. The EMCP 4.4 panel is used for monitoring and controlling many of the generator set functions. Some of the functions include:

- Sending start and stop signals to the engine
- Providing visual and audible indications when warning or shutdown events occur
- Displaying engine information and AC generator set information
- Displaying Suspect Parameter Number (SPN) and Failure Mode Identifier (FMI) information for events
- Programming set points for the standard EMCP 4.4 (The set points for optional modules are set with the use of Cat ET.)
- Annunciator configuration is done within the EMCP 4.4

## ECM Front Panel Components

The following components can be found on the front panel of the ECM:

- Information Display
- Alarm Indicators
- Alarm Acknowledge/Silence Key
- Event Reset Key
- Function Keys
- Navigation Keys
- System Overview Keys

### Information Display

**(1) Display Screen** – Information from the EMCP 4 is displayed on the display screen. This screen is used for the following programming and display functions.

- Displaying AC parameter information of the generator set
- Displaying engine parameter information of the generator set
- Programming set points for the generator
- Displaying engine event information

- Displaying event codes from other modules
- Programming the display preferences of the EMCP 4.4
- Changing password levels of the EMCP 4.4

### Alarm Acknowledge/Silence Key

**(10) Alarm Acknowledge/Silence Key** – Pressing the alarm acknowledge/silence key will cause the horn relay output to turn off and silence the horn. Pressing the key will also cause any yellow or red flashing lights to turn off or to become solid depending on the active status of the alarms. The alarm acknowledge/silence key may also be configured to send out a global alarm silence on the J1939 Data Link which will silence horns on annunciators. However, other modules must be configured to listen to the global acknowledge.

### Event Reset Key

**(11) Event Reset Key** – The event reset button will clear all inactive fault conditions.

### Alarm Indicators

**Yellow Warning Light** – The yellow warning light (10) is located directly above the alarm acknowledge/silence key (11). A flashing yellow light indicates that there are unacknowledged active warnings. A solid yellow light indicates that there are acknowledged warnings active. If there are any active warnings, the yellow light will change from flashing yellow to solid yellow after the alarm acknowledge/silence key is pressed. If there are no longer any active warnings, the yellow light will turn off after the alarm acknowledge/silence key is pressed.

**Red Shutdown Light** – The red shutdown (12) light is located directly above the event reset key (13). A flashing red light indicates that there are unacknowledged active shutdown events. A solid red light indicates that there are acknowledged shutdown events active. If there are any active shutdown events, the red light will change from flashing red to solid red after the alarm acknowledge/silence key is pressed. Any condition that has caused a shutdown event must be manually reset. If there are no longer any active shutdown events, the red light will turn off.

### Function Keys

**(2) F4** – Pressing the F4 key will enable the function that is described on the screen directly above this key. When this key is defined on screen to scroll up or down, the Scroll Up and Scroll Down keys will also function the same.

**(3) F3** – Pressing the F3 key will enable the function that is described on the screen directly above this key. When this key is defined on screen to scroll up or down, the Scroll Up and Scroll Down keys will also function the same.

**(4) F2** – Pressing the F2 key will enable the function that is described on the screen directly above this key. When this key is defined on screen to scroll up or down, the Scroll Up and Scroll Down keys will also function the same.

**(5) F1** – Pressing the F1 key will enable the function that is described on the screen directly above this key. When this key is defined on screen to scroll up or down, the Scroll Up and Scroll Down keys will also function the same.

**(15) RUN** – Pressing the “RUN” key causes the EMCP 4.4 to enter the run mode.

**(16) AUTO** – Pressing the “AUTO” key causes the EMCP 4.4 to enter the auto mode.

**(17) STOP** – Pressing the “STOP” key causes the EMCP 4.4 to enter the stop mode or the cool down mode.

**(18) Escape Key** – The escape key is used during menu navigation to navigate up through the menu/submenu structure. Each key press causes the user to move backward (upward) through the menus. The escape key is also used to cancel of data entry screens during set point programming. If the escape key is pressed during set point programming, then none of the changes displayed on the screen will be saved to memory.

**(21) OK Key** – The OK key is used during menu navigation to move forward (downward) through the menu/submenu structure. The key is also used during set point programming to save set points changes. Pressing the OK key during set point programming causes set point changes to be saved to memory.

## Navigation Keys

**(6) Control Key** – The control key will navigate the display to the screen that allows the user to monitor and/or adjust various special control features.

**(9) Main Menu Key** – The main menu will navigate the display to the main menu directly without having to navigate out of menus.

**(14) Event Log** – The event log button will navigate the display to the event log.

**(19) Up Key** – The up key is used to navigate up through the various menus or monitoring screens. The key is also used during set point entry. During numeric data entry, the key is used to increment the digits (0-9). If the set point requires selection from a

list, then the key is used to navigate up through the list.

**(20) Right Key** – The right key is used during set point adjustment. During numeric data entry, the key is used to choose which digit is being edited. The key is also used during certain set point adjustments to select a check box or to deselect a check box. If a box has a check mark inside, then pressing the key will cause the check mark to disappear. If the box does not have a check mark inside, then pressing the key will cause a check mark to appear inside.

**(22) Down Key** – The down key is used to navigate down through the various menus or monitoring screens. The key is also used during set point entry. During numeric data entry, the key is used to decrement the digits (0-9). If the set point requires selection from a list, then the key is used to navigate down through the list.

**(23) Left Key** – The left key is used during set point adjustment. During numeric data entry, the key is used to choose which digit is being edited. The key is also used during certain set point adjustments to select a check box or to deselect a check box. If a box has a check mark inside, then pressing the key will cause the check mark to disappear. If the box does not have a check mark inside, then pressing the key will cause a check mark to appear inside.

## System Overview Keys

**(7) AC Overview** – Pressing the AC overview key displays the first screen of AC information for the generator set. This initial information page contains various AC parameters that summarize the electrical operation of the generator set. More AC parameters can be viewed by pressing the down key multiple times.

**(8) Engine Overview** – Pressing the engine overview key displays the first screen of engine information. This initial information page contains various engine parameters that summarize the operation of the engine. More engine parameters can be viewed by pressing the down key multiple times.

## Rear Access Doors

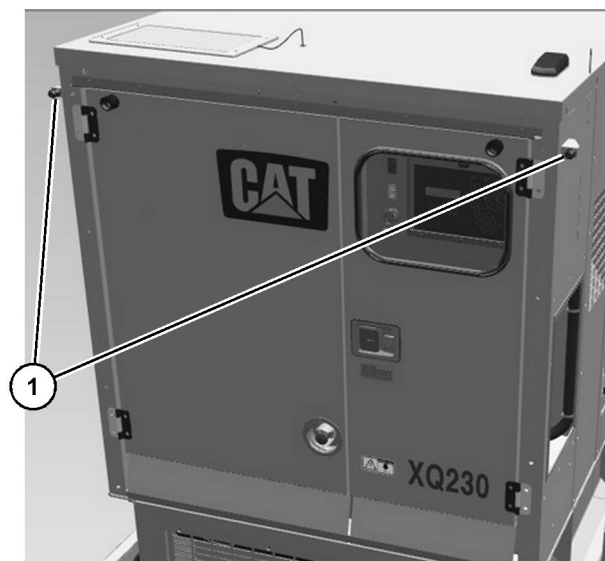


Illustration 40

g06389760

When making electrical connections or operating the unit, the two outer doors should be opened fully, and secured with the rubber door holdbacks provided (1). These doors should be kept closed while the engine is running, or when the unit is not in service. The door latch can be padlocked for added security if desired.

## Control Panel and Power Distribution Layout

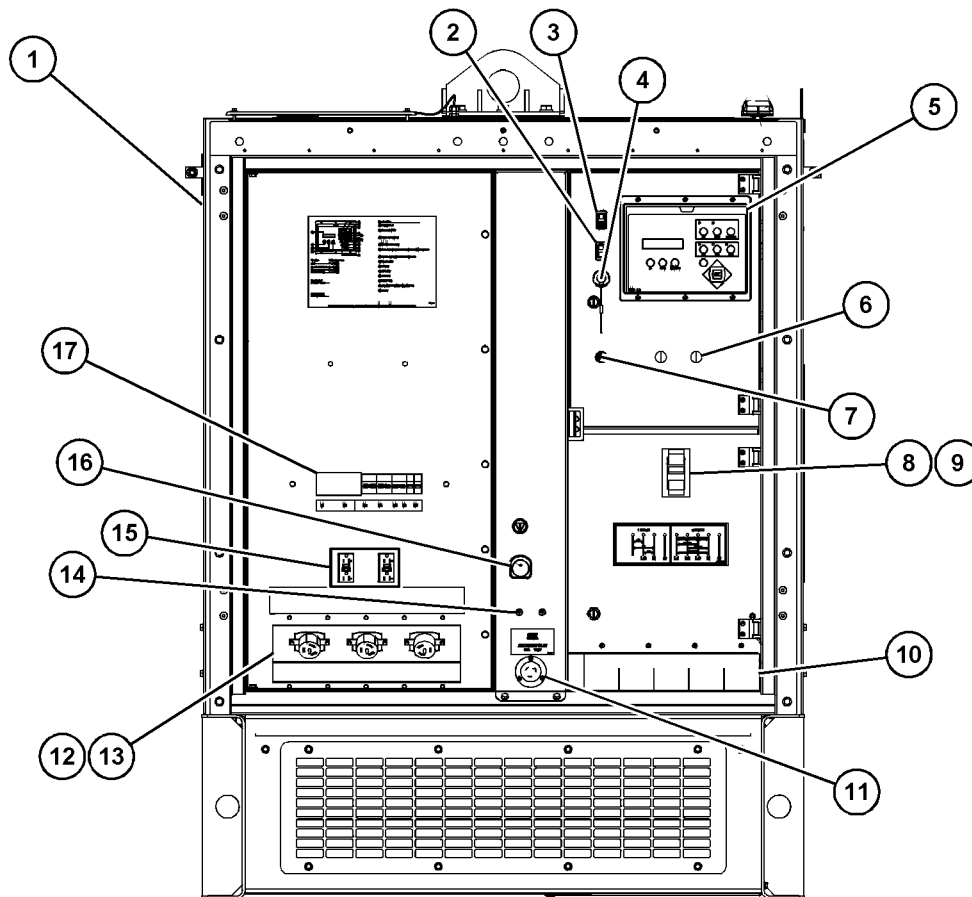


Illustration 41

g06389359

- |  |  |   |
|--|--|---|
| <p>(1) Steel enclosure with hinged, lockable door (not shown)</p> <p>(2) Glow plug lamp</p> <p>(3) Emissions system failure lamp</p> <p>(4) Cat ET service tool connector</p> <p>(5) EMCP 4.2B or EMCP 4.4 (paralleling option) (not pictured) digital generator set controller</p> <p>(6) Circuit breaker open and close pushbuttons (provided with paralleling option)</p> <p>(7) Alarm horn</p> | <p>(8) Manually operated circuit breaker, 3-pole, molded case, LSIG, 800A</p> <p>(9) Electrically operated circuit breaker, 3-pole, molded case, LSIG, 800A (provided with paralleling option)</p> <p>(10) Main bus connection (bus bars attached to breaker) behind door</p> <p>(11) Single-phase, NEMA locking input receptacles (30A @ 120V) to power block heater, battery charger, and generator space heater</p> | <p>(12) Single-phase, California style, twist-lock receptacles (50A @ 208V phase-to-phase, 120V phase-to-neutral, or 240/120)</p> <p>(13) 3-phase NEMA locking receptacles, 208V (optional) (not shown)</p> <p>(14) Two-wire remote start terminals</p> <p>(15) Single-phase GFCI duplex receptacles (20A @, 120V)</p> <p>(16) Emergency Stop</p> <p>(17) Circuit breakers for receptacles.</p> |
|--|--|---|

**Emergency Stop** – For use only in cases of real emergency, when the engine needs to be shut down immediately, or generator power needs to be disconnected immediately from the load. Do not use for normal engine stopping.

**Emissions System Failure Lamp** – When lit solid or blinking, indicates aftertreatment system inducement levels

**Alarm Horn** – Indicates shutdown alarm active. Use the “ACK” (acknowledge) key on the EMCP to silence.

### Standard Lugged Connection

When connection to the customer bus bar system using a standard lugged connection, insulate the bare end of the lug with tape. Insulating the tape will eliminate as much exposed live surface as possible.

## Load Connections

### **⚠ DANGER**

**DANGER: Shock/Electrocution Hazard-Do not operate this equipment or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings will result in serious injury or death.**

### NOTICE

Verify the correct load phase rotation with the generator prior to connecting the output power cables.

1. Ensure that the generator set is not operating. Place generator breaker in the “OPEN” or “OFF” position. The “OFF” position is the open position.
2. Connect the output power cables to the bus bars.

### **⚠ WARNING**

**Failure to connect the unit to a suitable grounded electrode can result in electrical shock and may cause injury or death.**

3. Connect the ground connection to a suitable grounding electrode of no more than 25 ohms.
4. Connect the control wiring (if equipped) for the automatic start/stop to the connection points for the remote start/stop.
5. Close the generator circuit breaker after the connection is made and the engine is running.

## Circuit Breakers and Receptacles

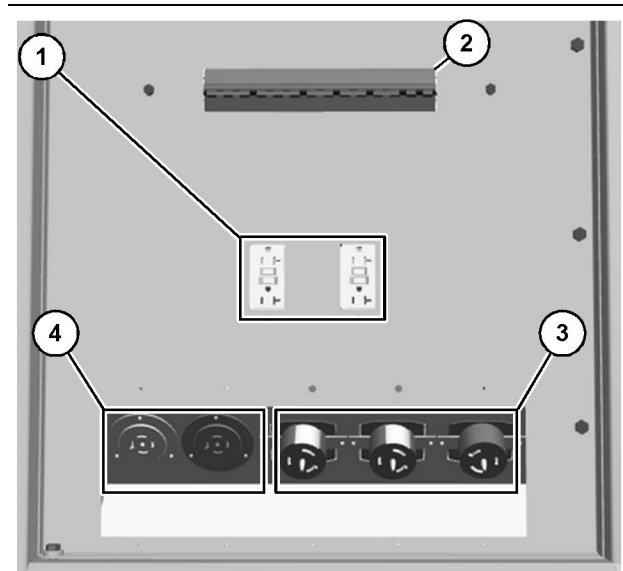


Illustration 42

g06389823

**Duplex Receptacles (1)** – For powering 120V devices having a standard, 3-prong AC plug. See table 6 for expected usage.

**Circuit Breakers (2)** – Breakers provided for circuit protection and mounted for easy access for on/off control to each receptacle.

**California Style Receptacles (3)** – Standard receptacles. Single phase, twist-lock. See table 6 for expected usage.

**NEMA Style Receptacles (4)** – Optional receptacles. Three phase, twist-lock. See table 6 for expected usage.

Table 6

| VSS Position                 | 600V (optional)   | 480V       | 208V       | 240/120 1PH             |
|------------------------------|-------------------|------------|------------|-------------------------|
| Duplex receptacles           | OV (disconnected) | 138V (L-N) | 120V (L-N) | 120V (L-N)              |
| NEMA Style receptacles       | OV (disconnected) | 240V (L-L) | 208V (L-L) | Use bus bar connections |
| California Style receptacles | OV (disconnected) | 240V (L-L) | 208V (L-L) | Use bus bar connections |

## Shore Power

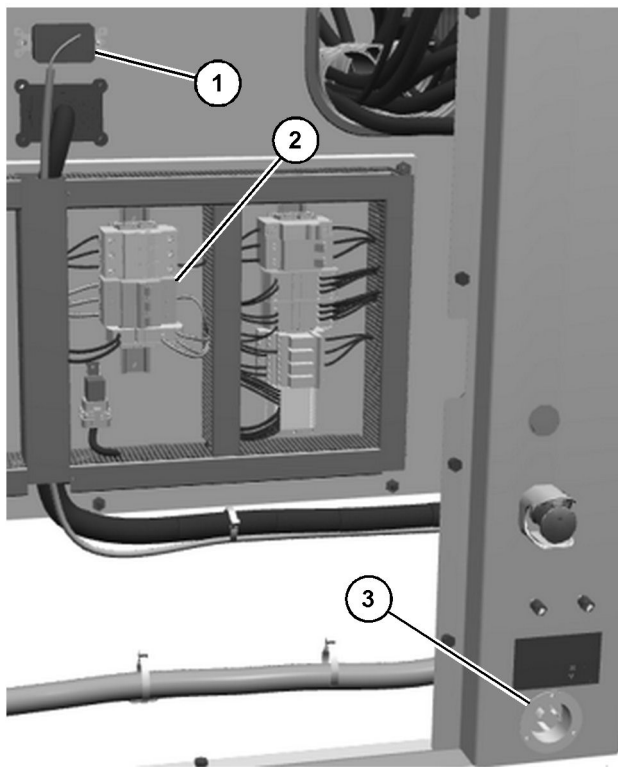


Illustration 43

g06389846

**Duplex Receptacle (1)** – Provided for battery charger and engine block heater.

**Circuit Breakers CB11, CB12, and CB13 (2)** – CB11 is for the generator anticondensation heater. CB12 is for the engine block heater. The device is plugged into the duplex receptacle (1). CB13 is for the battery charger. The device is plugged into the duplex receptacle (1).

**Shore Power Input Plug (3)** – Customer connection point to provide 120V power, which is distributed to on-board heaters, and battery charger through circuit breakers CB11, CB12, and CB13.

## Spare Terminals

If assistance in programming EMCP settings is needed, contact your Cat dealer.

|  |  |        |  |  |
|--|--|--------|--|--|
|  |  | DI-5   |  |  |
|  |  | DI-6   |  |  |
|  |  | R1-C   |  |  |
|  |  | R1-NO  |  |  |
|  |  | AN-REF |  |  |
|  |  | AN-A   |  |  |
|  |  | AN-B   |  |  |
|  |  | AN-SHD |  |  |
|  |  | BC-ALM |  |  |
|  |  | BC-ALM |  |  |

Illustration 44

g06390159

**DI-5** – EMCP 4.2B discrete input 5

**DI-6** – EMCP 4.2B discrete input 6

**R1-C** – EMCP 4.2B relay output 1 (common)

**R1-NO** – EMCP 4.2B relay output 1 (normally open)

**AN-REF** – EMCP 4.2B remote RS485 annunciator (reference)

**AN-A** – EMCP 4.2B remote RS485 annunciator (A)

**AN-B** – EMCP 4.2B remote RS485 annunciator (B)

**AN-SHD** – EMCP 4.2B remote RS485 annunciator (shield)

**BC-ALM** – Monitoring of battery charger alarms (all in series) when optional NFPA110 battery charger is installed. A closed circuit between both BC-ALM terminals indicates no alarm. An open circuit indicates alarm active.

## Voltage Selector Switch

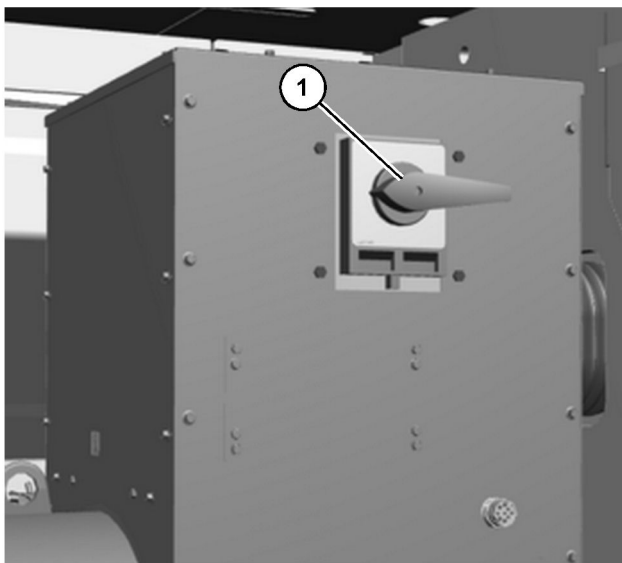


Illustration 45

g06389817

**Voltage Selector Switch (1)** – The voltage selector switch quickly and conveniently configures the generator windings to produce the desired voltage output. The EMCP monitors the “AUX” contacts of this switch to determine the position and automatically configures for the desired voltage. Never change switch position while the engine is running. The red tab can be pushed upwards to allow the user to add a padlock to lock the position if desired.

## Battery Disconnect/DC Distribution Breakers

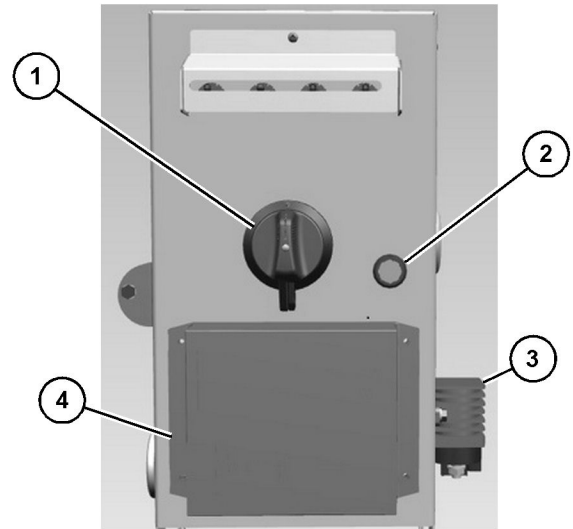


Illustration 46

g06394682

- (1) Battery disconnect switch
- (2) Wait to disconnect lamp
- (3) Glow plug relay
- (4) Battery charger

**Battery Disconnect Switch** – Provides a convenient means to cut off battery power to the unit. The only components not switched off are the telematics device, and solar battery charger. To allow the solar battery charger to maintain the charge, this switch must be turned off when the unit is not in use. This switch can be locked in the “OFF” position.

**Wait to Disconnect Lamp** – When lit, this indicates that the DEF purge cycle is active, or delayed engine shutdown is active, and that the user should not turn the battery disconnect switch to OFF. Normal operation is for the user to press “STOP” on the EMCP, wait for this lamp to go out, then turn the battery disconnect switch to OFF.

**Note:** This lamp will stay on continuously, and be of no use if the maintenance mode switch inside the control panel is turned on.

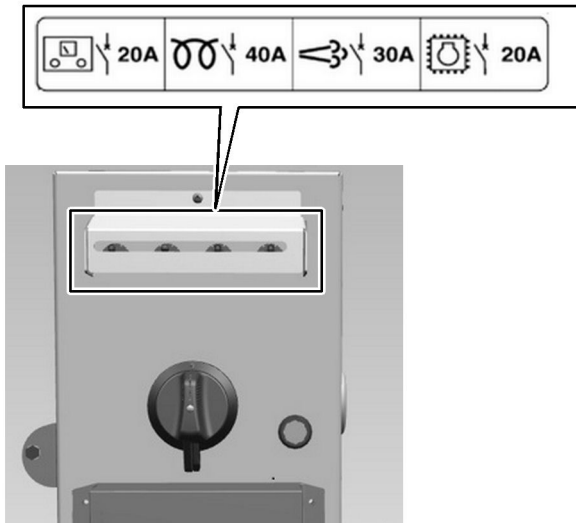


Illustration 47

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### DC distribution breakers

**DC Distribution Breakers** – Four DC breakers take a feed directly from the batteries, and distribute to the major electrical subsystems. From left to right, CB1 for the control panel, CB2 for the glow plugs, CB3 for the aftertreatment system, and CB4 for the engine.

A guard over the breakers protects the breakers against accidentally turning off a breaker, yet allows for visual inspection to see if any breakers are tripped.

## Generator Circuit Breaker

### Over Current Fault Trip Indicator

The generator circuit breaker is used to connect or disconnect load from the generator, and provide overcurrent protection for load cables.

If the generator circuit breaker experiences an overcurrent event, the circuit breaker will automatically open and the reset button (1) will extend. The circuit breaker will not be operational until the reset button (1) is pushed into the normal operating position.



Illustration 48

g06389948

(1) reset button

## Micrologic Trip Unit

The Micrologic trip unit is one component of the generator circuit breaker assembly. Micrologic trip units protect power circuits and provide current measurements, overload protection, and short-circuit protection.

**Note:** Equipment ground faults protection would require the user to install a separate CT kit which is not included in the unit.

Protection thresholds and delays are set using the rotary switches. The selected values are momentarily displayed in amperes and in seconds. A full-range of long-time settings are available via field-installable rating plug.

