CATERPILLAR®

SEBU8139-01
May 2006

Operation and Maintenance Manual

C6.6 Generator Set

SDA1-Up (Generator Set)
N6D1-Up (Generator Set)

Product and Dealer Information

City Of Wichita Water Utilities
Surface Water Treatment Plant and River Intake
ASR Phase II

Manufacture Contact Information

Manufactured By: Caterpillar

Manufacture Representative: Foley Equipment
1550 S. West St.
Wichita KS.
Phone: 316-943-4211
Fax: 316-943-5813
Internet Site: WWW.Foleyeq.com

Parts and Service Contact: Foley Equipment
1550 S. West St.
Wichita KS.
Phone: 316-943-4211
Fax: 316-943-5813
Internet Site: WWW.Foleyeq.com

Generator Model:	D150-8
Serial Number:	N6D00657
ID Number:	8EO023
Voltage:	277/480
Phase:	3 Phase
KW/KVA