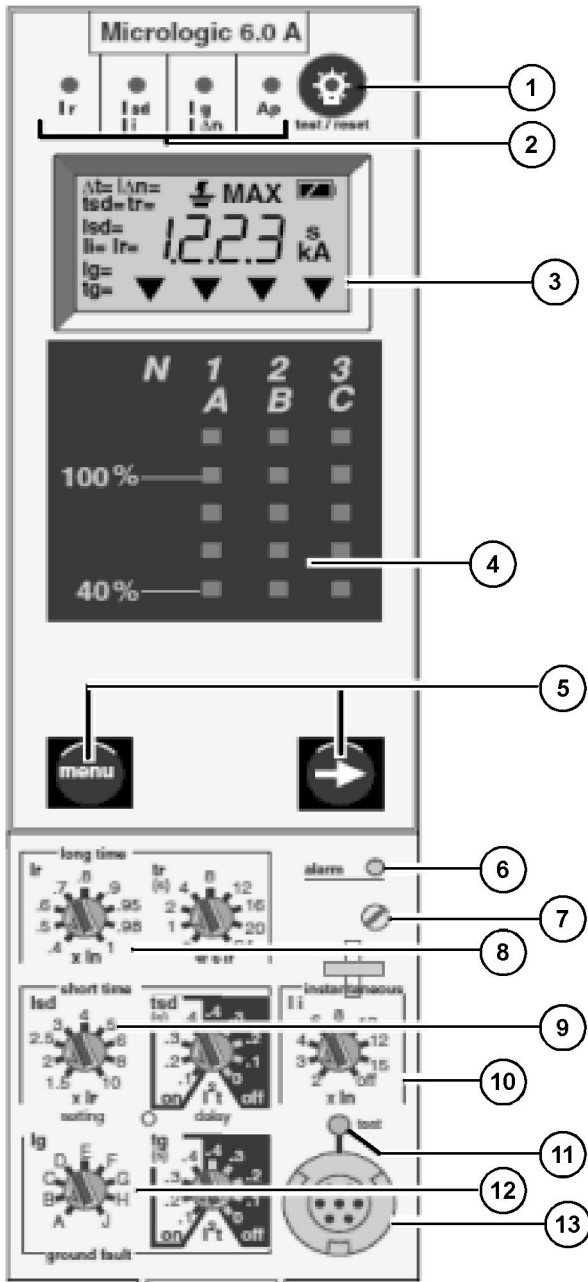


Illustration 49

g06389952

- (1) Test lamp, and reset
- (2) Trip cause indicator
- (3) Digital display
- (4) Three-phase bar graph and ammeter
- (5) Navigation buttons
- (6) Overload signal
- (7) Long-time rating screw
- (8) Long-time current setting and tripping delay
- (9) Short-time pickup and tripping delay
- (10) Instantaneous pickup
- (11) Electronic push-to-trip
- (12) Ground fault pickup and tripping delay
- (13) Test connector

## Split Door Design

The split door design allows for the lower door to be used to access bus bars in making power connections. Keep upper door closed except to access telematics device, solar battery charger, or maintenance mode switch. Opening lower door causes immediate tripping of the circuit breaker for safety purposes. The upper door cannot be opened unless the lower door is opened first.

## Upper Door

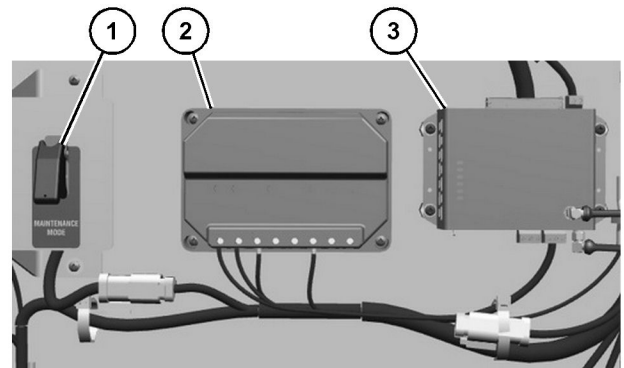


Illustration 50

g06389725

**Maintenance Mode Switch (1)** – Normally turned off (down position). When turned on (up position), will activate keyswitch input on engine ECM. Keyswitch input allows user to view engine parameters on the EMCP or flash/configure engine ECM while the engine is not running. Normally the EMCP will activate this input when the unit is started.

**Solar Battery Charger Control (2)** – Accepts power from the solar array mounted on the roof of the unit, and outputs a charging voltage to the batteries. Requires battery disconnect switch to be turned off, and circuit breakers CB1 (near battery disconnect switch), and CB6 (inside control panel) to be on.

**PLG Telematics (3)** – Communicates engine and generator parameters and GPS location of the unit using the antenna mounted on the roof of the unit.

## Lower Door

### Phase Load and Neutral Cable Connections

should be routed under the round plastic bar to provide strain relief.

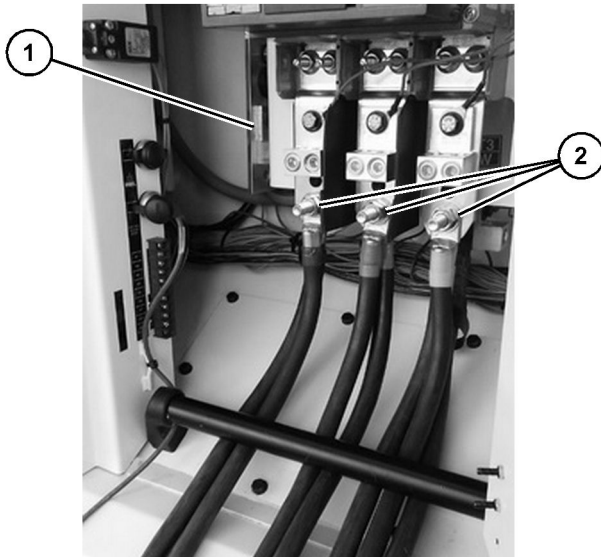


Illustration 51

g06389781

For each phase, and for neutral, there are two convenient means provided for customer cable connection. For cables having no ring terminal, use the mechanical lug with set screw. For cables with ring terminals, use a hole in the bus bar and attach with customer provided hardware.

**Neutral Cables Connection (1)** – The factory configuration has the neutral bonded to ground via cable. However, there are some instances in which grounding the neutral wire is undesirable. In other applications, having an ungrounded neutral lead is acceptable. Definite measures should be taken in such applications to prevent grounds to the phase leads. An example of such measures is ground fault protective circuits. Ground fault protection requires that the entire group of distribution circuits should be studied. The entire group of distribution circuits should be treated as a system. The customer should engage a certified, registered consultant if a new distribution system is being developed. The customer should also engage a certified, registered consultant if an existing system should be modified for the ground fault protection. The generator breaker has ground fault protection integrated. The factory configuration uses the breaker's residual ground fault protection which monitors the three phase currents and trip if strayed currents are detected. An optional neutral current transformer can be added to the breaker if monitoring neutral current is required for ground fault protection in certain applications.

**Phase Load Cables Connection (2)** – When attaching cables with ring terminals, always have the bolt threads oriented outwards (as shown) away from sheet metal to prevent short circuits. Also, cables

# Engine Starting

i06575204

## Starting the Engine

**SMCS Code:** 1000; 1450

**Note:** If the engine has not been used for 4 months or more, the first start procedure must be used.

### First Start Procedure

This procedure is intended to commence the oil lubrication process, while rotating the engine at cranking speed only, and not allowing the engine to start.

**Note:** Failure to complete steps 1 through 4 prior to starting the engine could cause the turbocharger bearings to fail for lack of lubrication. If the engine cranks and tries to start during the steps, press the emergency stop immediately.

1. Remove the electrical connector from the engine fuel lift pump. The electrical connector is the main two-way plug near the lift pump. Removing the connector will prevent fuel from entering the system. Switch on battery power.
2. Use Cat Electronic Technician (ET) service tool to disable all six injectors (this option is found in Cat ET under the diagnostic test).
3. Start the unit. The unit should run through a full starting sequence (three crank attempts). The engine will crank but not start.
4. You will get a fail to start warning on the control panel, which you must reset before moving to step 5.
5. Place the unit into idle mode using the electronic modular control panel (EMCP).
6. Disconnect battery power.
7. Replace the electrical connector to the engine fuel lift pump. Switch on battery power. The engine lift prime pump will complete a full priming cycle.  
  
If the battery has been disconnected, this step is unnecessary.
8. Start the unit. The unit will run at idle speed. Confirm the rpm on the control panel. If the unit ramps beyond idle speed up to rated speed, shut down the unit.

9. Let the unit run at idle speed for 1 minute.

## Starting the Engine

1. Verify that load is disconnected from the unit.
2. Start engine by pressing the RUN key on the EMCP.
3. When the indicator lamp for the glow plugs is extinguished, the engine crank cycle will begin automatically.

**Note:** The operating period of the warning light for the glow plugs will change due to the temperature of the engine.

---

### NOTICE

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

1. Repeat step 2 and step 3 if the engine fails to start.
- 

i07669841

## 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, starting the engine from an external electrical source may be necessary.

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 recharge batteries that are severely discharged fully. 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, Have the electronic modular control panel (EMCP) in "STOP" mode. 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. Have the EMCP in "STOP" mode on the stalled engine. Turn off all the engine 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 the combustible gases that are produced by some batteries.
4. Start the engine.
5. Immediately after the engine is started, disconnect the jump-start cables in reverse order.

After jump starting, the alternator may not be able to recharge batteries that are severely discharged fully. The batteries must be replaced or charged to the proper voltage with a battery charger after the engine is stopped. Many batteries which are considered unusable are still rechargeable. Refer to Operation and Maintenance Manual, "Battery - Replace" and Testing and Adjusting Manual, "Battery - Test".

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

# Engine Operation

i08593556

## Engine Operation (Hydrocarbon Mitigation)

**SMCS Code:** 1000

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

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

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

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

## Hydrocarbon Mitigation

The hydrocarbon mitigation is a feature to protect the DOC against temperatures below 325° C (617° F). Temperatures below this range can damage the aftertreatment of the machine. The initial occurrence displays as a warning and then if temperatures do not increase by the operator or strategy, the machine will go into shutdown. Messages appear sequentially as follows:

- First : Key cycle to warning
- Secondary : Warning to shut down

If the warning messages are not acknowledged, then the shutdown counter begins. Once the engine has shutdown for low exhaust temperatures, the 173-18 Engine Exhaust Manifold #1 Temperature #1: Low - Moderate Severity (2) will return until the engine has successfully reached target temperatures.

Once exhaust temperatures below 325° C (617° F) are observed for an hour, the Hydrocarbon Mitigation feature begins and the following conditions below become active.

## Cylinder Cutout Strategy

The cylinder cutout starts at 1000 rpm. The hydrocarbon mitigation monitors the exhaust and intake target temperatures and increases speed if temperatures are not achieved in intervals. The intervals are 20 minutes and with 200 rpm increments. The speed range for the strategy is 1000 rpm to 1800 rpm with a minimum run time of 100 minutes.

**Note:** This strategy only runs in non-work mode.

The strategy success criteria is based on the following:

- Intake air manifold temperature over 10° C (50° F)
- Exhaust manifold temperature over 325° C (617° F)

If successful, the machine will continue to run indefinitely at the current rpm until taken out of non-work mode.

## Exhaust Temperature Low Code Actions

Once the 173-18 Engine Exhaust Manifold #1 Temperature #1: Low - Moderate Severity (2) warning message is shown, there are two actions that can be taken to remove them:

### Non-Work Mode

Put the machine in Non-Work mode.

- This will allow Hydrocarbon Mitigation to start automatically and attempt to achieve the target temperatures for the intake and exhaust.
- If the strategy does not achieve target temperatures, the engine will return to low idle for 60 minutes and then Hydrocarbon Mitigation begins.
- If the strategy continues to fail, the next action will need to be taken to clear the codes.

### Non-Work Mode Failure

If the machine is being used at the time of the warning message and cannot be put into Non-Work mode, then raise the intake and exhaust temperature for their time thresholds.

- Intake air manifold temperature is greater than 10° C (50° F) for 10 minutes continuously
- Exhaust manifold temperature is greater than 325° C (617° F) for 30 minutes continuously
- Blender - Ideal time to perform this is during the 60 minute low time after a Hydrocarbon Mitigation failure.

**Note:** Hydrocarbon Mitigation will always start mitigation.

## Partial Load Operation

Extended operation at reduced load (less than 30%) may cause increased oil consumption and carbon buildup in the cylinders. Extended operation at reduced load may also cause fuel to slobber through the exhaust system. A loss of power and/or poor performance may result.

To maintain engine efficiency and performance, apply 70% load to the engine on an hourly basis. Operating the engine at a load level that is greater than 30% will also maintain engine efficiency and performance. This action will burn excess carbon from the cylinders.

i08685911

## Low Load Operating Conditions

**SMCS Code:** 1000

Generator set engines are designed for operation under loaded conditions. If the generator set engine is not operated with sufficient load, some of the components of the generator set engine may be unfavorably affected.

A regular exercising and testing regimen for all Electric Power Standby Generator Sets is encouraged.

Exercising the generator set or operating the genset for an extended time in a No Load or a Low Load (less than 30% of rated genset output capacity) condition can result in one or more of the following conditions:

- Exhaust manifold “slobber” (black oily substance found leaking from exhaust manifold joints).
- Higher than expected oil consumption.
- Emissions Aftertreatment systems may lose efficiency or malfunction. (If Equipped)

**Note:** When a generator set must be operated or exercised in a No Load condition or a Low Load condition, the following run time sequence must be performed.

- For No Load Operational/Exercising conditions: After every 8 hours of No load operation, the generator set engine must be subjected to a load test of equal to or greater than 50 percent of the output capacity of the generator set for a minimum of 30 minutes to ensure that adequate engine exhaust temperatures are achieved.

- For Low Load Operational/Exercising conditions: After every 24 hours of low load operation, the generator set engine must be subjected to a load test of equal to or greater than 50 percent of the output capacity of the generator set for a minimum of 30 minutes to ensure that adequate engine exhaust temperatures are achieved.
- For standby applications, operational testing of a minimum of 30 minutes is required to achieve optimal engine coolant temperature. Testing is desired at intervals of not more than 30 days to safeguard against system problems and aid of identifying routine maintenance needs.

Further performance and service information can be obtained by contacting your nearest authorized Cat® dealership.

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## Fuel Conservation Practices

**SMCS Code:** 1000; 1250

The efficiency of the engine can affect the fuel economy. The design and technology in manufacturing provides maximum fuel efficiency in all applications. Always ensure that genuine filters are used. Follow the recommended procedures to attain optimum performance for the life of the engine.

- Avoid spilling fuel.

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

- Be aware of the properties of the different fuels. Use only the recommended fuels. Refer to the Operations and Maintenance Manual, “Fuel Recommendations” for further information.
- Avoid unnecessary idling.
- Shut off the engine rather than idle for long periods of time.
- Observe the service indicator frequently. Keep the air cleaner elements clean.
- Ensure that the turbocharger is operating correctly so that the proper air/fuel ratio is maintained. Clean exhaust indicates proper functioning.
- Maintain a good electrical system.

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

- Ensure that the belts are correctly adjusted. The belts should be in good condition. Refer to the Specifications manual for further information.

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

# Generator Operation

i07651170

## Voltage Regulators

**SMCS Code:** 4467

### Integrated Voltage Regulator (IVR)

The Integrated Voltage Regulator (IVR) provides excitation current to the generator. The IVR is controlled by the IVR function in the EMCP4. The IVR function allows the EMCP4 to control the generator voltage, optimize transient performance, and provide feature specification.

The excitation module may interface with any of the following excitation systems: Self Excitation (SE), Internal Excitation (IE) and Permanent Magnet (PMG) excitation systems.

For additional information about the IVR, see Application and Installation, LEBE0006, and Special Instruction, REHS9106.

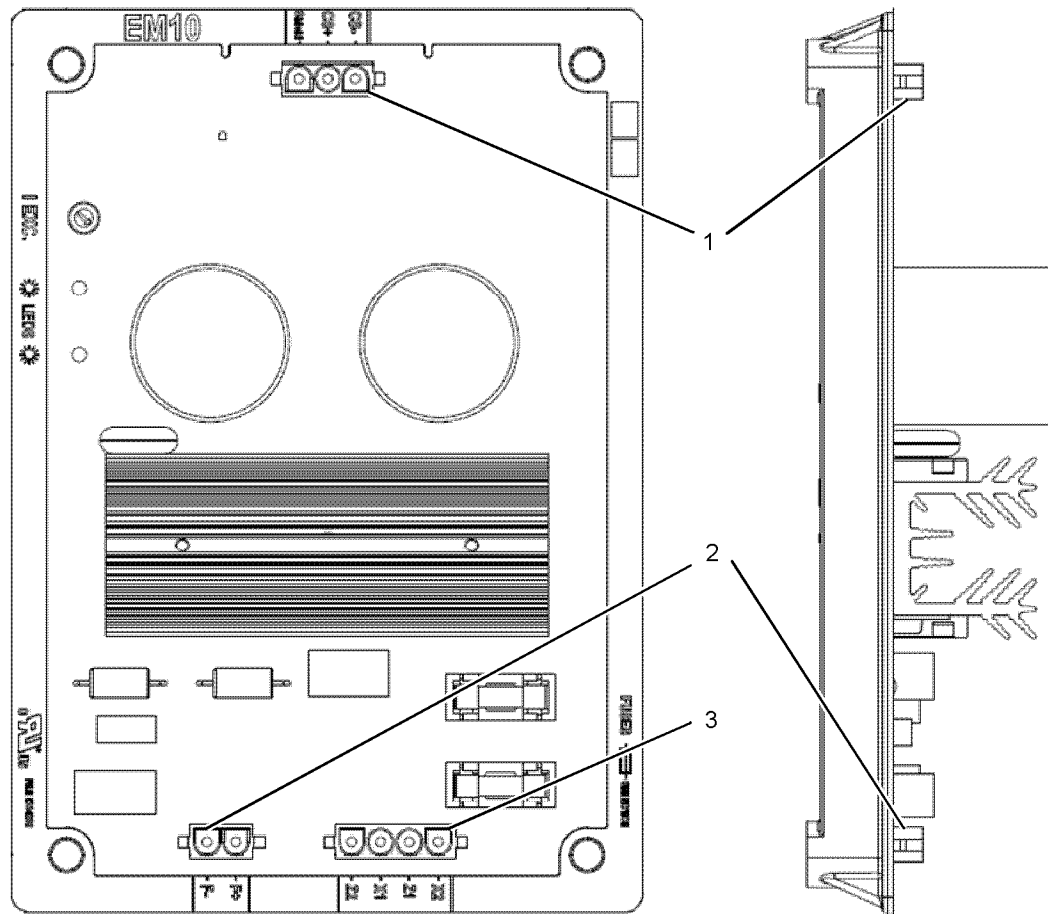


Illustration 52

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**Excitation Module 10 (EM10)**

(1) Connector P3

(2) Connector P2

(3) Connector P4

**EMCP IVR Connection**

To regulate the generator terminal voltage, the EMCP communicates the desired excitation command to the excitation module through a pulse width modulation (PWM) signal. A twisted pair of shielded cable must be used for the communication link. Table 7 details the connections to be made between the EMCP and Excitation Module.

Table 7

| EMCP 4.1 and EMCP 4.2 Connections to Excitation Module (70-pin connector) |    |                                   |      |
|---|----|-----------------------------------|------|
| EMCP 4.1 and EMCP 4.2 70-Pin Connector                                    |    | Excitation Module 3-Pin Connector |      |
| Digital Output #2 / IVR CS+   | 68 | CS+                               | P3-2 |

(Table 7, contd)

| Battery negative splice  | 60 or 65 | CS-                               | P3-3 |
|--|----------|-----------------------------------|------|
| Battery negative splice  | 60 or 65 | Shield                            | P3-1 |
| EMCP 4.3 and EMCP 4.4 Connections to Excitation Module (120-pin connector) |          |                                   |      |
| EMCP 4.3 and EMCP 4.4 120-Pin Connector                                    |          | Excitation Module 3-Pin Connector |      |
| PWM Output #2 Positive   | 28       | CS+                               | P3-2 |
| PWM Output #2 Negative   | 8        | CS-                               | P3-3 |
| Shield   | 19       | Shield                            | P3-1 |

(continued)

Operation Section  
Voltage Regulators

Table 8 provides information on the technical specification of the EM10 and EM15 modules. Selection of the appropriate module must be determined by the following:

- Nominal and maximum generator excitation current at full load (standby 0.8 PF).
- The maximum AC voltage input.

Table 8

| EM10 and EM15 Technical Specifications |   |        |
|--|---|--------|
|  | EM10  | EM15   |
| Compatible Generator Excitation Types  | Permanent Magnet (PM) Self-Excitation (SE) Internal Excitation (IE/AREP) <sup>(1)</sup> |        |
| Nominal Field Current Output           | 6A  | 7A     |
| Maximum (forcing) Field Current Output | 10A   | 15A    |
| Maximum AC Voltage Input               | 180Vms  | 240Vms |

<sup>(1)</sup> Internal Excitation (IE is also referred to as "Auxiliary Regulation Excitation Principle"(AREP)

**Note:** The X2 and Z1 connections are internally linked within the excitation module. The link provides a point of common connection for the auxiliary windings where an AREP or IE excitation supply is available. Also, the X2 and Z1 connections may be linked externally to the excitation module. Only three connections (X1, X2, and Z2) are needed for the EM. Refer to Systems Operation/Test and Adjust/Troubleshooting, UENR1209, "Integrated Voltage Regulator Connections" for excitation module wiring connections. The wiring diagrams are for self-excitation (shunt), auxiliary windings (AREP/IE), and permanent magnet (PM) configurations.

The voltage regulator knee frequency must be configured for your specific package requirements. The knee frequency for 50 Hz operation will usually be between 48.0 and 49.8 Hz. For 60 Hz operation, the parameter must be set between 58.0 to 59.8 Hz.

Refer to Illustration 53 for an example under-frequency roll-off (loading) profile.

## IVR Excitation Module Connections

The EM10 and EM15 excitation modules have three plug type multiple-pin connectors. The connectors are labeled P2, P3, and P4 as shown in illustration 52. Table 9 describes the signal and function of each connector pin.

Table 9

| Excitation Module Connections |        |  |
|-------------------------------|--------|--|
| Terminal                      | Label  | Signal/Function                            |
| P2-1                          | F+     | Exciter Field Positive                     |
| P2-2                          | F-     | Exciter Field Negative                     |
| P3-1                          | Shield | Excitation Command Control Signal Shield   |
| P3-2                          | CS+    | Excitation Command Control Signal Positive |
| P3-3                          | CS-    | Excitation Command Control Signal Negative |
| P4-1                          | X2     | Excitation Power Supply Input X2           |
| P4-2                          | Z1     | Excitation Power Supply Input Z1           |
| P4-3                          | X1     | Excitation Power Supply Input X1           |
| P4-4                          | Z2     | Excitation Power Supply Input Z2           |

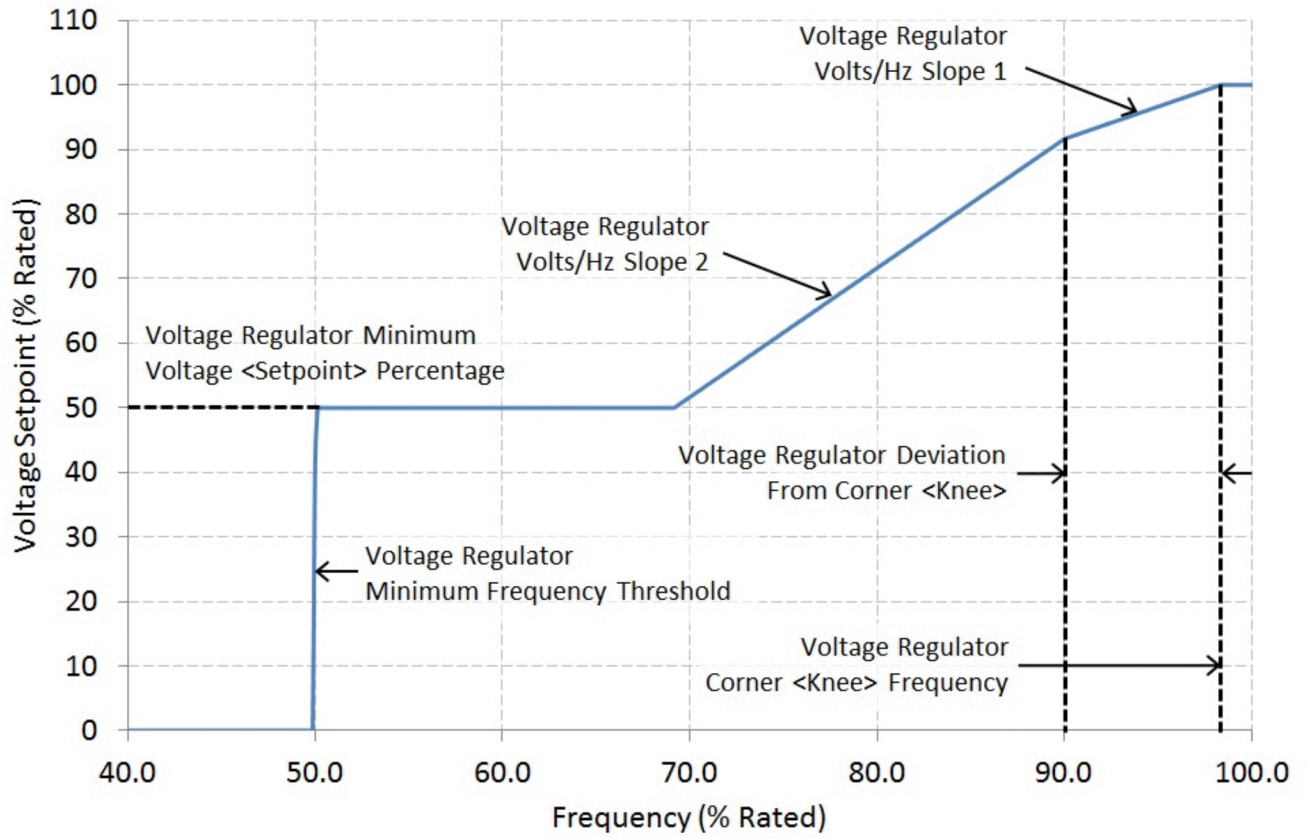


Illustration 53

g03487998

Under-frequency (loading) profile slope1 = 1.0 V/Hz, slope2 = 2.0 V/Hz

## Aftertreatment Operation

i07669875

### Diesel Particulate Filter Regeneration

SMCS Code: 108F

#### WARNING

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

### Regeneration

Regeneration is the removal of soot from the Diesel Particulate Filter (DPF). The Aftertreatment Regeneration Device (ARD) is used to regenerate the DPF. The DPF traps both soot and ash. The ash is removed through a manual cleaning process. Refer to Operation and Maintenance Manual, "Diesel Particulate Filter - Clean" for more information on the service of the DPF.

### Types of Regeneration

**Passive Regeneration** – Is a chemical reaction within the system and the engine will create enough heat to regenerate the DPF.

**Active Regeneration** – The engine does not create enough heat to regenerate the DPF. The ARD must be used to create the heat necessary to regenerate the DPF.

### Lamps

Some indicator lamps can be affected by the DPF regeneration. Also, the horn can be used to alert the operator.



**Engine Emission System Malfunction** – This indicator lamp will illuminate for a fault resulting from poor DEF quality, SCR system tampering, SCR system fault, or an impeded EGR valve.

### Modes of Regeneration

- Enhanced automatic regeneration

Enhanced automatic regeneration is controlled by the engine ECM.

**Enhanced automatic regeneration** – This mode of DPF regeneration allows for regeneration to take place at higher engine rpm and higher engine loads. In order for enhanced automatic regenerations to occur, the following conditions must be met:

- Soot level must be between level 2 and level 3 on the soot level monitor (if equipped).
- Engine speed must be greater than 1400 rpm.
- Minimum engine idle speed input must be set. Setting the input will not allow engine speed to fall below 1000 rpm during enhanced automatic regeneration. If minimum low idle speed input is not available, regeneration will stop if engine speed drops below 1000 rpm.

- Refer to the OEM for the applications interlocks required to be engaged before regeneration can take place.

### Inducement Override Switch

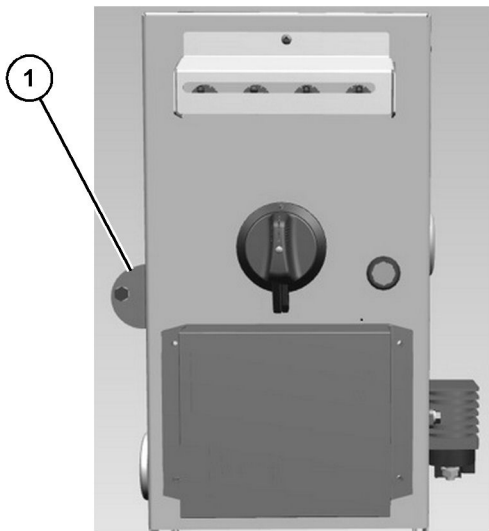


Illustration 54 g06389483

Only to be used to extend engine run time during inducement activated by the aftertreatment system. The engine ECM must be programmed to enable inducement override before this switch is operable. The switch guard is bolted to prevent accidental toggling of the switch due to the seriousness of misuse.

### Soot Level Monitoring and Indicator Lamps

During the normal working cycle of the engine the ECM will control when the regeneration will occur. Operation of the engine is not recommended with the amber warning light flashing, or the red lamp illuminated. Operation of the engine at this level could damage the DPF.

Some applications will be equipped with a monitoring gauge. Illustration 55 is an example of the levels of soot loading on a gauge.

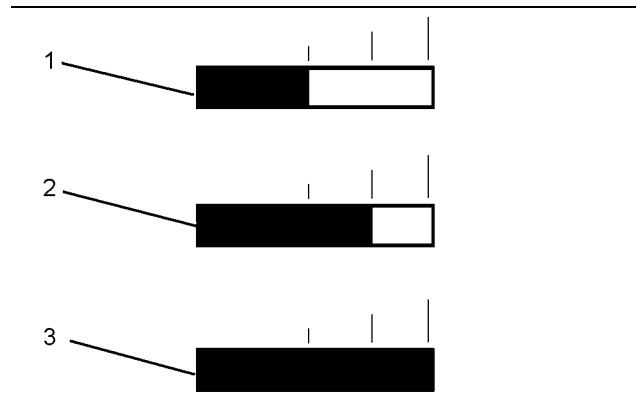


Illustration 55 g02153650

- (1) Normal operation level 1
- (2) Level 2 with DPF lamp illuminated
- (3) level 3 with DPF lamp illuminated.

During the normal working cycle of the engine the ECM will control when the regeneration will occur. Regeneration will take place by enhanced automatic regeneration. Operation of the engine at level 3 and not allowing regeneration to be performed could damage the DFP.

### Soot Level and Engine Loading

Illustration 56 is a guide to show engine RPM engine load and when regeneration can occur.

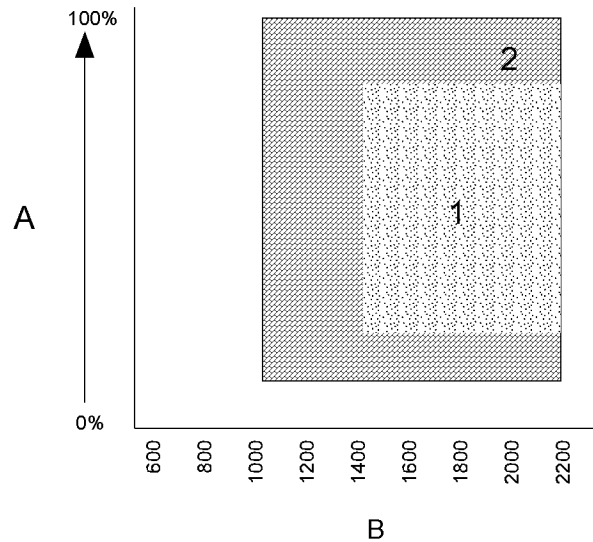


Illustration 56 g03193641

- (A) Engine load factor
- (B) Engine RPM
- (1) High-speed automatic regeneration (60-80% soot load)
- (2) High-speed automatic regeneration (80-100% soot load)

In some circumstances high-speed regeneration cannot occur. Allow the application to operate at a lower load factor to allow regeneration to occur.

i07272780

## Selective Catalytic Reduction Warning System

**SMCS Code:** 1091-WXX; 7400

The Selective Catalytic Reduction (SCR) system is a system used to reduce NOx emissions from the engine. Diesel Exhaust Fluid (DEF) is pumped from the DEF tank and is sprayed into the exhaust stream. The DEF reacts with the SCR catalyst to reduce NOx and leaves a nitrogen and water vapor.

### NOTICE

Stopping the engine immediately after the engine has been working under load can result in overheating of SCR components.

Refer to the Operation and Maintenance Manual, "Engine Stopping" procedure to allow the engine to cool and to prevent excessive temperatures in the turbocharger housing and the DEF injector.

### NOTICE

Allow the engine to perform a DEF purge of the DEF system before you perform a battery disconnect switch to OFF. Disconnecting the battery power too soon may prevent purging of the DEF lines after the engine is shut down. Refer to this Operation and Maintenance Manual, "Battery Disconnect Switch" for more information.

## Warning Strategy

The Electronic Control Module (ECM) will be enabled with a world-wide warning strategy.

## Warning Indicators

The warning indicators consist of a level gauge for the DEF, a low-level lamp for the DEF, an emission malfunction lamp, and the application stop lamp.

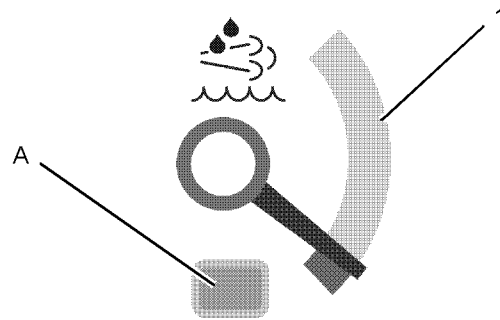


Illustration 57

g03069862

(1) DEF gauge  
 (A) Low-level warning lamp

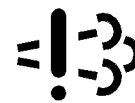


Illustration 58

g02852336

Emission malfunction lamp

## Warning Levels

The SCR has three levels of warning. Depending on the fault that has been detected and software enabled will govern the time that the system will stay at each warning level.

Any warning should be investigated immediately, contact your Cat dealer. The system is equipped with an override option. Once the override option has been used and the fault still exist, the engine will be locked in de-rate or shutdown mode.

## Definitions

- **Self-correct** Fault condition no longer exists. An active fault code will no longer be active.
- **Notification** Action taken by the system to alert the operator of pending Inducement.
- **Inducement** Engine derates, vehicle speed limits, or other actions intended to prompt the operator to repair or maintain the emission control system.

- **Inducement Categories** The Inducements are separated into categories. DEF Levels have inducement fault codes separate from the other inducement categories. DEF level inducements are based on the DEF level, the other inducement categories are based on escalating time. The escalating time inducements will always have an associated fault code along with the inducement fault code. The associated fault is the root cause. The escalating time inducement fault code is just an indicator of what level of inducement the engine is in. The escalating time inducement fault code also indicates how much time remains until the next level of inducement. There are three inducement categories that will trigger an escalating time inducement fault code.

**Note:** The associated codes for each of the escalating time categories can be found in Troubleshooting, SCR Warning System Problem.

- **First Time** When an escalating time inducement fault code becomes active for the first.
- **Repeat occurrence** When any escalating time inducement fault code becomes active again within 40 hours of the first occurrence. Engine must run for 40 hours without tripping any escalating time inducement fault before returning back to first occurrence times.
- **Safe Harbor Mode (Worldwide)** Safe Harbor Mode is a 20 minute engine run time period. Once in level 3 inducement, the operator can perform a key cycle and the engine will enter Safe Harbor Mode. Safe Harbor Mode can only be implemented once. Safe Harbor Mode is not allowed for DEF level inducements with Worldwide configuration.

## World-Wide SCR Warnings

- At Level 1 the emission malfunction lamp will be on solid.
- At Level 2 the emission malfunction lamp will flash.
- At Level 3 the emission malfunction lamp will flash and the stop lamp will activate.
- At Level 3 the engine may shut down, or operate at 1000 Revolutions Per Minute (RPM).
- At Level 3 cycling the keyswitch will give 20 minutes override at full power, before the shutdown or idle is triggered. The emission malfunction lamp will continue to flash.

Operation Section  
Selective Catalytic Reduction Warning System

## World-Wide Reduced Performance Setting

Table 10

| World-Wide Reduced Performance Setting  |                  |  |                                      |  |  |
|---|------------------|--|--------------------------------------|--|--|
| Category 1 Fault (Tampering Dosing Interruption and Quality)  |                  |  |                                      |  |  |
| -   | Normal operation | Level 1                                    | Level 2                              | Level 3  | Override   |
| Inducement Time First Occurrence  | None             | 2.5 Hours                                  | 70 minutes                           | 50 Percent torque<br><b>Shut down or idle<br/>Until fault heals</b>    | Cycling the keyswitch will give 20 minutes of full power |
| The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat occurrence inducement time will be triggered.<br>The override can only be used once |                  |  |                                      |  |  |
| Inducement Time Repeat Occurrence   | None             | 5 minutes                                  | 75 Percent torque                    | 50 Percent torque<br><b>Shut down or idle<br/>Until fault heals</b>    | Cycling the keyswitch will give 20 minutes of full power |
| Inducement  | None             | None                                       | None                                 |  |  |
| Notification  | None             | Emission malfunction lamp will be on solid | Emission malfunction lamp will flash | Emission malfunction lamp will flash<br>The stop lamp will be on solid | Emission malfunction lamp will flash                     |
| Contact your Cat dealer at level 1 warning, do not let the fault develop.   |                  |  |                                      |  |  |

Table 11

| World-Wide Reduced Performance Setting  |                  |  |                                      |  |  |
|---|------------------|--|--------------------------------------|--|--|
| Category 2 Fault (Non-Tampering Dosing and Interruption)  |                  |  |                                      |  |  |
| -   | Normal operation | Level 1                                    | Level 2                              | Level 3  | Override   |
| Inducement Time First Occurrence  | None             | 10 Hours                                   | 10 Hours                             | 50 Percent torque<br><b>Shut down or idle<br/>Until fault heals</b>    | Cycling the keyswitch will give 20 minutes of full power |
| The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat occurrence inducement time will be triggered.<br>The override can only be used once |                  |  |                                      |  |  |
| Inducement Time Repeat Occurrence   | None             | None                                       | 2 Hours                              | 50 Percent torque<br><b>Shut down or idle<br/>Until fault heals</b>    | Cycling the keyswitch will give 20 minutes of full power |
| Inducement  | None             | None                                       | 75 Percent of torque                 |  |  |
| Notification  | None             | Emission malfunction lamp will be on solid | Emission malfunction lamp will flash | Emission malfunction lamp will flash<br>The stop lamp will be on solid | Emission malfunction lamp will flash                     |
| Contact your Cat dealer at level 1 warning, do not let the fault develop.   |                  |  |                                      |  |  |

Table 12

| World-Wide Reduced Performance Setting                                  |                  |         |         |         |          |
|---|------------------|---------|---------|---------|----------|
| Category 3 Fault (Non-Tampering NOx Control Monitoring and Impeded EGR) |                  |         |         |         |          |
| -   | Normal operation | Level 1 | Level 2 | Level 3 | Override |

(continued)

Operation Section  
Selective Catalytic Reduction Warning System

(Table 12, contd)

|   |      |   |   |  |  |
|---|------|---|---|--|--|
| Inducement Time<br>First Occurrence   | None | 36 Hours                                      | 64 Hours                                | 50 Percent torque<br><b>Shut down or idle<br/>Until fault heals</b>          | Cycling the keyswitch<br>will give 20 minutes<br>of full power |
| The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat occurrence inducement time will be triggered.<br>The override can only be used once |      |   |   |  |  |
| Inducement Time<br>Repeat Occurrence  | None | None  | 5 Hours                                 | 50 Percent torque<br><b>Shut down or idle<br/>Until fault heals</b>          | Cycling the keyswitch<br>will give 20 minutes<br>of full power |
| Inducement  | None | None  | 75 Percent of torque                    |  |  |
| Notification  | None | Emission malfunction<br>lamp will be on solid | Emission malfunction<br>lamp will flash | Emission malfunction<br>lamp will flash<br>The stop lamp will be<br>on solid | Emission malfunction<br>lamp will flash                        |
| Contact your Cat dealer at level 1 warning, do not let the fault develop.   |      |   |   |  |  |

Operation Section  
Selective Catalytic Reduction Warning System

## World-Wide Reduce Time Setting

Table 13

| World-Wide Reduced Time Setting   |                  |  |                                      |   |  |
|---|------------------|--|--------------------------------------|---|--|
| Category 1 Fault (Tampering Dosing Interruption and Quality)  |                  |  |                                      |   |  |
| -   | Normal operation | Level 1                                    | Level 2                              | Level 3   | Override   |
| Inducement Time First Occurrence  | None             | 2.5 Hours                                  | 70 minutes                           | 50 Percent torque<br><b>Shut down or idle<br/>Until fault heals</b> | Cycling the keyswitch will give 20 minutes of full power |
| The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat inducement time will be triggered.<br>The override can only be used once. |                  |  |                                      |   |  |
| Inducement Time Repeat Occurrence   | None             | 5 minutes                                  | 5 minutes                            | 50 Percent torque<br><b>Shut down or idle<br/>Until fault heals</b> | Cycling the keyswitch will give 20 minutes of full power |
| Inducement  | None             | None                                       | None                                 |   |  |
| Notification  | None             | Emission malfunction lamp will be on solid | Emission malfunction lamp will flash | Emission malfunction lamp will flash<br>The stop lamp will activate | Emission malfunction lamp will flash                     |
| Contact your Cat dealer at level 1 warning, do not let the fault develop.   |                  |  |                                      |   |  |

Table 14

| World-Wide Reduced Time Setting   |                  |  |                                      |   |  |
|---|------------------|--|--------------------------------------|---|--|
| Category 2 Fault (Non-Tampering Dosing Interruption)  |                  |  |                                      |   |  |
| -   | Normal operation | Level 1                                    | Level 2                              | Level 3   | Override   |
| Inducement Time First Occurrence  | None             | 5 Hours                                    | 5 Hours                              | 50 Percent torque<br><b>Shut down or idle<br/>Until fault heals</b> | Cycling the keyswitch will give 20 minutes of full power |
| The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat inducement time will be triggered.<br>The override can only be used once. |                  |  |                                      |   |  |
| Inducement Time Repeat Occurrence   | None             | None                                       | 1 Hour                               | 50 Percent torque<br><b>Shut down or idle<br/>Until fault heals</b> | Cycling the keyswitch will give 20 minutes of full power |
| Inducement  | None             | None                                       | None                                 |   |  |
| Notification  | None             | Emission malfunction lamp will be on solid | Emission malfunction lamp will flash | Emission malfunction lamp will flash<br>The stop lamp will activate | Emission malfunction lamp will flash                     |
| Contact your Cat dealer at level 1 warning, do not let the fault develop.   |                  |  |                                      |   |  |

Table 15

| World-Wide Reduced Time Setting   |                  |         |         |         |          |
|---|------------------|---------|---------|---------|----------|
| Category 3 Fault (Non-Tampering NOx Control Monitoring and Impeded EGR) |                  |         |         |         |          |
| -   | Normal operation | Level 1 | Level 2 | Level 3 | Override |

(continued)

(Table 15, contd)

|   |      |  |                                      |   |  |
|---|------|--|--------------------------------------|---|--|
| Inducement Time First Occurrence  | None | 18 Hours                                   | 18 Hours                             | 50 Percent torque<br><b>Shut down or idle<br/>Until fault heals</b> | Cycling the keyswitch will give 20 minutes of full power |
| The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat inducement time will be triggered.<br>The override can only be used once. |      |  |                                      |   |  |
| Inducement Time Repeat Occurrence   | None | None                                       | 108 Minutes                          | 50 Percent torque<br><b>Shut down or idle<br/>Until fault heals</b> | Cycling the keyswitch will give 20 minutes of full power |
| Inducement  | None | None                                       | None                                 |   |  |
| Notification  | None | Emission malfunction lamp will be on solid | Emission malfunction lamp will flash | Emission malfunction lamp will flash<br>The stop lamp will activate | Emission malfunction lamp will flash                     |
| Contact your Cat dealer r at level 1 warning, do not let the fault develop.   |      |  |                                      |   |  |

### World-Wide DEF Level Warnings

Two options are available but only one option will be enabled.

- The low-level warning lamp will operate when DEF level reaches the trigger point of below 20 percent.
- At Level 1 the low-level warning lamp in the DEF gauge will illuminate and the emission malfunction lamp will be on solid.
- At Level 2 the low-level warning lamp for the DEF is active and the emission malfunction lamp will flash.
- At Level 3 all level 2 warning are operating, plus the stop lamp will become activate. The engine will shut down or will only operate at 1000 RPM.

Filling the DEF tank will remove the warning from the system.

Table 16

| World-Wide DEF Level Option 1 |                  |                            |  |  |   |
|-------------------------------|------------------|----------------------------|--|--|---|
| -                             | Normal operation | Initial indication         | Level 1  | Level 2  | Level 3   |
| Inducement Trigger            | Above 19 percent | Below 19 percent           | Below 12.5 percent   | 0 Percent reading  | Empty tank  |
| Inducement                    | None             | None                       | None   | Engine may be de-rated by 25 percent torque                      | The engine may be de-rated by 50 percent torque.<br>A shutdown or low idle only will be enforced after 5 minutes. |
| Notification                  | None             | Low-level lamp illuminated | Low-level lamp illuminated<br>Emission malfunction lamp on solid | Low-level lamp illuminated<br>Emission malfunction lamp flashing | Low-level lamp illuminated<br>Emission malfunction lamp flashing<br>Stop lamp on solid                            |

Operation Section  
 Selective Catalytic Reduction Warning System

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Table 17

| <b>World-Wide DEF Level Option 2</b> |                  |                            |  |  |  |
|--------------------------------------|------------------|----------------------------|--|--|--|
| -                                    | Normal operation | Initial indication         | Level 1  | Level 2  | Level 3  |
| Inducement Trigger                   | Above 19 percent | Below 19 percent           | Below 12.5 percent   | 6 Percent reading  | 0 Percent reading  |
| Inducement                           | None             | None                       | None   | None   | Shut down or idle only   |
| Notification                         | None             | Low-level lamp illuminated | Low-level lamp illuminated<br>Emission malfunction lamp on solid | Low-level lamp illuminated<br>Emission malfunction lamp flashing | Low-level lamp illuminated<br>Emission malfunction lamp flashing<br>Stop lamp on solid |

# Cold Weather Operation

i07651145

## Fuel and the Effect from Cold Weather

**SMCS Code:** 1000; 1250; 1280

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.

Quantities of No. 1 diesel fuel are limited. No. 1 diesel fuels may be 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.

**Note:** Using kerosene or jet A fuel to lower the cloud/pour point of ultra-low sulfur diesel fuel will void the factory warranty. Equipment will not be in compliance with emissions regulations if kerosene or jet A fuel is used.

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

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

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

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

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

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

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

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

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

i07677871

## Diesel Exhaust Fluid in Cold Weather

**SMCS Code:** 108K

Due to the freezing point of Diesel Exhaust Fluid (DEF) the aftertreatment system is equipped with electrically heated DEF lines. The system also has a coolant heated element in the DEF tank.

During periods of weather in which DEF can freeze the application should be stood on level ground when not in use. DEF can start to freeze at  $-11^{\circ}\text{C}$  ( $12.2^{\circ}\text{F}$ ).

**Note:** At certain angles DEF can cover the DEF filler cap. If the DEF freezes, the DEF tank vent could block. A blocked vent in the DEF tank assembly will cause operational difficulties.

For information on DEF refer to this Operation and Maintenance Manual, "Fluid Recommendations".

# Engine Stopping

i07660381

## Stopping the Engine

**SMCS Code:** 1000

---

### NOTICE

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

Avoid accelerating the engine prior to shutting it down.

Avoiding hot engine shutdowns will maximize turbo-charger shaft and bearing life.

---

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

1. Press the STOP key on the electronic modular control panel (EMCP).
2. After the preprogrammed cooldown period has expired, the engine will stop.

**Note:** If excessively high temperature in the aftertreatment system is detected, the engine (if enabled) will go into delayed engine shutdown mode. The engine will continue to run (4-15 minutes) until the temperature is sufficiently low, and the engine will then be stopped. During delayed engine shutdown mode, the EMCP will show that the engine is in cooldown, and the “wait to disconnect” lamp will be lit.

# Transportation Information

i08127870

## Roading

**SMCS Code:** 1000; 7002

### **WARNING**

**Improper hookup and towing is dangerous and could result in injury or death to yourself or to others.**

**DO NOT tow this power module unless you are a properly licensed driver, have been properly trained and are authorized to do so.**

## Preparing for Transport

Inspect tires for the following conditions: wear, damage, and proper inflation. Stand to the side of the tire tread and use a self-attaching chuck while you inflate a tire. Do not tow the power module with overinflated tires or underinflated tires. Inflate the tires according to the OEM instructions.

Do not change the size of the tires. Do not change the type of the tires. Tighten all lug nuts to the proper specification.

Check the power module for proper operation of the trailer brakes.

Refer to the OEM "Operators Manual" for more information on the trailer for operation and maintenance.

## Coupling Instructions

1. Never allow anyone behind the trailer or in between the tractor and the trailer when you are coupling or uncoupling the trailer.
2. Position the trailer to the proper height with the landing gear.
3. Back up the tractor to the trailer so the fifth wheel touches the trailer pickup plate.
4. Connect the air lines and the electric line and apply the trailer brakes.
5. Recheck the trailer height and adjust the trailer height with the landing gear if necessary.
6. Back up the tractor until the fifth wheel engages with the kingpin.

7. After you hook up the trailer, keep the trailer brakes applied. Move the tractor forward slightly. A slight pull will pull on the kingpin to check for a proper interlock.
8. Perform a visual check of the kingpin to ensure that the kingpin is securely locked.
9. Retract the landing gear completely before moving the power module.
10. When you are uncoupling, lower the landing gear enough to lift the weight from the tractor.
11. Keep the fifth wheel surface plate lubricated.

## Transporting the Generator Set

### NOTICE

Observe all local traffic regulations and observe federal traffic regulations involved in towing the power module for lawful operation.

Slow down and use caution during the following conditions:

- Heavy traffic
- Curves
- Rough roads
- Steep downgrades
- Slippery conditions

Do not exceed the legal speed limits. Adjust the towing speed for the road conditions. Allow increased distances to stop.

Avoid quick maneuvers and avoid sharp maneuvers. Be careful while you pass other vehicles in traffic. Remember that the power module is behind you.

The following obstructions on the road should be avoided: potholes, large rocks, and other obstructions. Avoid shoulders on the side of road that are soft and unstable. The weight of the power module may cause the power module to sink into the shoulder and the power module may overturn.

While you are backing up, maneuver the power module carefully. Stay clear of adjacent structures.

## Tightening Lug Nuts

Caterpillar recommends tightening all lug nuts to proper specification each time the package is prepared for transport.

Each lug nut should be tightened to  $149 \pm 14 \text{ N}\cdot\text{m}$  ( $110 \pm 10 \text{ lb}\cdot\text{ft}$ ).

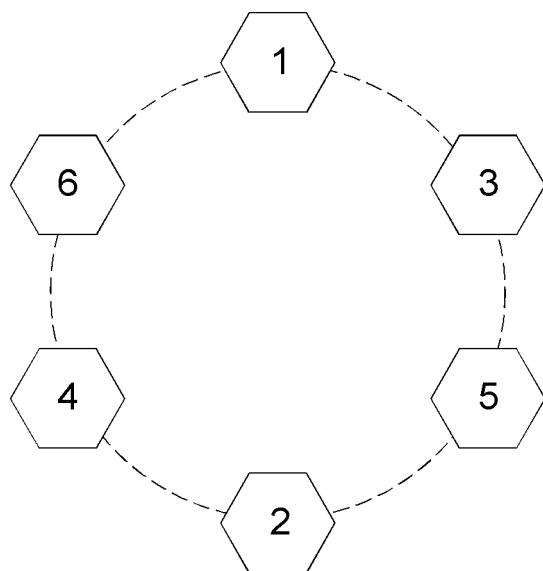


Illustration 59

g06557727

Lug nuts tightening sequence for 6-lug wheels

i05173610

## Setup

SMCS Code: 1000; 7002

### **⚠ WARNING**

Discharge air is hot and could cause property damage and/or personal injury.

**Note:** Do not operate the unit below any overhang.

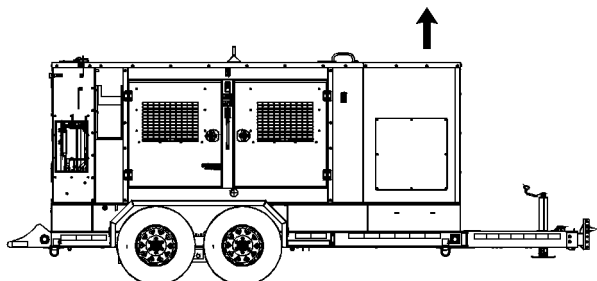


Illustration 60

g06389062

Typical flow of the exhaust

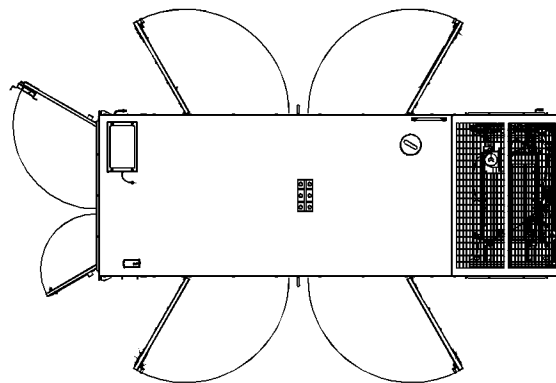


Illustration 61

g06389089

Top view of the package and the typical clearance around the package

The unit should have adequate clearance on all sides to allow proper air flow. Allow approximately 2 m (6.6 ft) of clearance on all sides.

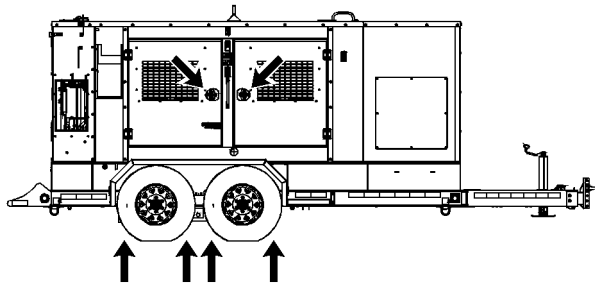
- Place the unit in a stable position.
- Ensure that you use wheel chocks that are suitable for the trailer.
- Unfasten the tow vehicle before you operate the unit.

### NOTICE

Ensure that the enclosure doors are closed and locked during generator set operation. Access to the generator set is prohibited during operation of the generator set. Access to the emergency stop push button cannot be obstructed or restricted. The emergency stop push button must be easily seen and the emergency stop push button must be readily accessible. The door latch cannot be lockable. The door latch cannot contain a provision for making the door latch lockable.

### **⚠ WARNING**

Failure to close doors when the unit is operating can result in doors opening and closing at a high rate of speed. Contact with the doors may cause personal injury or death.



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Illustration 62

g06389090

Typical chocking of the wheels and door latches

# Maintenance Section

## Refill Capacities

i07651117

### Refill Capacities

SMCS Code: 1000; 1348; 1395; 7560

#### 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 more oil. Refer to the OEM specifications to find the capacity of the auxiliary oil filter.

Table 18

| Engine Refill Capacities          |                     |                     |
|-----------------------------------|---------------------|---------------------|
| Compartment or System             | Minimum             | Maximum             |
| Crankcase Oil Sump <sup>(1)</sup> | 13.5 L<br>(14.3 qt) | 16.5 L<br>(17.5 qt) |

(continued)

(Table 18, contd)

<sup>(1)</sup> These values are the approximate capacities for the crankcase oil sump (aluminum) which includes the standard factory installed oil filters. Engines with auxiliary oil filters will require more oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.

#### Coolant

Table 19

| Engine Refill Capacities  |                        |
|---------------------------|------------------------|
| Compartment or System     | Capacity               |
| Engine & Radiator coolant | 35.6 L<br>(9.4 US gal) |
| Engine coolant            | 15.9 L<br>(4.2 US gal) |

#### Diesel Exhaust Fluid (DEF)

Table 20

| DEF Tank Refill Capacity |                    |
|--------------------------|--------------------|
| Compartment or System    | Capacity           |
| DEF Tank                 | 46 L (12.1 US gal) |

#### Fuel

Table 21

| Fuel Tank Refill Capacity |                    |
|---------------------------|--------------------|
| Compartment or System     | Capacity           |
| Fuel Tank                 | 992 L (262 US gal) |

i08711974

### Fluid Recommendations

SMCS Code: 1280; 1348; 1395; 7560

**NOTICE**

Every attempt is made to provide accurate, up-to-date information. By the use of this document, you agree that Caterpillar Inc. is not responsible for errors or omissions.

**NOTICE**

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

Refer to Operation and Maintenance Manual, SEBU6251, "Cat Commercial Diesel Engines Fluids Recommendations" for additional information.

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

## Diesel Engine Oil

### Cat DEO (Diesel Engine Oil)

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

- **Cat DEO-ULS (Diesel Engine Oil Ultra Low Sulfur) (SAE 5W-40)**
- **Cat DEO-ULS (Diesel Engine Oil Ultra Low Sulfur) (SAE 10W-30)**
- **Cat DEO-ULS (Diesel Engine Oil Ultra Low Sulfur) (SAE 15W-40)**

### Engine Oil

Cat oils have been developed and tested to provide the full performance and life that has been designed and built into Cat engines.

Cat DEO-ULS or oils that meet the Cat ECF-3 specification and the API CJ-4 are required for use in the applications listed below. Cat DEO-ULS and oils meeting Cat ECF-3 specification and the API CJ-4 and ACEA E9 oil categories have been developed with limited sulfated ash, phosphorus, and sulfur. These chemical limits are designed to maintain the expected aftertreatment devices life, performance, and service interval. If oils meeting the Cat ECF-3 specification and the API CJ-4 specifications are not available, oils meeting ACEA E9 may be used. ACEA E9 oils are validated using some but not all ECF-3 and API CJ-4 standard engine performance tests. Consult your oil supplier when considering use of an oil that is not Cat ECF-3 or API CJ-4 qualified.

Table 22

| Lubricant Viscosities for Ambient Temperatures |                                       |                 |      |     |     |     |
|--|---------------------------------------|-----------------|------|-----|-----|-----|
| Compartment or System                          | Oil Type and Performance Requirements | Oil Viscosities | °C   |     | °F  |     |
|  |                                       |                 | Min  | Max | Min | Max |
| Engine Crankcase                               | Cat DEO-ULS Cold Weather              | SAE 0W-40       | -40  | 40  | -40 | 104 |
|  | Cat DEO-ULS SYN                       | SAE 5W-40       | -30  | 50  | -22 | 122 |
|  | Cat DEO-ULS                           | SAE 10W-30      | -18  | 40  | 0   | 104 |
|  | Cat DEO-ULS                           | SAE 15W-40      | -9.5 | 50  | 15  | 122 |

#### NOTICE

Do not use oil renewal systems in engines equipped with aftertreatment systems. Reduced life or damage to the aftertreatment may occur.

## S·O·S Services Oil Analysis

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### NOTICE

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

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

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

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

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

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### 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.

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Refer to Operation and Maintenance Manual, SEBU6251, "Cat Commercial Diesel Engines Fluids Recommendations" to obtain additional information about S·O·S Services oil analysis. You can also contact your local Cat dealer to obtain additional information about the S·O·S Services Oil Analysis program.

## Fuel System

Filter the fuel entering the bulk storage fuel tank through a filter with a rating of 10 micron (c) absolute or less. Filter the fuel at the last dispensing stage into the engine fuel tank through a filter with a rating of 4 microns (c) absolute or less. The use of a series of filters is recommended. The use of filters which are made from wire mesh is not recommended. Filters with cellulose media or synthetic media are downstream of the wire mesh filters. The use of water separators is also recommended with the fuel filters.

Use Catr Advanced Efficiency Fuel Filters on diesel engines which burn distillate fuels to provide maximum life to the fuel system.

## Diesel Fuel Recommendations

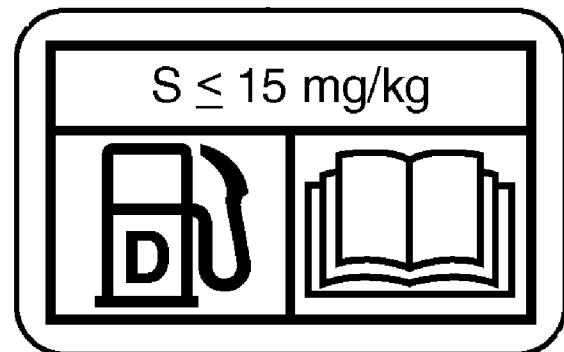


Illustration 63

g02052934

EAME Film

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

The preferred fuels provide maximum engine service life and performance. The preferred fuels are distillate fuels. These fuels must meet the "Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines" which is found in Operation and Maintenance Manual, SEBU6251, "Cat Commercial Diesel Engines Fluids Recommendations".

The permissible fuels are some crude oils, some blends of crude oil with distillate fuel, and some biodiesel. These fuels are not suitable for use in all engine applications. A complete fuel analysis is required. Consult your Caterpillar dealer for further information. For information which concerns biodiesel or biodiesel blends, refer to Operation and Maintenance Manual, SEBU6251, "Cat Commercial Diesel Engines Fluids Recommendations".

**Note:** Use lubricating oils which are compatible with the certification of the engine, the engine aftertreatment system, and the sulfur levels of the fuel.

**Note:** For specific information on diesel fuel sulfur levels, refer to Operation and Maintenance Manual, SEBU6251, "Cat Commercial Diesel Engines Fluids Recommendations".

Low sulphur diesel (LSD) fuel 0.05 percent ( $\leq 500$  ppm (mg/kg) sulfur) is recommended for use in engines that are pre-Tier 4 models, Diesel fuels with greater than  $\geq 0.05$  percent (500 ppm (mg/kg)) sulphur is acceptable for use in areas of the world where allowed by law. Pre Tier 4 engines that are equipped with a diesel oxidization catalyst (DOC) require the use of LSD fuel or ULSD fuel.

Low sulfur diesel fuel (LSD) contains no more than 500 ppm (mg/kg) of sulfur. ULSD is required by regulation for engines which are certified to EUIIIA standard.

Other governments may require the use of ULSD fuel. Consult local officials for guidance on fuel requirements.

Diesel fuel must meet "Cat Specification for Distillate Fuel" and the latest versions of "ASTM D975" or "EN 590" to ensure optimum engine performance.

**Misfueling with fuels of higher sulfur level can have the following negative effects:**

- Reduce engine efficiency and durability.
- Increase the wear.
- Increase the corrosion.
- Increase the deposits.
- Lower fuel economy
- Shorten the time period between oil drain intervals (more frequent oil drain intervals).
- Increase overall operating costs.

Failures that result from the use of improper fuels are not Cat factory defects. Therefore the cost of repairs would not be covered by a Cat warranty.

Caterpillar does not require the use of ULSD in off road and machine applications that are not Tier 4/ Stage IIIB certified engines. ULSD is not required in engines that are not equipped with after treatment devices. Always follow operating instructions. Fuel tank inlet labels are installed to ensure that the correct fuels are used.

Refer to Operation and Maintenance Manual, SEBU6251, "Cat Commercial Diesel Engines Fluids Recommendations" for more details about fuels, lubricants, and Tier 4 requirements. This manual may be found on the web at Safety.Cat.com.

## Aftermarket Fuel Additives

**Note:** For the best results, fuel which is treated with fuel additives should be treated by the fuel supplier.

Cat Diesel Fuel Conditioner is the only fuel conditioner/additive available that is tested and approved by Caterpillar for use in Caterpillar Diesel Engines. Cat Diesel Fuel Conditioner is a proprietary metal and ash free formulation. The conditioner has been extensively tested for use with distillate diesel fuels for use in Cat diesel engines. Cat Diesel Fuel Conditioner helps address challenges that various fuels present regarding fuel life/stability, engine startability, injector deposits, fuel system life, and long-term engine performance.

## Lubricating Grease

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### NOTICE

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

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Cat provides various greases that vary in performance from a moderate performance to high performance. Cat greases service the entire line of Cat products in the wide variety of climates throughout the world. From this variety of Cat grease products, you can find a Cat grease that will meet or exceed the performance requirements of most engines.

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

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

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

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

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

**Note:** All Cat greases are chemically compatible with each other. Mixing of Cat greases does not result in an adverse chemical reaction. However, mixing of Cat greases may result in reduced performance.

Non-Cat commercial greases are as a group second choice greases. Within this grouping of second choice greases, there are tiered levels of performance. For more information, refer to Operation and Maintenance Manual, SEBU6251, "Cat Commercial Diesel Engines Fluids Recommendations".

## Coolant

### NOTICE

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

### NOTICE

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

### NOTICE

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

### NOTICE

Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without water temperature regulators.

The following two coolants are used in Cat Diesel Engines:

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

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

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

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

Table 23

| Service Life Before Flushing and Before Refilling                     |                             |
|---|-----------------------------|
| Coolant   | Service Life <sup>(1)</sup> |
| Cat ELC   | 12,000 hours, or 6 years    |
| Commercial coolant that meets the Cat EC-1 specification              | 6000 hours, or 6 years      |
| Cat DEAC  | 3000 hours, or 3 years      |
| Commercial Heavy-Duty Coolant that meets "ASTM D4985" or "ASTM D6210" | 3000 hours, or 1 year       |

<sup>(1)</sup> Use the interval that occurs first.

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

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

## S·O·S Services Coolant Analysis

Table 24

| Recommended Interval |  |   |
|----------------------|--|---|
| Type of Coolant      | Level 1  | Level 2   |
| DEAC                 | Every 250 Hours <sup>(1)</sup><br><sup>(2)</sup> | Every 2000 Hours<br>or Yearly <sup>(1)</sup> <sup>(3)</sup> |
| ELC                  | Optional <sup>(3)</sup>                          | Yearly <sup>(3)</sup>                                       |

(1) This interval is recommended for the sampling of all conventional heavy-duty coolant.

(2) This interval is also recommended for the sampling of a commercial coolant that meets the Cat (Engine Coolant specification - 1) requirement.

(3) The Level 2 coolant analysis should be performed sooner if a problem is suspected or identified.

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 performed at your Cat dealer. Cat S·O·S Coolant Analysis is the best way to monitor the condition of your coolant and your cooling system. S·O·S Coolant Analysis is a program that is based on periodic samples.

### 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.

For more information, refer to Operation and Maintenance Manual, SEBU6251, "Cat Commercial Diesel Engines Fluids Recommendations".

# Maintenance Recommendations

i08186078

## System Pressure Release

SMCS Code: 1250; 1300; 1350; 5050

### Coolant System

#### WARNING

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

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

### Fuel System

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

### High-Pressure Fuel Lines (If Equipped)

#### WARNING

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

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

The following are the differences:

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

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

1. Stop the engine.
2. Wait for 10 minutes.

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

### Engine Oil

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

i07660374

## Welding on Engines with Electronic Controls

SMCS Code: 1000

#### NOTICE

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

Proper welding procedures are necessary to avoid damage to the engine 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 correct procedure must be followed. When welding on a unit that is equipped with a Cat Electronic Engine, the following is considered to be the safest procedure:

#### NOTICE

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

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

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

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

1. Stop the engine. Turn the switched power to the OFF position.
2. Disconnect the negative battery cable from the battery. If a battery disconnect switch is provided, open the switch.

3. Disconnect the J1/P1 and J2/P2 connectors from the ECM. Move the harness to a position that will not allow the harness to move back accidentally, and contact any of the ECM pins.
4. Disconnect any component with a microprocessor from the engine harness, such as:
  - Engine ECM
  - Product Link
  - Cell/Sat Radio
  - DOC Identity Modules
  - Control panel 70-pin bulkhead connector
  - Aftertreatment system ECM

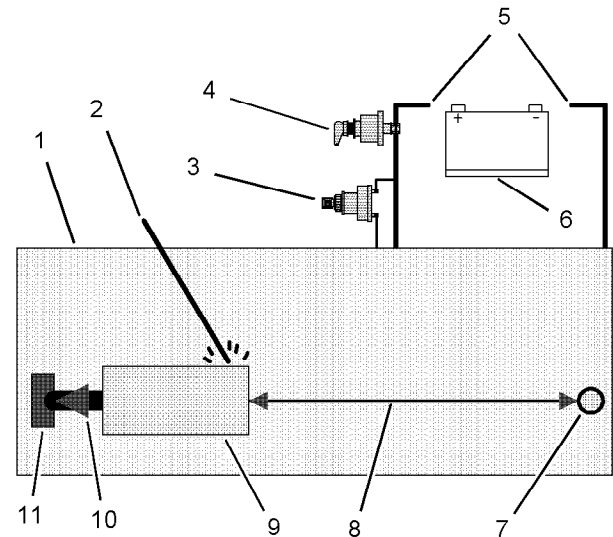


Illustration 64

g01075639

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

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

5. Connect the welding ground cable directly to the part that will be welded. Place the ground cable as close as possible to the weld. This location will 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, current flow from the welder could severely damage the component. Current flow from the welder could also severely damage electrical/electronic components that are located between the welder ground and the weld.

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

7. Use standard welding practices to weld the materials.

i08704510

## Maintenance Interval Schedule (Prime)

**SMCS Code:** 1000; 4450; 7500

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

### When Required

|  |     |
|--|-----|
| “ Battery - Replace”                     | 91  |
| “ Battery or Battery Cable - Disconnect” | 92  |
| “ DEF Filler Screen - Clean”             | 97  |
| “ Diesel Exhaust Fluid - Fill”           | 100 |
| “ Engine - Clean”                        | 103 |
| “ Engine Air Cleaner Element - Replace”  | 103 |
| “ Fuel System - Prime”                   | 112 |
| “ Generator - Dry”                       | 117 |
| “ Generator Set - Test”                  | 120 |
| “ Trailer - Inspect”                     | 125 |

### Daily

|   |     |
|---|-----|
| “ Battery Electrolyte Level - Check”                  | 91  |
| “ Coolant Level - Check”                              | 95  |
| “ Electrical Connections - Check”                     | 102 |
| “ Engine Air Cleaner Service Indicator - Inspect”     | 104 |
| “ Engine Oil Level - Check”                           | 108 |
| “ Fuel System Primary Filter/Water Separator - Drain” | 115 |
| “ Fuel Tank Water and Sediment - Drain”               | 117 |

|                           |     |
|---------------------------|-----|
| “ Generator - Inspect”    | 118 |
| “ Generator Load - Check” | 119 |
| “ Walk-Around Inspection” | 130 |

### Every Week

|                        |     |
|------------------------|-----|
| “ Generator - Inspect” | 118 |
|------------------------|-----|

### Every 250 Service Hours

|                                      |     |
|--------------------------------------|-----|
| “ Coolant Sample (Level 1) - Obtain” | 95  |
| “ Engine Oil Sample - Obtain”        | 109 |

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

|                                      |     |
|--------------------------------------|-----|
| “ Coolant Sample (Level 2) - Obtain” | 96  |
| “ Engine Valve Lash - Check”         | 111 |

### Every 500 Service Hours

|                                    |     |
|------------------------------------|-----|
| “ Fuel Filter (In-Line) - Replace” | 112 |
|------------------------------------|-----|

### Every 500 Service Hours or 1 Year

|   |     |
|---|-----|
| “ Belts - Inspect/Adjust/Replace”                                 | 92  |
| “ Coolant Sample (Level 2) - Obtain”                              | 96  |
| “ Engine Crankcase Breather Element - Replace”                    | 105 |
| “ Engine Oil and Filter - Change”                                 | 109 |
| “ Fuel System Primary Filter (Water Separator) Element - Replace” | 113 |
| “ Fuel System Secondary Filter - Replace”                         | 115 |
| “ Hoses and Clamps - Inspect/Replace”                             | 120 |

### Every 1000 Service Hours or 1 Year

|                               |     |
|-------------------------------|-----|
| “ Rotating Rectifier - Check” | 124 |
|-------------------------------|-----|

### Every 2000 Service Hours or 1 Year

|                              |     |
|------------------------------|-----|
| “ Alternator - Inspect”      | 91  |
| “ Engine Mounts - Inspect”   | 108 |
| “ Engine Valve Lash - Check” | 111 |
| “ Starting Motor - Inspect”  | 124 |

“ Turbocharger - Inspect“ ..... 129

### **Every 3000 Service Hours or 2 Years**

“ Water Pump - Inspect“ ..... 132

### **Every 3000 Service Hours or 3 Years**

“ Coolant Temperature Regulator - Replace“ ..... 97

### **Every 5000 Service Hours**

“ Diesel Exhaust Fluid Filter - Replace“ ..... 101

“ Injector (Diesel Exhaust Fluid) - Replace“ ..... 121

### **Every 6000 Service Hours or 3 Years**

“ Coolant Extender (ELC) - Add“ ..... 94

### **Every 10 000 Service Hours**

“ DEF Manifold Filters - Replace“ ..... 98

### **Every 12 000 Service Hours or 6 Years**

“ Coolant (ELC) - Change“ ..... 93

### **Overhaul**

“ Overhaul Considerations“ ..... 122

i08704511

## Maintenance Interval Schedule (Standby)

**SMCS Code:** 1000; 4450; 7500

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

### When Required

|  |     |
|--|-----|
| “ Battery - Replace”                     | 91  |
| “ Battery or Battery Cable - Disconnect” | 92  |
| “ DEF Filler Screen - Clean”             | 97  |
| “ Diesel Exhaust Fluid - Fill”           | 100 |
| “ Engine - Clean”                        | 103 |
| “ Engine Air Cleaner Element - Replace”  | 103 |
| “ Fuel System - Prime”                   | 112 |
| “ Generator - Dry”                       | 117 |
| “ Generator Set - Test”                  | 120 |
| “ Trailer - Inspect”                     | 125 |

### Every Week

|   |     |
|---|-----|
| “ Battery Electrolyte Level - Check”                  | 91  |
| “ Coolant Level - Check”                              | 95  |
| “ Electrical Connections - Check”                     | 102 |
| “ Engine Air Cleaner Service Indicator - Inspect”     | 104 |
| “ Engine Oil Level - Check”                           | 108 |
| “ Fuel System Primary Filter/Water Separator - Drain” | 115 |
| “ Fuel Tank Water and Sediment - Drain”               | 117 |

|                           |     |
|---------------------------|-----|
| “ Generator - Inspect”    | 118 |
| “ Generator Load - Check” | 119 |
| “ Walk-Around Inspection” | 130 |

### Every 6 Months

|                                      |     |
|--------------------------------------|-----|
| “ Coolant Sample (Level 1) - Obtain” | 95  |
| “ Engine Oil Sample - Obtain”        | 109 |

### Every Year

|   |     |
|---|-----|
| “ Alternator - Inspect”   | 91  |
| “ Belts - Inspect/Adjust/Replace”                                 | 92  |
| “ Coolant Sample (Level 2) - Obtain”                              | 96  |
| “ Engine Crankcase Breather Element - Replace”                    | 105 |
| “ Engine Mounts - Inspect”  | 108 |
| “ Engine Oil and Filter - Change”                                 | 109 |
| “ Engine Valve Lash - Check”                                      | 111 |
| “ Fuel Filter (In-Line) - Replace”                                | 112 |
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### Every 3 Years

|  |    |
|--|----|
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### Every 5000 Service Hours

|  |     |
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### **Every 10 000 Service Hours**

“ DEF Manifold Filters - Replace“ . . . . . 98

### **Overhaul**

“ Overhaul Considerations“ . . . . . 122

i08259468

## 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 to ensure proper battery performance and/or proper performance of the electrical system. Make repairs, as required.

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

i02322315

## 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. Switch the engine to the OFF position. Remove all electrical loads.
2. Turn off any battery chargers. Disconnect any battery chargers.

3. The NEGATIVE "-" cable connects the NEGATIVE "-" battery terminal to the NEGATIVE "-" terminal on the starting motor. Disconnect the cable from the NEGATIVE "-" battery terminal.
4. The POSITIVE "+" cable connects the POSITIVE "+" battery terminal to the POSITIVE "+" terminal on the starting motor. Disconnect the cable from the POSITIVE "+" battery terminal.

**Note:** Always recycle a battery. Never discard a battery. Dispose of 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 engine start switch is OFF.

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

i02724529

## Battery Electrolyte Level - Check

**SMCS Code:** 1401-535-FLV

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

Maintenance Section  
Battery or Battery Cable - Disconnect

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

- Use a solution of 0.1 kg (0.2 lb) baking soda and 1 L (1 qt) of clean water.
- Use a solution of ammonium hydroxide.

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.

i07819485

## Battery or Battery Cable - Disconnect

SMCS Code: 1401; 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. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, two negative connection must be disconnected.
3. Remove the positive connection.
4. Clean all disconnected connection and battery terminals.
5. 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 correctly. Coat the clamps and the terminals with a suitable silicone lubricant or petroleum jelly.

6. Tape the cable connections to help prevent accidental starting.
7. Proceed with necessary system repairs.
8. To connect the battery, connect the positive connection before the negative connection.

i07671948

## Belts - Inspect/Adjust/Replace

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

### NOTICE

Ensure that the engine is stopped before any servicing or repair is performed.

To maximize the engine performance, inspect the belt (1) for wear and for cracking. Replace the belt if the belt is worn or damaged.

- If the belt (1) has more than four cracks per 25.4000 mm (1 inch), the belt must be replaced.
- Check the belt for the following items: cracks, splits, glazing, grease, splitting, and broken ribs
- Remove any deposits that are on the belt.

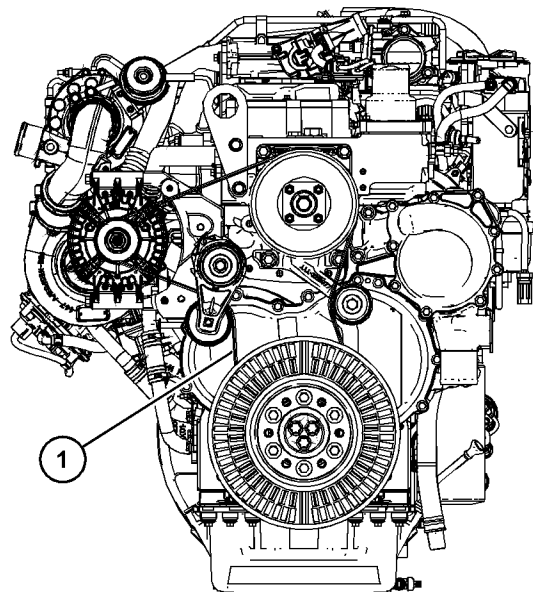


Illustration 65

Typical example

g06390231

i04239711

## 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.

### Drain

#### **WARNING**

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

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.
2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove the cooling system drain plugs.

Allow the coolant to drain.

#### NOTICE

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

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

InsideUSA 1-800-542-TOOL  
Inside Illinois 1-800-541-TOOL  
Canada 1-800-523-TOOL  
International 1-309-578-7372

### Flush

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

#### NOTICE

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

3. Fill the cooling system with clean water. Install the cooling system filler cap.
4. Start and run the engine at low idle until the temperature reaches 49 to 66 °C (120 to 150 °F).
5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, "Torque Specifications" for more information on the proper torques.

### Fill

#### NOTICE

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

1. Fill the cooling system with Extended Life Coolant (ELC). Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for more information on cooling system specifications. Refer to this Operation and Maintenance Manual, "Refill Capacities" for information about the capacity of the cooling system. 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 1 minute in order to purge the air from the cavities of the engine block. Stop the engine.

Maintenance Section  
Coolant Extender (ELC) - Add

---

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. Only install the used filler cap if the gasket is not damaged. Use a 9S-8140 Pressurizing Pump to pressure test a reinstalled 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.

i08397632

## Coolant Extender (ELC) - Add

**SMCS Code:** 1352-544-NL

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

---

### NOTICE

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

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

---

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

### WARNING

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

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

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

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

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

---

### NOTICE

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

Refer to Special Publication, NENG2500, "Cat Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Cat Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

---

1. Loosen the cooling system filler cap slowly in order to relieve pressure. Remove the cooling system filler cap.
2. If necessary, drain enough coolant from the cooling system in order to add the Cat ELC Extender.
3. Add Cat ELC Extender according to the requirements for the cooling system capacity. Refer to this Operation and Maintenance Manual, "Refill Capacities" or to this Operation and Maintenance Manual, "Fluid Recommendations" for more information.
4. Clean the cooling system filler cap. Inspect the gaskets on the cooling system filler cap. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.

i07668757

## Coolant Level - Check

SMCS Code: 1395-082

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

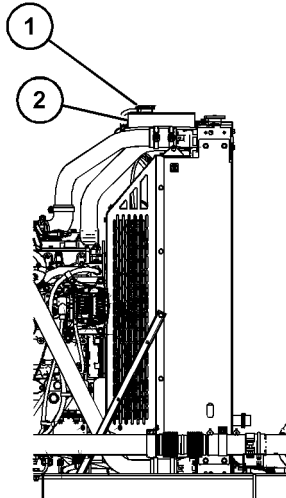


Illustration 66

g06389026

- (1) Cooling system filler cap  
(2) Sight glass

### 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 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.

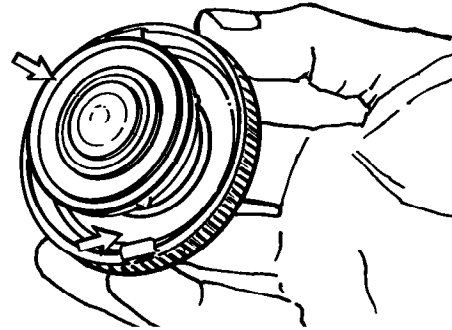


Illustration 67

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.

i07682822

## Coolant Sample (Level 1) - Obtain

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

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

**Note: Obtaining a Coolant Sample (Level 1) is optional if the cooling system is filled with one of the following coolants: Cat ELC (Extended Life Coolant), Cat ELI (Extended Life Inhibitor) and Conventional Heavy-Duty Coolant.**

**Note: Obtain a Coolant Sample (Level 1) if the cooling system is filled with any of the following coolants: Cat DEAC, Cat SCA and Conventional Heavy-Duty Coolants.**

For additional information about coolant analysis and about other coolants, see this Operation and Maintenance Manual, "Fluid Recommendations" or consult your Cat dealer.

## Sampling Conditions

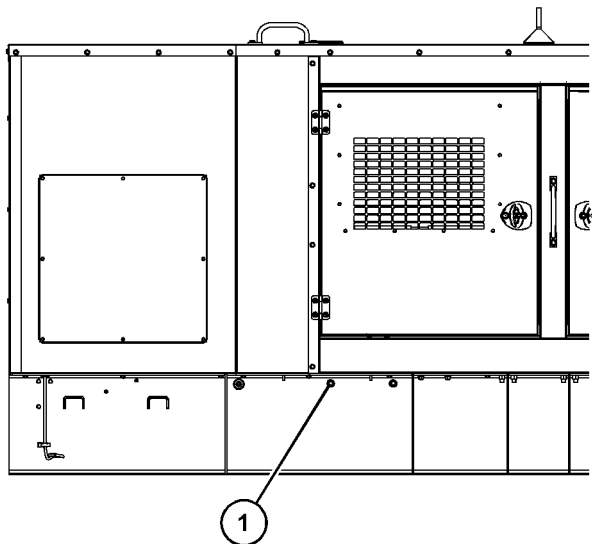


Illustration 68

g06394464

(1) Remote coolant drain plug

The engine should be running at operating temperature when the sample is obtained.

Collect sample via the remote coolant drain plug (1). The valve for the remote coolant drain plug is located inside the enclosure, above the drain plug.

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.
- 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 to avoid contamination.

- Never collect samples from expansion bottles.

## Timing of the Sampling

Table 25

| Recommended Interval                                    |                         |                       |
|---|-------------------------|-----------------------|
| Type of Coolant   | Level 1                 | Level 2               |
| Cat DEAC<br>Cat SCA<br>Conventional Heavy-Duty Coolants | Every 250 hours         | Yearly <sup>(1)</sup> |
| Cat ELC<br>Cat ELI<br>Commercial EC-1 Coolants          | Optional <sup>(1)</sup> | Yearly <sup>(1)</sup> |

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

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

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

### NOTICE

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

Submit the sample for Level 1 analysis.

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

i08422574

## Coolant Sample (Level 2) - Obtain

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

An S·O·S Coolant Analysis (Level 2) is a comprehensive chemical evaluation of the coolant. This analysis is also a check of the overall condition of the cooling system. The S·O·S Coolant Analysis (Level 2) has the following features:

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

The results are reported and appropriate recommendations are made.

## Obtaining the Sample

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

Submit the sample for Level 2 analysis.

For further information, refer to this Operation and Maintenance Manual, "Fluid Recommendations".

i08272084

## Coolant Temperature Regulator - Replace

**SMCS Code:** 1355-510

Replace the water temperature regulator before the water temperature regulator fails. 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 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.

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.

---

### NOTICE

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

Cat engines incorporate a shunt bypass 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.

---

### NOTICE

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

Refer to Special Publication, NENG2500, "Cat Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Cat Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

---

**Note:** If replacing only the water temperature regulator, only drain the coolant to a level that is below the water temperature regulator housing.

Refer to two articles in the Disassembly and Assembly Manual, "Water Temperature Regulator - Remove and Water Temperature Regulator - Install" for the replacement procedure or consult your Cat dealer.

i05920856

## DEF Filler Screen - Clean

**SMCS Code:** 108K-070-Z3

---

### NOTICE

Ensure that the engine is stopped before any servicing or repair is performed.

---

Maintenance Section  
DEF Manifold Filters - Replace

**NOTICE**

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

Refer to Special Publication, NENG2500, "Cat Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Cat Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

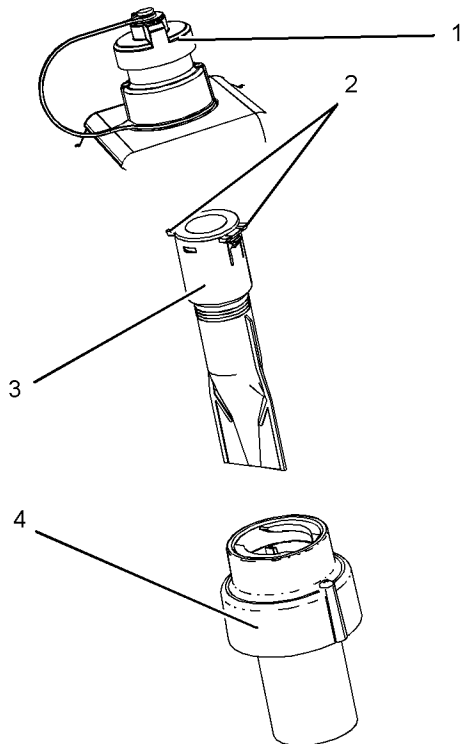


Illustration 69

g03725939

Typical example

1. Ensure that the area around cap on the Diesel Exhaust Fluid (DEF) tank is clean. Remove cap (1).
2. Using a suitable tool, press the tabs (2) in order to release the tabs. With the tabs released remove the filter screen (3) from DEF tank neck adapter (4).

3. The filter screen can be cleaned in clean water and dried using compressed air. Refer to this Operation and Maintenance Manual, "General Hazard Information" for information on using compressed air.
4. If the filter screen cannot be cleaned or the filter screen is damaged, then the filter screen must be replaced.
5. Install filter screen (3) into DEF tank neck adapter (4). Press filter screen into neck adapter and ensure that tabs (2) are located correctly. Install cap (1).

i06895786

## DEF Manifold Filters - Replace

SMCS Code: 108K-510-FI

**NOTICE**

Ensure that the engine is stopped before any servicing or repair is performed.

**NOTICE**

Care must be taken to ensure that Diesel Exhaust Fluid (DEF) for the system 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.

Dispose of all fluids according to local regulations and mandates.

Ensure that the area around the DEF manifold is free from contamination before any servicing or repair is performed.

### Type 1 Manifold

To remove the DEF manifold and the hoses connections from the DEF tank, refer to Disassembly and Assembly, Manifold (DEF Heater) - Remove and Install.

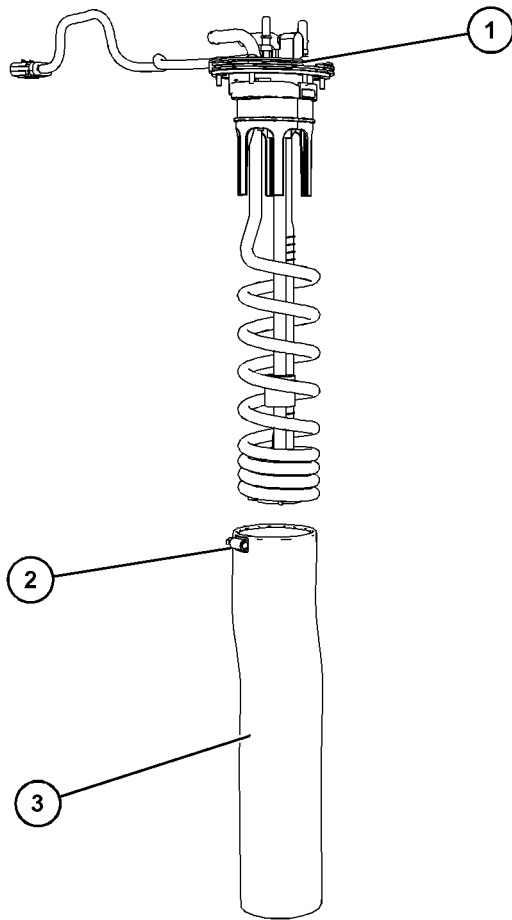


Illustration 70

g06159418

1. Note the location of the clamp (2) before removal.
2. Loosen clamp (2) and remove outer filter (3) from DEF manifold (1). Discard the old outer filter (3).

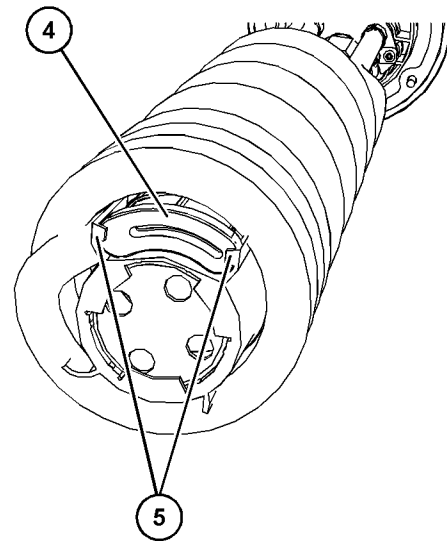


Illustration 71

g06159419

3. Pull locking tabs (5) outwards and remove the DEF filter (4) from DEF pickup tube (not shown). Discard used DEF filter (4).
4. With locking tabs (5) held open, install new DEF filter (4) onto DEF pickup tube. Ensure that the tabs (5) are holding the DEF filter (4) correctly.

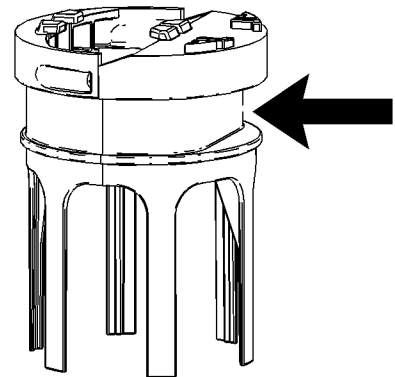


Illustration 72

g03665754

5. Install new outer filter (3) on to the DEF manifold (1). Ensure that the location of the clamp (2) is correctly placed. Refer to illustration 72 for clamp location. Tighten the clamp to a torque of 4.5 N·m (40 lb in).

6. Install the DEF tank header, refer to Disassembly and Assembly, Manifold (DEF Heater) - Remove and Install.

## Type 2 Manifold

To remove the DEF manifold and the hoses connections from the DEF tank, refer to Disassembly and Assembly, Manifold (DEF Heater) - Remove and Install.

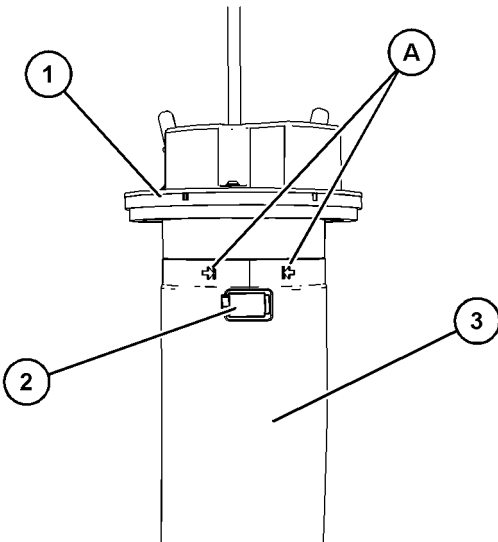


Illustration 73

g06159487

1. Note the location of clamp (2). The clamp (2) must be between the marked location (A).
2. Loosen clamp (2) and remove outer filter (3) from DEF tank header (1).

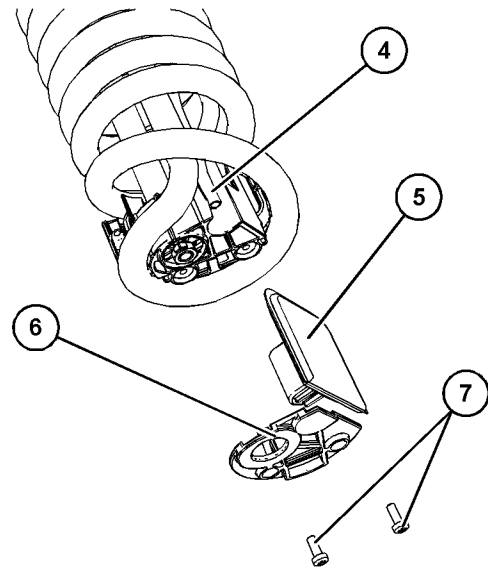


Illustration 74

g06159580

3. Remove screws (7) and remove retaining plate (6).
4. Remove DEF filter (5) from pickup tube (4) and discard the used filter (5).
5. Install new filter (5) onto pickup tube (4).
6. Install the retaining plate (6) and install screws (7). Tighten screws (7) securely.
7. Install outer filter (3) onto DEF tank header (1). Ensure that the clamp (2) is located between the location points (A).
8. Tighten clamp (2) to a torque of 4.5 N·m (40 lb in).
9. Install the DEF tank header, refer to Disassembly and Assembly, Manifold (DEF Heater) - Remove and Install.

i06730798

## Diesel Exhaust Fluid - Fill

**SMCS Code:** 108K-544

Refer to the original equipment manufacture information for the Diesel Exhaust Fluid (DEF) tank capacity.

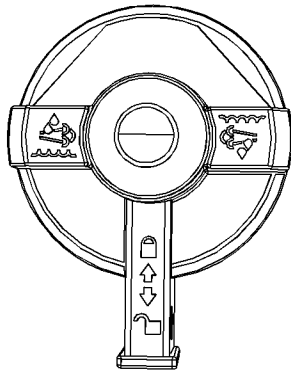


Illustration 75

g03379943

Lockable type DEF Filler cap

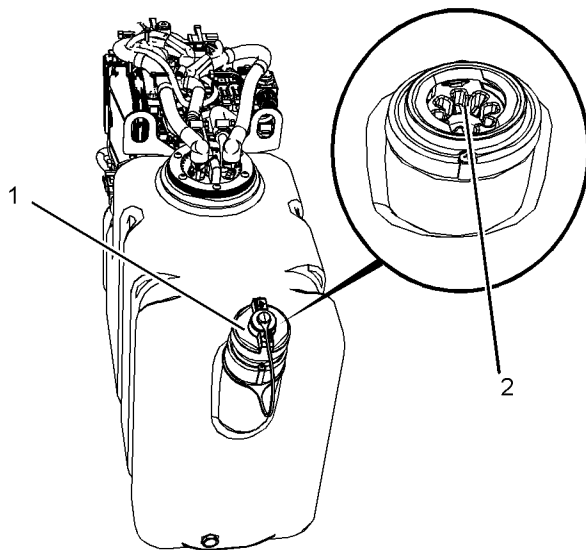


Illustration 76

g03417998

Typical example

Ensure that the correct specification Diesel Exhaust Fluid (DEF) is used. Ensure the cleanliness of the DEF, refer to this Operation and Maintenance Manual, "Fluid Recommendations" for more information.

Care should be taken when dispensing DEF. Spills should be cleaned immediately. All surfaces should be wiped clean and rinsed with water.

DEF that has been spilt will crystallize when the water within the liquid evaporates. Spilt DEF will attack paint and metal. If DEF is spilt, wash the area with water.

Caution should be used when dispensing DEF near an engine that has recently been running. Spilling DEF onto hot components may cause the release of ammonia vapors. Do not breathe ammonia vapors. Do not clean up any spills with bleach.

1. Ensure that the engine is stopped. Ensure that the DEF cap (1) and the surrounding area are clean and free from dirt.
2. Remove the DEF cap from the tank.
3. Fill the tank with the required amount of DEF. Ensure that dirt is not introduced into the tank during filling. Do not over fill the tank. The DEF may require room for expansion.

**Note:** Always fill the DEF tank on level ground. Cold weather can affect DEF, refer to this Operation and Maintenance Manual, "Diesel Exhaust Fluid in cold Weather" for more information.

4. The opening on the DEF tank (2) is a special diameter. Ensure that the correct nozzle is used when filling the DEF tank.

5. Check the cleanliness of DEF cap and install the DEF cap.

i07073188

## Diesel Exhaust Fluid Filter - Replace

SMCS Code: 108K-510-FI

### WARNING

Personal injury can result from improper handling of chemicals.

Make sure you use all the necessary protective equipment required to do the job.

Make sure that you read and understand all directions and hazards described on the labels and material safety data sheet of any chemical that is used.

Observe all safety precautions recommended by the chemical manufacturer for handling, storage, and disposal of chemicals.

The Diesel Exhaust Fluid (DEF) pump can be located next to the DEF tank. On some application the DEF pump can be installed away from the DEF tank.

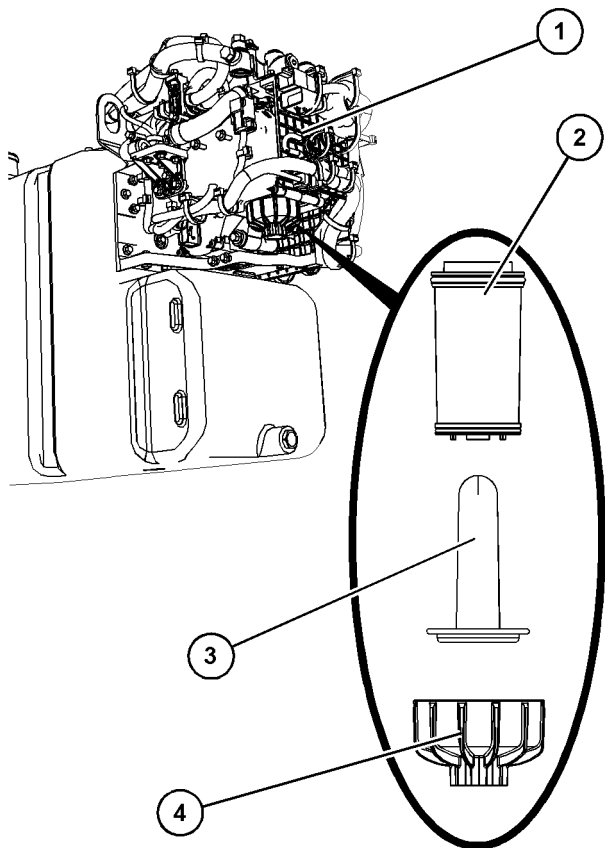


Illustration 77

g06215651

Typical example

1. Ensure that the area around the DEF filter is clean and free from dirt. Use a 27mm Bi-Hex socket to remove filter cap (4).
2. Remove the expansion device (3).

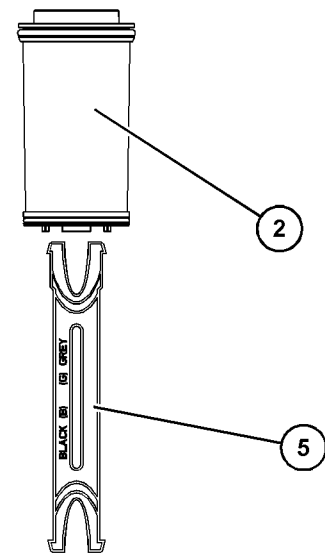


Illustration 78

g06215916

Typical example

3. Use supplied tool (5) to remove filter element (2) from DEF pump assembly (1).
4. Install new filter element (2) into DEF pump assembly (1).
5. Install expansion device (3) into filter element (2). Install filter cap (4) and tighten cap to 20 N·m (15 lb ft).

i07682906

## Electrical Connections - Check

SMCS Code: 4459-535

### DANGER

**DANGER: Shock/Electrocution Hazard-Do not operate this equipment or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings will result in serious injury or death.**

Checking the electrical connections is an important part of the maintenance for the generator set. Improper connections may cause the generator set to malfunction.

Check all exposed electrical connections for tightness.

Check the following devices for loose mounting or for physical damage:

- Transformers

- Fuses
- Capacitors
- Lightning arresters

Check the connections for the following components:

- Load cables
- Cables for the generator
- Potential transformers
- Current transformers

Check all lead wires and electrical connections for proper clearance. Inspect all cables for chafing, abrasion, and corrosion. Repair any damaged wires prior to use.

i07819515

## 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 to prevent electrical components from being damaged by excessive water when the engine is cleaned. Pressure washers and steam cleaners should not be directed at any electrical connectors or the junction of cables into the rear of the connectors. Avoid electrical components such as the alternator, the starter, and the ECM. Protect the fuel injection pump from fluids to wash the engine.

Ensure that care is taken that the safety labels, emission label, and all other information labels are not removed during engine cleaning.

## Aftertreatment

During the engine cleaning process, ensure that water or cleaning fluids cannot enter the aftertreatment system. If cleaning fluids enters the aftertreatment system, damage could occur.

i07682831

## Engine Air Cleaner Element - Replace

SMCS Code: 1051-510; 1054-510

#### NOTICE

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

#### NOTICE

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

## Servicing the Air Cleaner Elements

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

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

- Check the precleaner (if equipped) and the dust bowl daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.
- Operating in dirty conditions may require more frequent service of the air cleaner element.

Maintenance Section  
Engine Air Cleaner Service Indicator - Inspect

- The air cleaner element should be replaced at least one time per year.

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

## Air Cleaners

Some application can have dual elements. The dual air cleaner contains a primary air cleaner element and a secondary air cleaner element. Both element must be replaced at the same time.

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

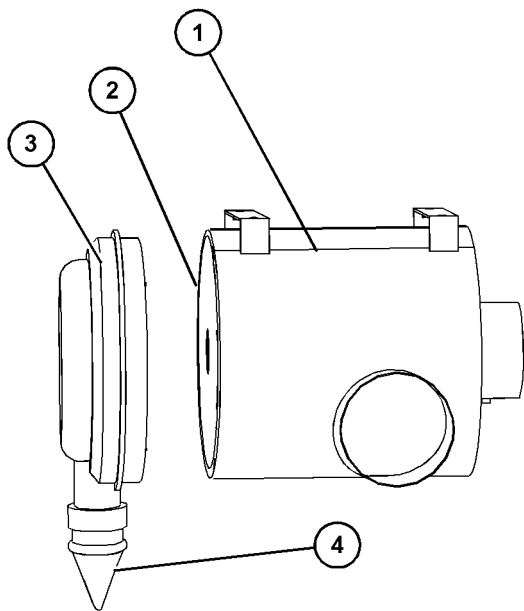


Illustration 79

g06394497

### Typical example

1. Ensure that the outer body of the air cleaner to be serviced is clean and free from dirt.
2. Remove end cover (3) from air cleaner body (1). If necessary, clean end cover and ensure that the valve (4) is clean and free from dirt. Check the valve (4) for wear or damage, replace if necessary.

3. Remove primary air filter element (2) and if equipped, remove the secondary air filter element (Not Shown). Discard all old air filter elements.
4. If equipped, install new secondary air filter element (Not Shown) and install new primary air filter element (2).
5. Install end cover (3) to air cleaner body (1) and secure end cover. If necessary, reset the air service indicator, refer to this Operation and Maintenance Manual, Engine Air Cleaner Service Indicator - Inspect for more information.

i02335405

## Engine Air Cleaner Service Indicator - Inspect

**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 element or in a remote location.

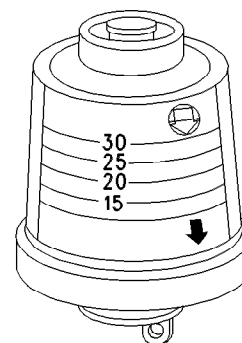


Illustration 80

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 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 restricted.

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

i07668738

## Engine Crankcase Breather Element - Replace

SMCS Code: 1317-510-FQ

### WARNING

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

### NOTICE

Ensure that the engine is stopped before any servicing or repair is performed.

### NOTICE

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

Refer to Special Publication, NENG2500, "Cat Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Cat Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

The crankcase breather is an important component to keep your engine emissions compliant.

- The filter element within the crankcase breather must be serviced at the prescribed service interval.

- The correct filter element must be installed before the engine is operated.
- The installation of the filter element is important.
- The quality of the filter element that is installed is important.

For information on aftermarket products, refer to Operation and Maintenance Manual, "Engine Description". Within that section, refer to the title "Aftermarket Products and Caterpillar Engines".

The breather element can be serviced from the top position or the breather element can be serviced from the bottom position.

## Top Service

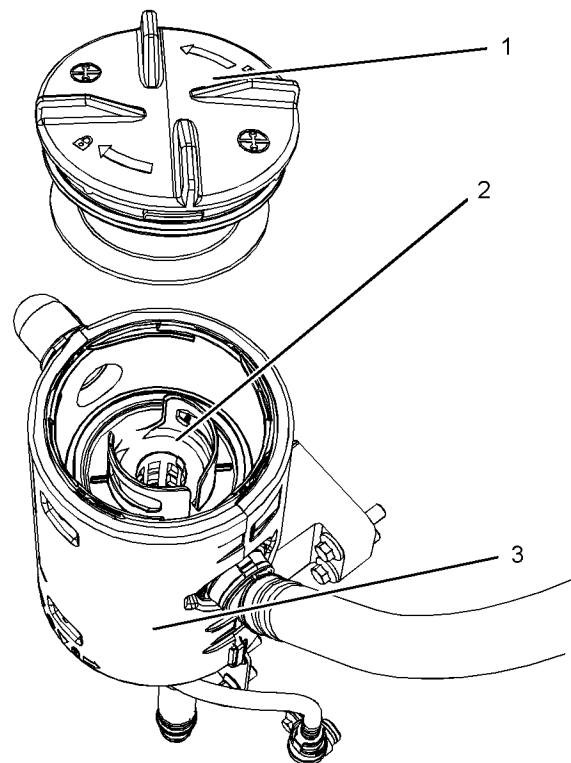


Illustration 81

g03090965

1. Ensure that dirt cannot enter the breather assembly. Ensure that the outside body of the breather assembly is clean and free from damage. Place a container under the breather assembly.
2. Rotate the top cap (1) counterclockwise into the unlocked position. Remove the top cap from the body of the breather (3) and remove the filter element (2).

Maintenance Section  
 Engine Crankcase Breather Element - Replace

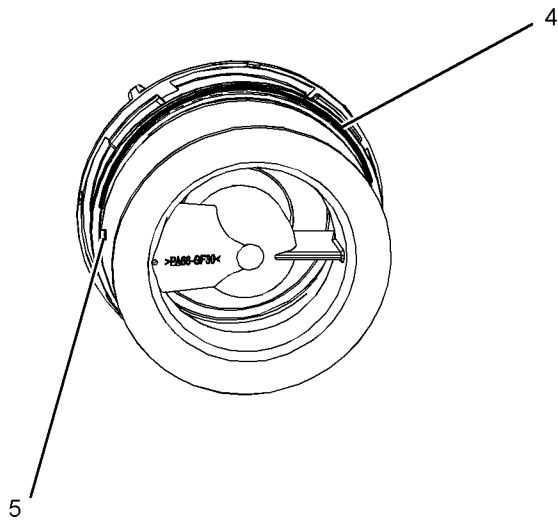


Illustration 82

g03090963

3. Remove the old seal (4) and install a new seal.

**Note:** The cut away from section (5) in the top cap allows access to the seal.

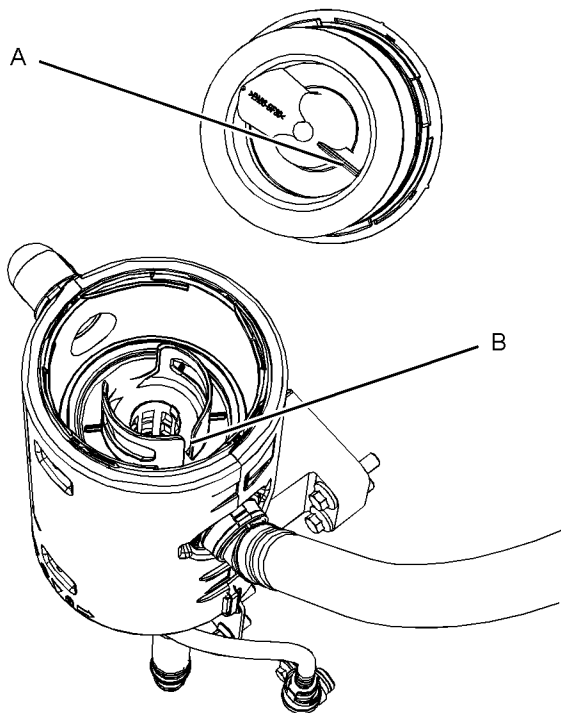


Illustration 83

g03090938

(A) Alignment position  
 (B) Alignment position

4. Install a new filter element into the breather body (3). Ensure the correct position of the element, refer to illustration 83. Align position (A) on the top cap to position (B) on the filter element.

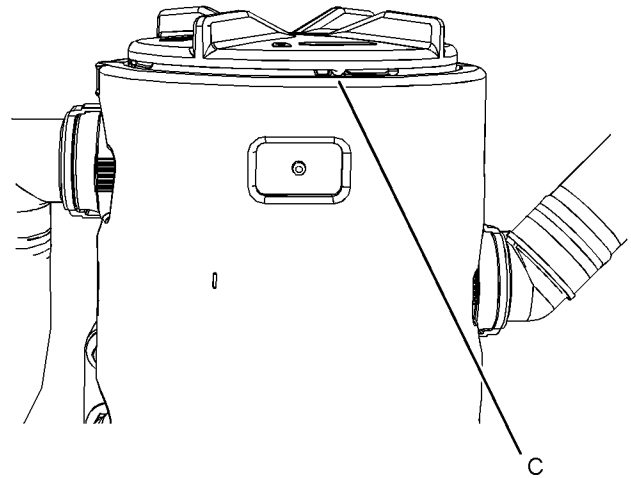


Illustration 84

g02346577

Typical example

5. Install the top cap (1). Rotate the top cap by hand clockwise until the top cap locks into the locked position (C) on the breather body.

6. Remove the container.

## Bottom Service

Ensure that dirt cannot enter the breather assembly.

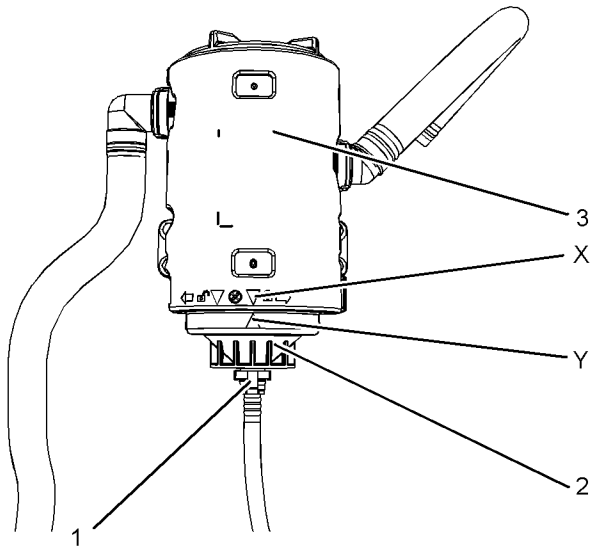


Illustration 85

g02346498

**Typical example**

(X) Alignment mark  
(Y) Alignment mark

1. Ensure that the outside body of the breather assembly is clean and free from damage. Place a container under the breather.
2. Remove the tube connection (1). Ensure that dirt cannot enter the tube connection. Note the position of the alignment marks (X and Y). Rotate the bottom cap (2) counterclockwise to release the cap and the filter element (4) from the breather body (3).

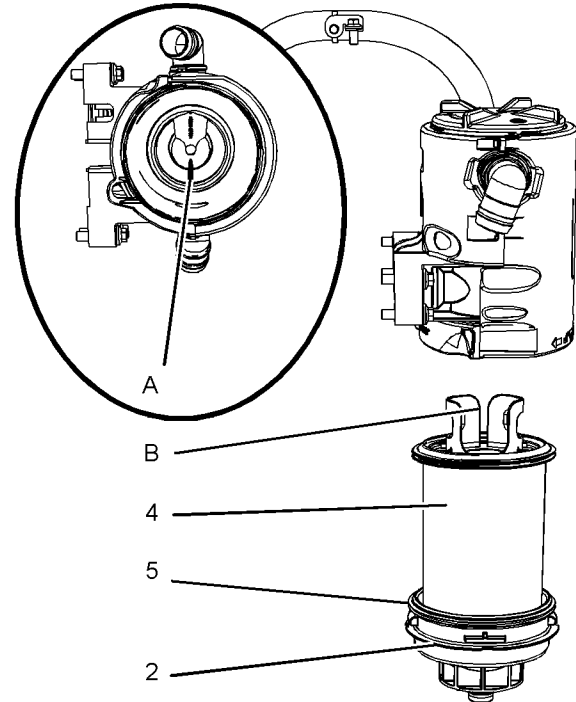


Illustration 86

g03090968

**Typical example**

(A) Alignment position  
(B) Alignment position

3. Remove the filter element (4). Remove the seal (5).

**Note:** The bottom cap has a section that allows access to remove the seal.

4. Install a new seal (5). Install a new filter element into the bottom cap (2).
5. Align position (A) on the top cap to position (B) on the filter element. Refer to illustration 86 .
6. Install the assembly of the filter element and the bottom cap (2). Rotate the bottom cap by hand clockwise until the bottom cap locks into the locked position on the breather body. Ensure that the alignment marks (X and Y) are correctly aligned. Refer to illustration 85 .

7. Install tube connection (1). Ensure that the retaining clips on the tube connection are correctly engaged. Remove the container.

i05909059

## Check the System

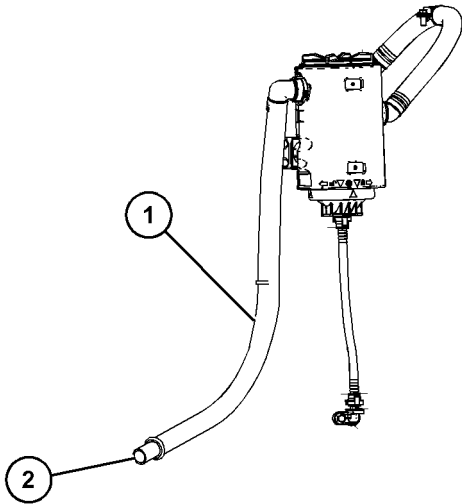


Illustration 87

g06387950

Typical example

Inspect the breather tube (1) for damage. Ensure that the outlet (2) is clean and free from any obstructions. Ice can cause obstructions in adverse weather conditions.

i02456872

## Engine Mounts - Inspect

**SMCS Code:** 1152; 1152-040

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

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

Any engine mount that shows deterioration should be replaced. Refer to Special Publication, SENR3130, "Torque Specifications" for the recommended torques. Refer to the OEM recommendations for more information.

## Engine Oil Level - Check

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

### **WARNING**

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

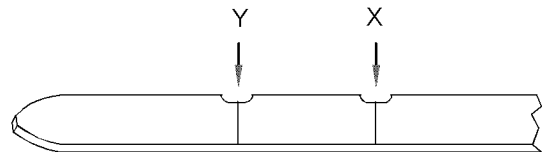


Illustration 88

g01165836

(Y) "Min" mark. (X) "Max" mark.



Illustration 89

g02173847

(L) "Min" mark. (H) "Max" mark.

### **NOTICE**

Perform this maintenance with the engine stopped.

**Note:** Ensure that the engine is either level or that the engine is in the normal operating position in order to obtain a true level indication.

**Note:** After the engine has been switched OFF, wait for 10 minutes in order to allow the engine oil to drain to the oil pan. Then, check the oil level.

1. Maintain the oil level between the “ADD” mark (Y) and the “FULL” mark (X) on the engine oil dipstick. Or maintain the engine oil level between the H and L mark. Do not over fill the crankcase.

---

#### NOTICE

Operating your engine when the oil level is above the “FULL” mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil's lubricating characteristics and could result in the loss of power.

---

2. Remove the oil filler cap and add oil, if necessary. Clean the oil filler cap. Install the oil filler cap.

i08397634

## Engine Oil Sample - Obtain

**SMCS Code:** 1348-554-SM

In addition to a good preventive maintenance program, Caterpillar recommends using S·O·S oil analysis at regularly scheduled intervals. S·O·S oil analysis provides infrared analysis, which is required for determining nitration and oxidation levels.

### Obtain the Sample and the Analysis

#### WARNING

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

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

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

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

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

Caterpillar recommends using the sampling valve 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.

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

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

i07693997

## Engine Oil and Filter - Change

**SMCS Code:** 1318-510

#### WARNING

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

---

#### NOTICE

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.

Dispose of all fluids according to local regulations and mandates.

---

Maintenance Section  
Engine Oil and Filter - Change

---

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

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

## Drain the Engine Lubricating Oil

**Note:** Ensure that the vessel that will be used is large enough to collect the waste 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 oil pan:

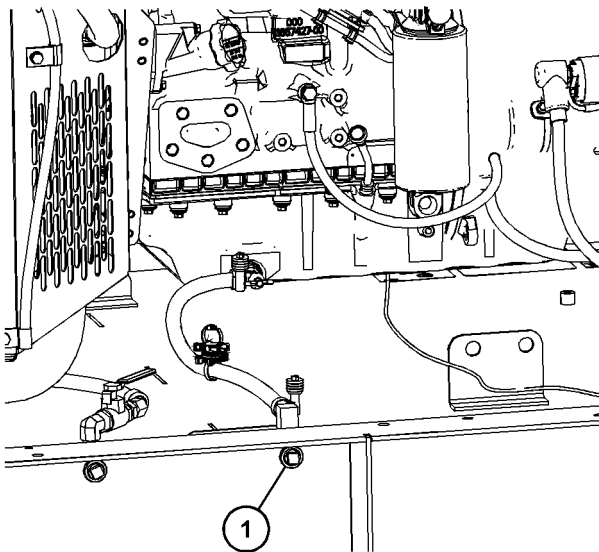


Illustration 90

g06390315

Typical example

- If the engine is equipped with a drain valve, turn the drain valve knob counterclockwise to drain the oil. After the oil has drained, turn the drain valve knob clockwise to close the drain valve.
- If the engine is not equipped with a drain valve, remove oil drain plug (1) to allow the oil to drain. If the engine is equipped with a shallow oil pan, remove the bottom oil drain plugs from both ends of the oil pan.

After the oil has drained, the oil drain plugs should be cleaned and installed. If necessary, replace the O ring seal. Tighten the drain plug to 34 N·m (25 lb ft).

## Replace the Oil Filter

---

**NOTICE**

Caterpillar oil filters are manufactured to Caterpillar specifications. Use of an oil filter that is not recommended by Caterpillar could result in severe damage to the engine bearings, crankshaft, and so forth, 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 1U-8760 Chain Wrench.

**Note:** Some oil filters may be installed horizontally.

**Note:** The following actions can be carried out as part of the preventive maintenance program.

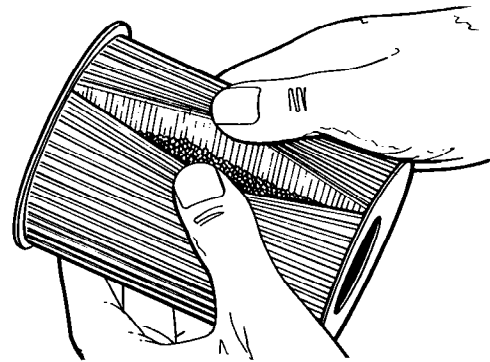


Illustration 91

g00588944

Element with debris

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

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

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

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

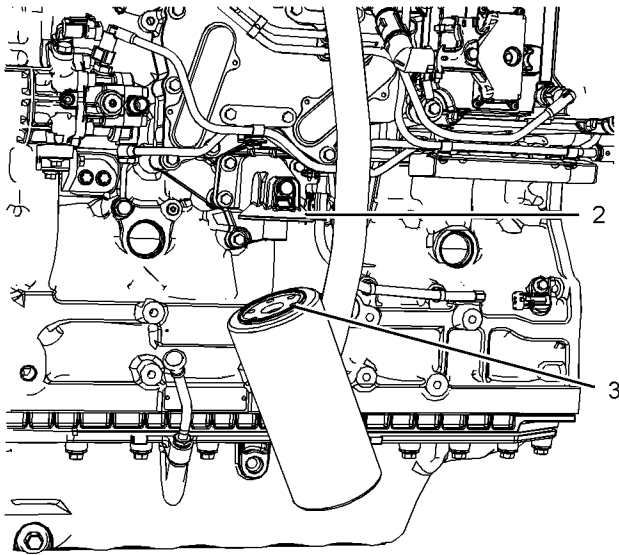


Illustration 92

g01333549

Typical example

3. Clean the sealing surface of the oil filter base (2).
4. Apply clean engine oil to the O ring seal (3) for the new oil filter.

#### NOTICE

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

5. Install the engine oil filter. Spin on the oil filter until the O ring seal contacts the oil filter base. Rotate the oil filter  $\frac{3}{4}$  of a full turn.

## Fill the Oil Pan

1. Remove the oil filler cap. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for more information on suitable oils. Fill the oil pan with the correct amount of new engine lubricating oil. Refer to this Operation and Maintenance Manual, "Refill Capacities" for more information on refill capacities.

#### NOTICE

If equipped with an auxiliary oil filter system or a remote filter system, follow the OEM or the filter manufacturer's recommendations. Underfilling or over filling the crankcase with oil can cause engine damage.

2. Start the engine and run the engine at "LOW IDLE" for 2 minutes. Perform this procedure to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.
3. Stop the engine and allow the oil to drain back to the oil pan for a minimum of 10 minutes.

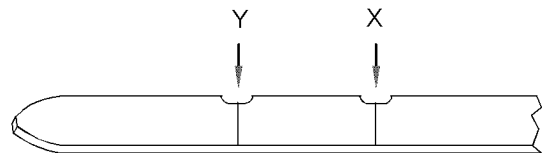


Illustration 93

g01165836

Typical example

4. Remove the engine oil level gauge to check the oil level. Maintain the oil level between the "MIN" and "MAX" marks on the engine oil level gauge.

i03964791

## Engine Valve Lash - Check

SMCS Code: 1105-535

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

### WARNING

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

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

i04945626

## Fuel Filter (In-Line) - Replace

SMCS Code: 1261; 1261-510

### 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.

**Note:** Refer to Systems Operation, Testing, and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

#### NOTICE

Ensure that the engine is stopped before any servicing or repair is performed.

The location of the in-line fuel filter will depend on the application that the engine has been installed.

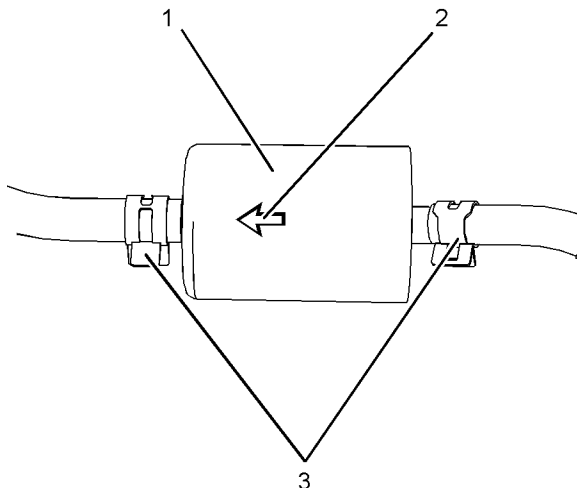


Illustration 94

g03130884

Typical example

1. Turn the fuel supply valve (if equipped) to the OFF position. Remove any brackets that hold the in-line fuel filter (1) in place, refer to OEM information.
2. Release the hose clips (3) and remove the hose lines from the in-line fuel filter. Remove the in-line filter.
3. Install a new in-line filter and secure, refer to OEM information. Ensure that the arrow mark (2) is aligned to the direction of fuel flow from the tank to the fuel pump.
4. Install the fuel hose lines and install the hose clips (3). Turn the fuel supply valve (if equipped) to the ON position.
5. The in-line fuel filter must be changed with the primary filter and the secondary fuel filter.

i05774864

## Fuel System - Prime

SMCS Code: 1250-548; 1258-548

**Note:** Refer to Systems Operation, Testing, and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Ensure that all adjustments and repairs are performed by authorized personnel that have had the correct training.

#### 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.

If air enters the fuel system, the air must be purged from the fuel system before the engine can be started. Air can enter the fuel system when the following events occur:

- The fuel tank is empty or the fuel tank has been partially drained.
- The low-pressure fuel lines are disconnected.
- A leak exists in the low-pressure fuel system.
- The fuel filter has been replaced.

Use the following procedures in order to remove air from the fuel system:

1. Ensure that the fuel system is in working order. Check that the fuel supply valve (if equipped) is in the “ON” position.
2. Turn the keyswitch to the “RUN” position.
3. The keyswitch will allow the electric priming pump to operate. Operate the electric priming pump. The ECM will stop the pump after 2 minutes.
4. Turn the keyswitch to the “OFF” position. The fuel system should now be primed and the engine should be able to start.

- Operate the engine starter and crank the engine. After the engine has started, operate the engine at low idle for a minimum of 5 minutes. Ensure that the fuel system is free from leaks.

**Note:** Operating the engine for this period will help ensure that the fuel system is free of air. **DO NOT loosen the high-pressure fuel lines in order to purge air from the fuel system. This procedure is not required.**

After the engine has stopped, you must wait for 10 minutes in order to allow the fuel pressure to be purged from the high-pressure fuel lines before any service or repair is performed on the engine fuel lines. The 10 minute wait will also allow static charge to dissipate from the low-pressure fuel system. If necessary, perform minor adjustments. Repair any leaks from the low-pressure fuel system and from the cooling, lubrication, or air systems. Replace any high-pressure fuel line that has leaked. Refer to Disassembly and Assembly Manual, "Fuel Injection Lines - Install".

If you inspect the engine in operation, always use the proper inspection procedure in order to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, "General hazard Information".

If the engine will not start, refer to Troubleshooting, "Engine Cranks but will not Start".

i04921313

## Fuel System Primary Filter (Water Separator) Element - Replace

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

### 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.**

**Note:** Refer to Systems Operation, Testing, and Adjusting, "Cleanliness of Fuel System Components" for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

### NOTICE

Ensure that the engine is stopped before any servicing or repair is performed.

## Remove the Element

- Turn the fuel supply valve (if equipped) to the OFF position before performing this maintenance.
- Place a suitable container under the water separator in order to catch any fuel that might spill. Clean up any spilled fuel. Clean the outside body of the filter assembly.

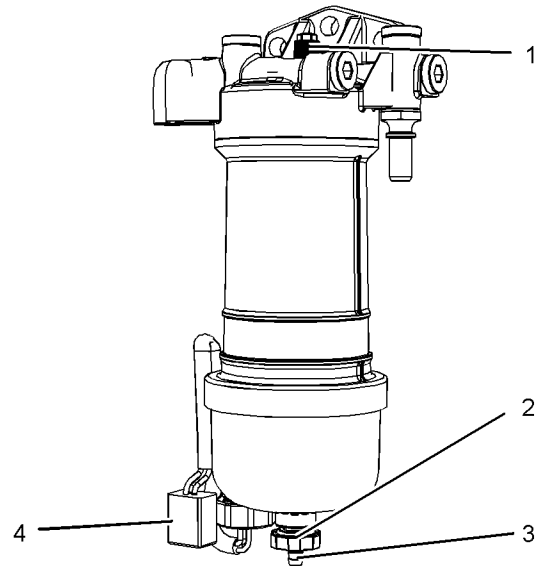


Illustration 95

g03086757

Typical example

- Install a suitable tube onto drain (3). Open the drain valve (2). Rotate the drain valve counterclockwise. Two full turns are required.
- Loosen the vent screw (1).
- Allow the fuel to drain into the container. Remove the tube from the drain valve.
- Tighten the vent screw (1) securely. Remove the wiring harness from connection (4).
- Rotate filter bowl (6) counterclockwise and remove the filter bowl from assembly. Refer to your caterpillar dealer for the correct tool.

Maintenance Section  
 Fuel System Primary Filter (Water Separator) Element - Replace

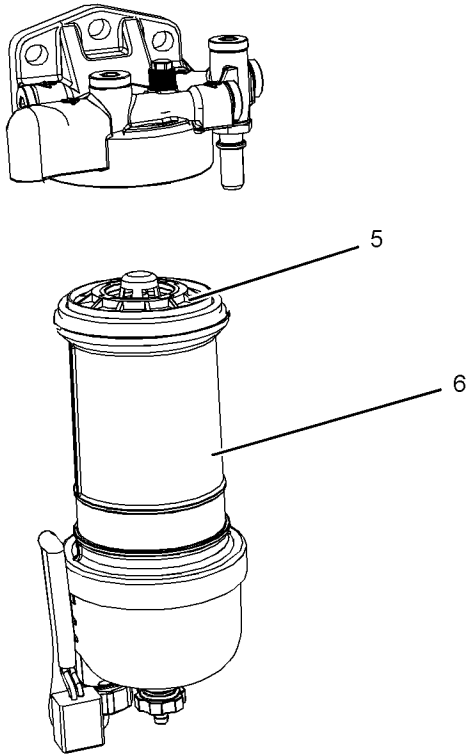


Illustration 96

g02148402

Typical example

8. Rotate the filter element (5) counterclockwise and remove the filter element . Clean the filter bowl.

### Install the New Filter Element

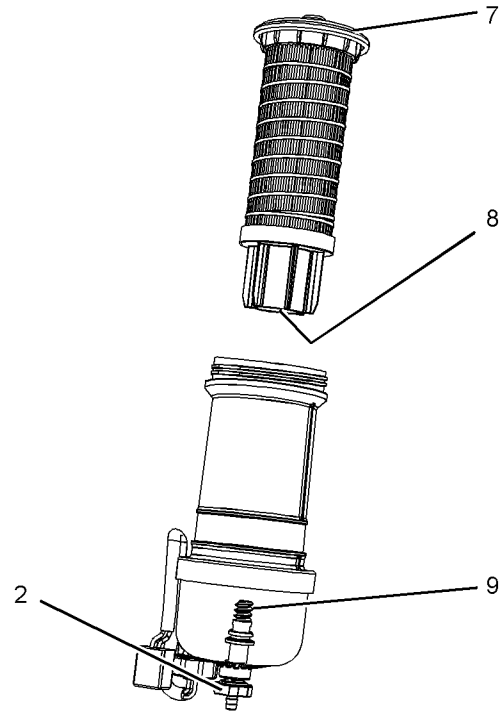


Illustration 97

g03086798

Typical example

1. Locate the thread in the new filter element (8) onto the threads (9). Spin on the filter element and tighten the drain valve (2) securely.
2. Lubricate the O ring seal (7) with clean engine oil. Do NOT fill the bowl with fuel before the assembly is installed.
3. Do not use a tool in order to install the filter assembly. Tighten the filter bowl (6) by hand. Install the filter bowl (6). Turn the filter bowl clockwise until the filter bowl locks into position against the stops.
4. Remove the container and dispose of the fuel in a safe place.

- The secondary filter element must be replaced at the same time as the primary filter element. Also, the in-line filter must be changed. Refer to the Operation and Maintenance Manual, "Fuel System Filter - Replace".

i06891342

## 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

Ensure that the engine is stopped before any servicing or repair is performed.

### NOTICE

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

## Drain Procedure

- Place a suitable container under the water separator to catch any fluid that might spill. Clean up any spilled fluid.
- Ensure that the outer body of the filter assembly is clean and free from dirt.

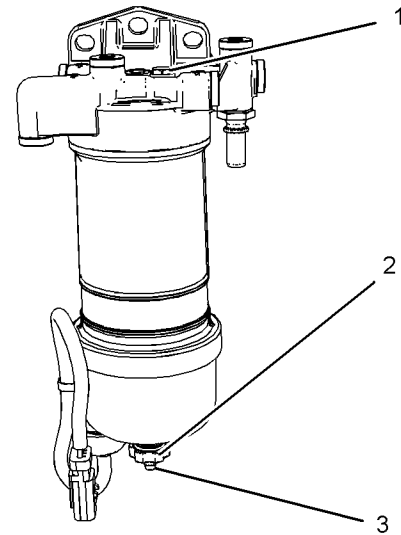


Illustration 98

g03858194

Typical example

- Install a suitable tube onto drain (3). Open the drain valve (2). Rotate the drain valve counterclockwise. Two full turns are required. Loosen vent screw (1).
- Visually check that the fluid will drain. Allow the fluid to drain into the container.
- When fluid free from water comes from the primary fuel filter, tighten the drain valve clockwise by hand pressure only. Remove the tube and remove the container.
- Tighten the vent screw to a torque of 2.5 N·m (22 lb in).

i04921888

## 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

Ensure that the engine is stopped before any servicing or repair is performed.

Refer to **Systems Operation, Testing, and Adjusting, "Cleanliness of Fuel System Components"** for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

## Remove the Element

1. Turn the fuel supply valve (if equipped) to the OFF position before performing this maintenance.
2. Place a suitable container under the fuel filter in order to catch any fuel that might spill. Clean up any spilled fuel. Clean the outside body of the filter assembly.

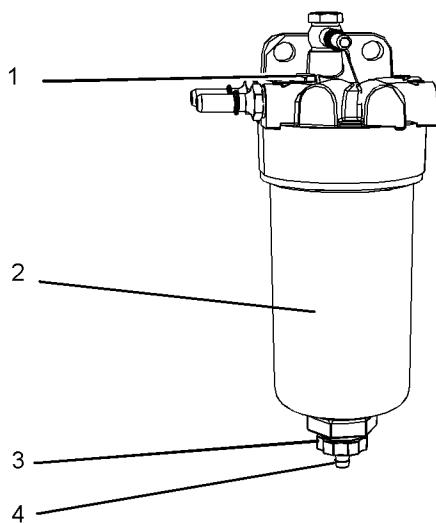


Illustration 99

g03088718

3. Install a suitable tube onto drain (4). Open the drain valve (3). Rotate the drain valve counterclockwise. Two full turns are required. Loosen vent screw (1).
4. Allow the fuel to drain into the container and remove the tube.
5. Tighten the vent screw (1) securely.
6. Remove the filter bowl (2). Rotate the filter assembly counterclockwise in order to remove the assembly. Refer to your caterpillar dealer for the correct tool number.

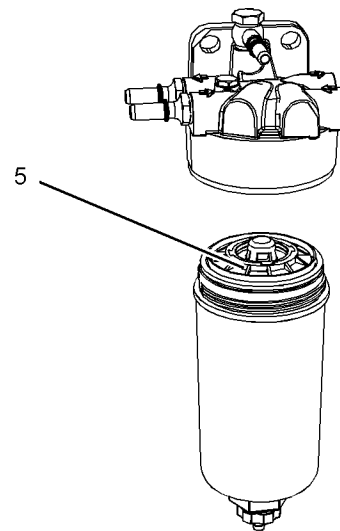


Illustration 100

g02546456

7. Rotate the filter element (5) counterclockwise and remove the filter element. Clean the filter bowl.

## Install the Element

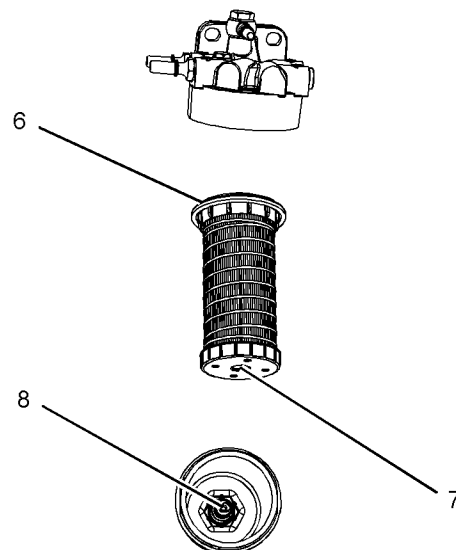


Illustration 101

g03088837

1. Locate the thread (7) in the filter element onto the threads (8). Spin on the element and tighten the drain valve (3) by hand.
2. Lubricate the O ring seal (6) with clean engine oil. Do NOT fill the filter bowl (2) with fuel before the filter assembly is installed.

3. Do not use a tool in order to install the filter assembly. Tighten the assembly by hand. Install the filter bowl (2). Turn the filter bowl clockwise until the filter bowl locks into position against the stops.
4. Turn the fuel supply valve to the ON position.
5. The primary fuel filter the secondary fuel filter must be replaced at the same time. Refer to the Operation and Maintenance Manual , “Fuel System Primary Filter (Water Separator) Element - Replace”. Also, the in-line fuel must be replaced when the primary and secondary filters are replaced. Refer to Operation and Maintenance Manual , “Fuel Filter (In-Line)- Replace”
6. Prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime” for more information.

i02348492

## 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.

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.

Water can be introduced into the fuel tank when the fuel tank is being filled.

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. Allow five minutes after the fuel tank has been filled before draining water and sediment from the fuel tank.

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 at the following intervals:

- Weekly
- Service intervals
- 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.

i08287069

## Generator - Dry

**SMCS Code:** 4450-569

### NOTICE

Do not operate the generator if the windings are wet. If the generator is operated when the windings are wet, damage can occur due to insulation breakdown.

When moisture is present or when moisture is suspected in a generator, the generator must be dried before being energized.

If the drying procedure does not restore the insulation resistance to an acceptable value, the winding should be reconditioned.

**Note:** For additional information, refer to Special Instruction, SEHS9124 .

## Drying Methods

The following methods can be used for drying a generator:

- Self-circulating air method
- Oven method

---

### NOTICE

Do not allow the winding temperature to exceed 85 °C (185.0 °F). Temperatures that are greater than 85 °C (185.0 °F) will damage the winding insulation.

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### Self-Circulating Air Method

**Note:** Disable the excitation before using this method.

Run the engine and disconnect the generator load. This action will help circulate air. Operate the generator space heaters.

### Oven Method

Place the entire generator inside a forced air drying oven for 4 hours at 65 °C (149 °F).

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### NOTICE

Use a forced air type oven rather than a radiant type oven.

Radiant type ovens can cause localized overheating.

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i08336866

## Generator - Inspect

**SMCS Code:** 4450-040

### WARNING

**Personal injury or death can result from improper troubleshooting and repair procedures.**

**The following troubleshooting and repair procedures should only be performed by qualified personnel familiar with this equipment.**

---

### WARNING

**The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.**

**Place the engine control switch in the “OFF” position. Attach “DO NOT OPERATE” tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.**

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Refer to Safety Section, “Generator Isolating for Maintenance” for information regarding the procedure to isolate the generator safely.

Proper maintenance of electrical equipment requires periodic visual examination of the generator and periodic visual examination of the windings. Proper maintenance of electrical equipment also requires appropriate electrical checks and appropriate thermal checks. Insulation material should be examined for cracks. The insulation material should be examined for accumulations of dirt and dust. If there is an insulation resistance value that is below normal, a conductive path may be present. This conductive path may be made of one of the following materials:

- Carbon
- Salt
- Metal dust
- Dirt that is saturated with moisture

These contaminants will develop a conductive path which may produce shorts. Cleaning is advisable if heavy accumulations of dirt can be seen or if heavy accumulations of dust can be seen. If excess dirt is the cause of a restriction in the ventilation, cleaning is also advisable. Restricted ventilation will cause excessive heating.

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### NOTICE

To avoid the possibility of deterioration to the generator windings, do not clean the generator unless there is visual, electrical, or thermal evidence that dirt is present.

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If harmful dirt accumulations are present, various cleaning techniques are available. The cleaning procedure that is used may be determined by one of the items on the following list:

- The extent of the cleaning procedure that is being attempted
- The type of enclosure of the generator
- The voltage rating of the generator
- The type of dirt that is being removed

## Cleaning (Assembled Generators)

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### NOTICE

Do not use water to clean the generator.

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### NOTICE

Do not use trichloroethane, perchloroethylene, trichloroethane, or any alkaline products to clean the generator.

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Cleaning may be required at the point of installation. Complete disassembly of the generator may not be necessary or feasible. In this case, a vacuum cleaner should be used to pick up the following items: dry dirt, dust, and carbon. Cleaning the generator will prevent the spreading of these contaminants.

A small nonconductive tube may need to be connected to the vacuum cleaner. The small nonconductive tube will allow the vacuum cleaner to clean the surfaces that are not exposed. After dust is removed, use a small brush attached to the vacuum hose to remove dirt that is firmly attached to the surface.

After the initial cleaning with a vacuum, compressed air may be used to remove the remaining dust and dirt. Compressed air that is used for cleaning should be free of moisture and free of oil. Air pressure should be a maximum of 210 kPa (30 psi) to prevent mechanical damage to the insulation. If the above cleaning procedures are not effective, consult a Caterpillar dealer.

## Cleaning (Disassembled Generators)

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### NOTICE

Do not use water to clean the generator.

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### NOTICE

Do not use trichloroethane, perchloroethylene, trichloroethane, or any alkaline products to clean the generator.

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An initial insulation resistance check should be made on the generator to confirm electrical integrity. A minimum reading of 1 megohm would be expected with severely contaminated generators. A zero megohm reading may indicate an insulation breakdown. An insulation breakdown requires more than cleaning. An insulation breakdown requires repair.

Use the following for cleaning the stator, the rotor, the exciter, and the diode bridge:

- Toluene
- Benzene
- Cyclohexane

Avoid permitting the solvent to run into the slots. Apply the solvent with a brush. Use a sponge on the windings frequently to remove the debris. Dry the winding with a dry cloth. Allow the solvent to evaporate before reassembling the generator.

Allow the generator to dry at room temperature. Check the insulation resistance. The insulation resistance should now be normal. If the insulation resistance is not normal, repeat the procedure.

**Note:** For more information on drying methods, refer to Special Instructions, SEHS9124, "Cleaning and Drying of Electric Set Generators".

**Note:** For installation and maintenance of M17XXL4, M22XXL4, and M27XXL4 frames (if equipped) refer to Special Instruction, UENR8811, "Caterpillar M17XXL4, M22XXL4, M27XXL4 Low Voltage Alternator 4 Pole".

i08286680

## Generator Load - Check

SMCS Code: 4450-535-LA

### WARNING

**Personal injury or death can result from high voltage.**

**When power generation equipment must be in operation to make tests and/or adjustments, high voltage and current are present.**

**Improper test equipment can fail and present a high voltage shock hazard to its user.**

**Make sure the testing equipment is designed for and correctly operated for high voltage and current tests being made.**

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During normal operation, monitor the power factor and monitor generator loading.

When a three-phase generator is installed, ensure that the total current in any one phase does not exceed the nameplate rating. Or, when a three-phase generator is reconnected, ensure that the total current in any one phase does not exceed the nameplate rating. Each phase should carry the same load. Carrying the same load allows the three-phase generator to work at the rated capacity. If one-phase current exceeds the nameplate amperage, an electrical imbalance will occur. An electrical imbalance can result in an electrical overload and an electrical imbalance can result in overheating on three-phase generators. This imbalance is not applicable to single-phase generators.

The power factor can be referred to as the efficiency of the load. This power factor can be expressed as the ratio of kVA to actual kW. The power factor can be calculated by dividing kW by kVA. Power factor is expressed as a decimal. Power factor is used to mean the portion of current that is supplied to a system that is doing useful work. The portion of the current that is not doing useful work is absorbed in maintaining the magnetic field in motors. This current (reactive load) can be maintained without engine power.

i05731121

## Generator Set - Test

SMCS Code: 4450-081

### WARNING

**Personal injury or death can result from high voltage.**

**When power generation equipment must be in operation to make tests and/or adjustments, high voltage and current are present.**

**Improper test equipment can fail and present a high voltage shock hazard to its user.**

**Make sure the testing equipment is designed for and correctly operated for high voltage and current tests being made.**

**When servicing or repairing electric power generation equipment:**

- **Make sure the unit is off-line (disconnected from utility and/or other generators power service), and either locked out or tagged DO NOT OPERATE.**
- **Make sure the generator engine is stopped.**
- **Make sure all batteries are disconnected.**
- **Make sure all capacitors are discharged.**

Table 26

| Required Tools |                       |     |
|----------------|-----------------------|-----|
| Part Number    | Part Description      | Qty |
| 6V - 7070      | Digital Multimeter    | 1   |
| -              | 12 VDC Battery        | 1   |
| -              | Potential Transformer | 1   |

The generator set functional test is a simplified test that can be performed in order to determine if the generator is functional. The generator set functional test should be performed on a generator set that is under load.

The generator set functional test determines if the following statements happen:

- A phase voltage is being generated.
- The phase voltages are balanced.
- The phase voltages change relative to engine speed.

The generator set functional test consists of the following steps:

1. Stop the generator. Connect the potential transformer high voltage winding to the generator terminals (T1) and (T2). Connect the voltmeter to the low voltage winding. If two transformers are available, connect the high voltage winding of the second transformer to the generator terminals (T1) and (T3). Connect the secondary terminals that correspond to generator terminal (T2) of both transformers together.
2. Disconnect wires "E+" and "E-" from the voltage regulator. Disconnect the generator from the load.
3. Connect a 12 VDC automotive battery to wires "E+" and "E-".
4. Measure the AC voltage across the low voltage terminals of the transformer that correspond to the following generator terminals: "T1" and "T2", "T2" and "T3" and "T3" and "T1". Record the voltages.

i02349879

## Hoses and Clamps - Inspect/Replace

SMCS Code: 7554-510; 7554-040

### WARNING

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

If you inspect the engine in operation, always use the proper inspection procedure in order to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, "General hazard Information".

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.

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 harden. Hardening of the hoses will cause 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

Refer to the OEM information for further information on removing and replacing fuel hoses (if equipped).

The coolant system and the hoses for the coolant system are not usually supplied by Perkins. The following text describes a typical method of replacing coolant hoses. Refer to the OEM information for further information on the coolant system and the hoses for the coolant system.

### **WARNING**

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

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:** For the correct coolant, see this Operation and Maintenance Manual, "Fluid Recommendations".

8. Refill the cooling system. Refer to the OEM information for further information on refilling the cooling system.
9. Clean the cooling system filler cap. Inspect the cooling system filler cap's seals. Replace the cooling system filler cap if the seals are damaged. Install the cooling system filler cap.
10. Start the engine. Inspect the cooling system for leaks.

i06893302

## Injector (Diesel Exhaust Fluid) - Replace

SMCS Code: 108I-510

- DEF \_\_\_\_\_ Diesel Exhaust Fluid

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

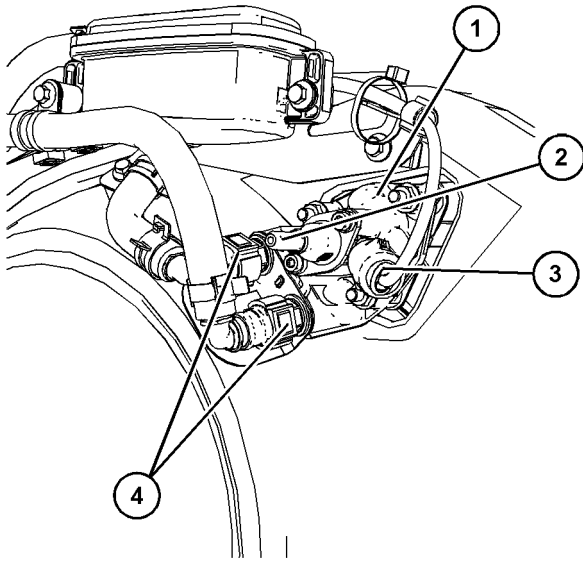


Illustration 102

g06158030

**Typical example**

- (1) DEF injector
- (2) DEF connector
- (3) Electrical connector
- (4) Coolant connector

For a detailed procedure to remove and install the DEF injector (1), refer to Disassembly and Assembly, DEF Injector and Mounting - Remove and Install.

After installation of the DEF injector, use the electronic service tool to perform the "DEF Dosing System Verification test".

i02299454

**Overhaul Considerations****SMCS Code:** 7595-043

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

The need for an overhaul is generally indicated by increased fuel consumption and by reduced power.

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

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

**Oil Consumption as an Overhaul Indicator**

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

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

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

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

**Overhaul Options****Before Failure Overhaul**

A planned overhaul before failure may be the best value for the following reasons:

- Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the standards for reusable parts.
- The engine's service life can be extended without the risk of a major catastrophe due to engine failure.
- The best cost/value relationship per hour of extended life can be attained.

**After Failure Overhaul**

Many options are available if a major engine failure occurs. An overhaul should be performed if the engine block or the crankshaft can be repaired.

If the engine block is repairable and/or the crankshaft is repairable, the overhaul cost should be less than the cost of a new engine with a similar exchange core.

This lower cost can be attributed to these aspects:

- Caterpillar dealer exchange components

- Caterpillar Inc. remanufactured exchange components

## Overhaul Recommendation

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

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

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

## Rebuild or Exchange

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

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

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

- Salvaging
- Repairing
- Replacing

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

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

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

## Inspection and/or Replacement

The following components may not last until the second overhaul.

- Piston rings
- Thrust bearings
- Main bearings
- Connecting rod bearings
- Crankshaft seals
- Engine mounts
- Hoses

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

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

Inspect the crankshaft for any of the following conditions:

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

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

- Rod bearing
- Main bearings

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

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

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

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

- Camshaft bearings
- Valve lifters

## Testing

Test the following components during the overhaul.

- Fuel injection nozzles
- Fuel injection pump

Maintenance Section  
Rotating Rectifier - Check

Testing the fuel system during the overhaul will ensure that your engine operates at peak efficiency. Your Caterpillar dealer can provide these services and components in order to ensure that your fuel system is operating within the appropriate specifications.

## Cleaning

Caterpillar Inc. recommends the use of Hydrosolv Liquid Cleaners. Table 27 lists the Hydrosolv Liquid Cleaners that are available from your Caterpillar dealer.

Table 27

| HydrosolvLiquid Cleaners |               |                      |
|--------------------------|---------------|----------------------|
| Part Number              | Description   | Size                 |
| 1U-8812                  | Hydrosolv4165 | 4 L (1 US gallon)    |
| 1U-5490                  |               | 19 L (5 US gallon)   |
| 8T-7570                  |               | 208 L (55 US gallon) |
| 1U-8804                  | Hydrosolv100  | 4 L (1 US gallon)    |
| 1U-5492                  |               | 19 L (5 US gallon)   |
| 8T-5571                  |               | 208 L (55 US gallon) |

## Obtain Coolant Analysis

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

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

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

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

## S·O·S Coolant Analysis (Level II)

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

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

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

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

i08361465

## Rotating Rectifier - Check

SMCS Code: 4465-535

### WARNING

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the "OFF" position. Attach "DO NOT OPERATE" tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

Check the exciter armature. Ensure that the rotating rectifier is tight. If a failure of a rectifier is suspected, refer to Maintenance Procedure, "Rotating Rectifier - Test".

i02348493

## Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

Caterpillar recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for correct operation. Check the electrical connections and clean the electrical connections. Refer to the Systems Operation, Testing and Adjusting Manual, "Electric Starting System - Test" for more information on the checking procedure and for specifications or consult your Caterpillar dealer for assistance.

i08417428

## Trailer - Inspect

**SMCS Code:** 6331-040

### Maintenance For Tires

Explosive separation of a tire and/or rim parts can cause serious injury or death. Always follow the recommendations of the manufacturer or refer to the tire supplier.

Always maintain the correct tire pressure. Inflate the tires according to the instructions of the tire manufacturer. Do not inflate the tires above the pressure that is recommended by the tire manufacturer.

Inspect the tires and wheels prior to moving the trailer package. Do not tow the package if the following conditions exist:

- The tire pressure is too high.
- The tire pressure is too low.
- A tire has cuts or bubbles.
- A tire has excessive wear.
- The rims are damaged.
- Lug bolts or nuts are missing.

Maintain the proper torque on the lug nuts of the wheels.

Tire pressure rising during towing is a normal condition and tire pressure should not be reduced. High speeds during transporting may produce excessive tire pressures due to heat. Never purge the air from the tires. The tires can be cooled by **REDUCING THE TOWING SPEED** of the package or by stopping the package.

Adjust the tire pressure from a distance. Use a long hose with a self-attaching chuck. Always stand behind the tread when you adjust the tire pressure.

Do not inflate the tires with flammable gases or from systems that utilize an alcohol injector.

## Maintenance For The Running Gear

Refer to "Dexter Operation Maintenance Service Manual: LIT-123-00" for detailed information about the running gear, the brakes, the wheels, the suspension, the hubs, and the bearings.

Inspect the wheel bearings. Check the lubrication level of the wheel bearings. Fill the wheel bearings only with Multipurpose Lithium Complex Grease (MPGL). Do not overfill the wheel bearings.

Inspect the running gear for damage and wear.

### Electric Drum Brakes

#### Break-In Period for Electric Drum Brakes

Brakes should be manually adjusted after the first 200 miles of operation, and each 3,000 miles thereafter.

The break-in period is a typical phenomenon with drum brakes, and especially electric drum brakes. The required break-in period applies to new axles, and anytime new brake shoes, and/or magnets are installed as part of regular maintenance. Extensive brake testing has shown that the break-in period for our drum brakes can range from 20 to 50 brake applications.

Brakes can be seated in by applying approximately 8-10 volts to the trailer brakes at an initial speed of 40 mph and allowing the truck/trailer combination to slow down to 20-25 mph. For best results, do not use truck brakes during this procedure. The trailer brakes will seat in faster by using them to stop both the truck and trailer. The easiest method is to apply the trailer brakes using the manual activation lever, located on the in-cab brake controller. Care must be taken not to overheat the lining material, therefore brake applications conducted at one mile intervals will suffice. The driver should feel a noticeable difference in the brake performance during this period, sometimes in as few as 10 applications. After 50 applications, the brake lining material will be fully cured from the heat and develop close to 100% contact with the braked drum surface.

This break-in period not only seats the shoe lining material, but also seats in the brake electromagnets. During the break-in period, the linings will wear at a faster rate than they do after they are seated in.

Properly functioning brake shoes and drums are essential to ensure safety. Brake components must be inspected by dealer at least once per year, or each 12,000 miles. Brake adjustment is not covered under the axle warranty. The brake shoes must be adjusted after the first 200 miles of use, and each 3,000 miles thereafter. Most axles are fitted with a brake mechanism that will automatically adjust the brake shoes when the trailer is "hard braked" from a rearward direction. Trailer disc brakes are self-adjusting and do not need to be periodically adjusted. Using pads or shoes without enough brake lining material can result in brake damage, create excessive heat and potentially cause the loss of braking capacity. Read axle and brake manual to see how to adjust brakes or contact your dealer for assistance.

Some braking systems are not automatically adjusted. These brakes require manual adjustment. The following steps apply to adjust most manually adjustable brakes.

Read axle and brake manual to see how to adjust brakes or contact your dealer for assistance on brake adjustment.

1. Jack up the trailer and secure on adequate capacity jack stands.
2. Be sure the wheel and brake drum rotate freely.
3. Remove the adjusting-hole cover from the adjusting slot on the bottom of the brake backing plate.
4. With a screwdriver or standard adjusting tool, rotate the starwheel of the adjuster assembly to expand the brake shoes. Adjust out the brake shoes until the pressure of the linings against the drum makes the wheel difficult to turn.

**Note:** Your trailer maybe equipped with drop spindle axles. See axle manual for your axle type. You will need a modified adjusting tool for adjusting the brakes in these axles.

5. Rotate the starwheel in the opposite direction until the wheel turns freely with slight drag.
6. Replace the adjusting-hole cover.
7. Repeat the above procedure on all brakes.
8. Lower the trailer to the ground.

## Troubleshooting

This section is a guideline for ensuring operation of your braking system. The safety of you, those traveling with you, and those sharing the road is paramount, and it starts with the ability to safely stop the tow vehicle and the towed vehicle.

Most brake malfunctions can be corrected by utilizing the information found in table 28 . Mechanical failure is the most common form of malfunction, however, if the brake system fails and it's not mechanical, it is usually electrical. A voltmeter and ammeter are essential tools to diagnose these problems. Mechanical problems are mostly self-evident; something is bent or broken. Consult the troubleshooting chart to determine the probable cause and corrective actions for a variety of issues with the braking system.

Table 28

| <b>Troubleshooting the Braking System</b> |   |  |
|---|---|--|
| <b>Problem</b>                            | <b>Probable Cause</b>                   | <b>Corrective Action</b>               |
| No brakes                                 | Open circuits                           | Find and correct                       |
|   | Short circuits                          | Test and correct                       |
|   | Severe under-adjustment                 | Adjust brakes                          |
| Weak brakes                               | Grease or oil on magnets or linings     | Clean or replace                       |
|   | Corroded connections                    | Clean and correct cause of corrosion   |
|   | Worn linings or magnets                 | Replace                                |
|   | Scored or grooved braked drums          | Machine or replace                     |
|   | Improper synchronization                | Correct                                |
|   | Under-adjustment                        | Adjust brakes                          |
|   | Glazed linings                          | Re-burnish or replace                  |
| Locking brakes                            | Under-adjustment                        | Adjust                                 |
|   | Improper synchronization                | Correct                                |
|   | Loose, bent, or broken brake components | Test and correct                       |
|   | Out-of-round brake drums                | Machine or replace                     |
|   | Insufficient wheel load                 | Adjust system resistor and synchronize |
| Intermittent brakes                       | Broken wires                            | Test and correct                       |
|   | Loose connections                       | Repair or replace                      |
|   | Faulty ground                           | Find and repair                        |
| Brakes pull to one side                   | Wrong magnet lead wire color            | Adjust                                 |
|   | Incorrect adjustment                    | Correct                                |
|   | Grease or oil on linings or magnets     | Clean or replace                       |
|   | Broken wires                            | Find and repair                        |
|   | Bad connections                         | Find and repair                        |
| Harsh brakes                              | Under-adjustment                        | Adjust                                 |
|   | Improper synchronization                | Correct                                |
| Noisy brakes                              | Under-adjustment                        | Adjust                                 |
|   | Lack of lubrication                     | Lubricate                              |
|   | Broken component                        | Replace component                      |
|   | Incorrect brake components              | Correct                                |
| Surging brakes                            | Grease or oil on linings or magnets     | Clean or replace                       |
|   | Out-of-round or cracked brake drums     | Machine or replace                     |
| Dragging brakes                           | Over-adjustment                         | Readjust                               |
|   | Out-of-round brake drums                | Machine or replace                     |
|   | Incorrect brake components              | Replace                                |

(continued)

(Table 28, contd)

|  |  |                   |
|--|--|-------------------|
|  | Loose, bent or broken brake components | Replace           |
|  | Faulty breakaway switch                | Repair or replace |
|  | Loose wheel bearing adjustment         | Adjust            |
|  | Bent spindle                           | Replace axle      |

**Note:** If all trailer lights and brakes do not work, check your wiring plug connection and make sure the ball is making solid contact with the coupler (that is how a trailer is grounded). Too much grease or not using dielectric grease on the ball and coupler can cause this to happen.

### Measuring Voltage



Illustration 103 g06641601

#### Measuring voltage with probes

The braking system voltage is measured at the two lead wires of the magnet on any brake. Use the pin probes inserted through the insulation of the lead wires. To ensure that the battery is indicating a full charge, the towing vehicle engine should be running with the trailer coupler connected when checking the voltage.

Voltage in the system should begin at 0 volts, and as the brake pedal of the tow vehicle is applied, voltage will gradually increase to about 12 volts. If the system does not indicate at least 12 volts, problems may occur in the wiring of the system, the battery, or alternator of the tow vehicle. When the brakes are applied, a gradual increase in voltage ensures smooth and firm trailer braking. A quick increase in voltage will cause the braking system to feel like the trailer is grabbing too quickly. Taking a voltage reading is usually done with probes inserted into the wire connector .

### Measuring Amperage



Illustration 104 g06641606

#### Measuring amperage with probes

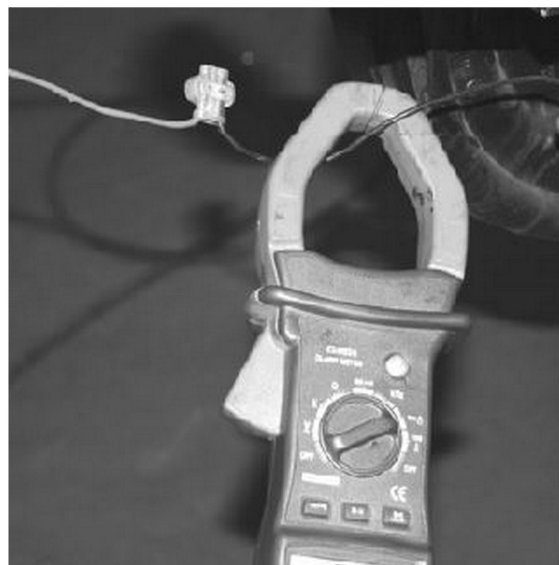


Illustration 105 g06641607

#### Measuring amperage with an amp clamp

The braking system amperage is the amount of current flowing through the system when all magnets have been energized. The amperage will change proportionately with the voltage. To ensure that the battery is indicating a full charge, the towing vehicle engine should be running with the trailer coupler connected when checking the voltage.

If a resistor is used in the brake system, it must be set at zero or bypassed completely to obtain the maximum amperage reading. Individual amperage draw can be measured by inserting the ammeter in the line at the magnet you want to check. Disconnect one of the magnet lead wire connectors and attach the ammeter between the two wires. Consult the amperage chart for normal amp readings. Make sure that the wires are properly reconnected and sealed after testing is completed. Testing for amperage can be done with probes (fig.104 ) or alligator clips on the leads or an amp clamp (fig. 105 ).

Table 29

| Amperage for Braking System |            |             |            |
|-----------------------------|------------|-------------|------------|
| Amps/<br>Magnet             | Two Brakes | Four Brakes | Six Brakes |
| 3.0                         | 6.0        | 12.0        | 18.0       |

Low or no voltage is the most common problem with the braking system. Amperage at the brakes is also a relatively common issue. Common causes of these conditions are:

- Low-quality electrical connections
- Open circuits
- Insufficient wire gauge
- Broken wires
- Blown fuses (fusing of brakes is not recommended)
- Short circuits (indicated by high amperage)

Possible causes of shorts are:

- Shorted magnet coils
- Bare wires contacting a grounded object

Finding the cause of a short circuit in the system is done by isolating one section at a time. If the high amperage reading drops to zero by unplugging the trailer, then the short is in the trailer. If the amperage reading remains high with all the brake magnets disconnected, the short is in the trailer wiring. All electrical troubleshooting procedures should start at the controller. Most complaints regarding brake harshness or malfunction are traceable to improperly adjusted or nonfunctional controllers. See your controller manufacturer's data for proper adjustment and testing procedures. For best results, all the connection points in the brake wiring should be sealed to prevent corrosion. Loose or corroded connectors will cause an increase in resistance, which reduces the voltage available for the brake magnets.

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## Turbocharger - Inspect

**SMCS Code:** 1052-040

A regular visual inspection of the turbocharger is recommended. 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 intake and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of oil into a turbocharger 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 renewed.

A visual inspection of the turbocharger can minimize unscheduled downtime. A visual inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

## Removal and Installation

For options regarding the removal, installation, and replacement, consult your Cat dealer. Refer to the Disassembly and Assembly, "Turbocharger - Remove and Turbocharger - Install" and Systems Operation, Testing and Adjusting, "Turbocharger - Inspect" for further information.

## Inspecting

### NOTICE

The compressor housing for the turbocharger must not be removed from the turbocharger for inspection or removed for the cleaning of the compressor.

1. Remove the pipe from the turbocharger exhaust outlet and remove the air intake pipe to the turbocharger. Visually inspect the piping for the presence of oil. Clean the interior of the pipes in order to prevent dirt from entering during reassembly.
2. Check for obvious heat discoloration of the turbocharger. Check for any loose bolts or any missing bolts. Check for damage to the oil supply line and the oil drain line. Check for cracks in the housing of the turbocharger. Ensure that the compressor wheel can rotate freely.
3. Check for the presence of oil. If oil is leaking from the back side of the compressor wheel, there is a possibility of a failed turbocharger oil seal.  
  
The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the intake air (clogged air filters), which causes the turbocharger to slobber.
4. Inspect the bore of the housing of the turbine outlet for corrosion.

5. Fasten the air intake pipe and the exhaust outlet pipe to the turbocharger housing. Ensure that all clamps are installed correctly and that all clamps are tightened securely.

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## Walk-Around Inspection

SMCS Code: 1000-040

### Inspect the Tube of the Crankcase Breather

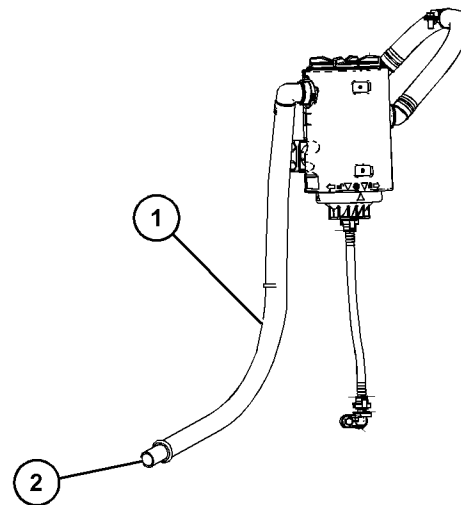


Illustration 106

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Inspect the breather tube (1) for damage. Ensure that the outlet (2) is clean and free from any obstructions. Ice can cause obstructions in adverse weather conditions.

### 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 correct place. Repair damaged guards or replace missing guards.

- Wipe all caps and plugs before the engine is serviced to reduce the chance of system contamination.

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#### 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.

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#### NOTICE

Accumulated grease and/or oil on an engine is a fire hazard. Remove the accumulated grease and oil. Refer to this Operation and Maintenance Manual, "Engine - Clean" for more information.

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- Ensure that the cooling system hoses are correctly clamped and that the cooling system hoses are tight. Check for leaks. Check the condition of all pipes.
- Inspect the water pump for coolant leaks.

**Note:** The water pump seal is lubricated by the 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. Remove the water pump. Refer to Disassembly and Assembly, "Water Pump - Remove and Install". For more information, consult your Perkins dealer or your Perkins distributor.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters, and the rocker cover.
- Inspect the piping for the air intake system and the elbows for cracks and for loose clamps. Ensure that hoses and tubes are not contacting other hoses, tubes, wiring harnesses, etc.
- Ensure that the areas around the rotating parts are clear.
- Inspect the alternator belts and any accessory drive belts for cracks, breaks, or other damage.
- Inspect the wiring harness for 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.

## High Pressure Fuel Lines

### WARNING

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

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After the engine has stopped, you must wait for 10 minutes to allow the fuel pressure to be purged from the high-pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments. Repair any leaks from the low-pressure fuel system and from the cooling, lubrication, or air systems. Replace any high-pressure fuel line that has leaked. Refer to Disassembly and assembly Manual, "Fuel Injection Lines - Install".

If you inspect the engine in operation, always use the proper inspection procedure to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, "General hazard Information".

Visually inspect the high-pressure fuel lines for damage or signs of fuel leakage. Replace any damaged high-pressure fuel lines or high-pressure fuel lines that have leaked.

Ensure that all clips on the high-pressure fuel lines are in place and that the clips are not loose.

- Inspect the rest of the fuel system for leaks. Look for loose fuel line clamps.
- Drain the water and the sediment from the fuel tank daily 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. Check for any loose tie-wraps or missing tie-wraps.
- Inspect the 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 cannot be calibrated.

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## Water Pump - Inspect

**SMCS Code:** 1361-040

A failed water pump might cause severe engine overheating problems that could result in the following conditions:

- Cracks in the cylinder head
- A piston seizure
- Other potential damage to the engine

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

Visually inspect the water pump for leaks.

**Note:** If engine coolant enters the engine lubricating system the lubricating oil and the engine oil filter must be replaced. This will remove any contamination that is caused by the coolant and this will prevent any irregular oil samples.

The water pump is not a serviceable item. In order to install a new water pump, refer to the Disassembly and Assembly Manual, "Water Pump - Remove and Install" or contact your Caterpillar dealer.

## Warranty Section

## Warranty Information

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### Emissions Warranty Information

**SMCS Code:** 1000

The certifying engine manufacturer warrants to the ultimate purchaser and each subsequent purchaser that:

1. New non-road diesel engines and stationary diesel engines less than 10 liters per cylinder (including Tier 1 and Tier 2 marine engines < 37 kW, but excluding locomotive and other marine engines) operated and serviced in the United States and Canada, including all parts of their emission control systems (“emission related components”), are:
  - a. Designed, built, and equipped so as to conform, at the time of sale, with applicable emission standards prescribed by the United States Environmental Protection Agency (EPA) by way of regulation.
  - b. Free from defects in materials and workmanship in emission-related components that can cause the engine to fail to conform to applicable emission standards for the warranty period.
2. New non-road diesel engines (including Tier 1 and Tier 2 marine propulsion engines < 37 kW and Tier 1 through Tier 4 marine auxiliary engines < 37 kW, but excluding locomotive and other marine engines) operated and serviced in the state of California, including all parts of their emission control systems (“emission related components”), are:
  - a. Designed, built, and equipped so as to conform, at the time of sale, to all applicable regulations adopted by the California Air Resources Board (ARB).
  - b. Free from defects in materials and workmanship which cause the failure of an emission-related component to be identical in all material respects to the component as described in the engine manufacturer's application for certification for the warranty period.

3. New non-road diesel engines installed in construction machines conforming to the South Korean regulations for construction machines manufactured after January 1, 2015, and operated and serviced in South Korea, including all parts of their emission control systems (“emission related components”), are:
  - a. Designed, built, and equipped so as to conform, at the time of sale, with applicable emission standards prescribed in the Enforcement Rule of the Clean Air Conservation Act promulgated by South Korea MOE.
  - b. Free from defects in materials and workmanship in emission-related components that can cause the engine to fail to conform to applicable emission standards for the warranty period.

The aftertreatment system can be expected to function properly for the lifetime of the engine (emissions durability period) subject to prescribed maintenance and operating environment requirements being followed.

A detailed explanation of the Emission Control Warranty that is applicable to new non-road and stationary diesel engines, including the components covered and the warranty period, is found in a supplemental Special Publication. Consult your authorized Cat dealer to determine if your engine is subject to an Emission Control Warranty and to obtain a copy of the applicable Special Publication.

## Reference Information Section

### Engine Ratings

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### Engine Rating Conditions

**SMCS Code:** 1000

All engine ratings are in compliance with the following standard ambient air conditions of "SAE J1349":

- 99 kPa (29.3 inches of Hg)
- 30 percent relative humidity
- A temperature of 25 °C (77 °F)

Ratings relate to the standard conditions of "ISO8665", of "ISO3046/1", of "DIN6271", and of "BS5514".

The engine ratings are based on the following fuel specifications:

- Low heat value (LHV) of the fuel of 42 780 kJ/kg (18,390 Btu/lb) at 29 °C (84 °F)
- Gravity (API) of 35 degrees at 15 °C (60 °F)
- Specific gravity of .849 at 15 °C (60 °F)
- Density of 850 kg/m<sup>3</sup> (7.085 lb/US gal)

The engine ratings are gross output ratings.

**Gross Output Ratings** – The total output capability of the engine that is equipped with standard accessories.

Standard accessories include the following components:

- Oil pumps
- Fuel pumps
- Water pumps

Subtract the power that is required to drive auxiliary components from the gross output. This action will produce the net power that is available for the external load (flywheel).

## Engine Rating Definitions

**SMCS Code:** 1000

It is important to know the use of the engine so that the rating will match the operating profile. The proper rating selection is also important so that the customer's perception of price and value is realized.

In selecting a rating for a specific application, the most important consideration is the time that is spent at full throttle. These rating definitions identify the percent of time at full throttle. The definitions also identify the corresponding times below rated rpm.

**Note:** The examples of the applications are only for reference. For an exact determination of the appropriate rating, follow the OEM specifications or consult your Caterpillar dealer.

**A Rating** – This rating is used for heavy-duty applications that are operated at rated load and at rated rpm up to 100 percent. This rating is used for engines that operate without interruption of load cycling. Typical applications include the following examples: pipeline pumping and ventilation.

**B Rating** – This rating is used when power and/or rpm are cyclic. The engine should be run at full load. The engine should not exceed 80 percent of the duty cycle. Typical applications include the following examples: irrigation, operation where normal pump demand is 85 percent of the engine rating, oil pumping/drilling, field mechanical pumping/drilling and stationary/plant air compressors.

**C Rating** – This rating is used when power and/or rpm are cyclic. The horsepower and the rpm of the engine can be utilized continuously for one hour. This is followed by one hour of operation at the A rating or below the A rating. The engine should be run at full load. The engine should not exceed 50 percent of the duty cycle. Typical applications include the following examples: agricultural tractors, harvesters and combines, off-highway trucks, fire pumps, blast hole drills, rock crushers, wood chippers with high torque rise and oil field hoisting.

**D Rating** – This rating is used when rated power is required for periodic overloads. The maximum horsepower and the rpm of the engine can be utilized continuously for a maximum of 30 minutes. This is followed by one hour of operation at the C rating. The engine should be run at full load. The engine should not exceed 10 percent of the duty cycle. Typical applications include the following examples: offshore cranes, runway snow blowers, water well drills, portable air compressors and fire pump certification power.

**E Rating** – This rating is used when rated power is required for a short time for initial starting or for sudden overload. The rating is also used for emergency service when standard power is not

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available. The horsepower and the rpm of the engine can be utilized continuously for a maximum of 15 minutes. This is followed by one hour of operation at the C rating or by the duration of the emergency. The engine should be run at full load. The engine should not exceed 5 percent of the duty cycle. Typical applications include the following examples: standby centrifugal water pumps, oil field well servicing, crash trucks, portable air compressors and gas turbine starting motors.

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**NOTICE**

Operating engines above the rating definitions can result in shorter service life before overhaul.

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# Customer Service

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## Customer Assistance

**SMCS Code:** 1000; 4450

### USA and Canada

If a problem arises concerning the operation or service of an engine, the problem will be managed by the dealer in your area.

Your satisfaction is a primary concern to Caterpillar and to Cat 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 without additional assistance, use the phone number 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.  
Electric Power North America  
Attn: Product Support Manager  
AC 6109  
Mossville, Illinois 61552

Keep in mind: probably, your problem will ultimately be solved at the dealership, using the dealership facilities, equipment, and personnel. Therefore, follow the steps in sequence when a problem is experienced.

### Outside of USA and of Canada

If a problem arises outside of USA and outside Canada, and if the problem cannot be resolved at the dealer level, consult the appropriate Caterpillar office.

Latin America, Mexico, Caribbean  
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  
Caterpillar Japan Ltd.  
SBS Tower  
10-1, Yoga 4-Chome  
Setagaya-Ku, Tokyo 158-8530  
Japan  
Phone: 81-3-5717-1150  
Fax: 81-3-5717-1177

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:** 4450; 7567

### **WARNING**

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

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

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Quality Cat replacement parts are available from Cat dealers throughout the world. Cat dealer parts inventories are up to date. The parts stocks include all the parts that are normally needed to protect your Cat engine investment.

When you order parts, specify the following information:

- Part number
- Part name
- Quantity

If there is a question concerning the part number, provide your dealer with a complete description of the needed item.

When a Cat engine requires maintenance and/or repair, provide the dealer with all the information that is stamped on the Information Plate. This information is described in this Operation and Maintenance Manual (Product Information Section).

Discuss the problem with the dealer. Inform the dealer about the conditions of the problem and the nature of the problem. Inform the dealer about when the problem occurs. This information will help the dealer in troubleshooting the problem and solving the problem faster.

# Reference Materials

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## Maintenance Records

**SMCS Code:** 1000; 4450

Caterpillar recommends the retention of accurate maintenance records. Accurate maintenance records can be used for the following purposes:

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

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

Maintenance records are a key element of a maintenance program that is managed. Accurate maintenance records can help your Cat dealer to fine-tune the recommended maintenance intervals to meet the specific operating situation. These recommendations 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 to determine when the load sensitive components should be inspected or repaired. Fuel consumption assists in determining 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 documents should show this information: date, service hours, fuel consumption, unit number, and engine serial number. The following types of documents should be kept as proof of maintenance or repair for warranty:

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

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



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## Reference Material

**SMCS Code:** 1000; 4450

Additional literature regarding your product may be purchased from your local Cat dealer or by visiting [publications.cat.com](http://publications.cat.com). Use the product name, sales model, and serial number to obtain the correct information for your product.

[publications.cat.com](http://publications.cat.com)

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## Decommissioning and Disposal

**SMCS Code:** 1000

When the product is removed from service, local regulations for the product decommissioning will vary. Disposal of the product will vary with local regulations.

Improperly disposing of waste can threaten the environment. Obey all local regulations for the decommissioning and disposal of materials.

Utilize appropriate personal protective equipment when decommissioning and disposing product.

Consult the nearest Cat dealer for additional information. Including information for component remanufacturing and recycling options.

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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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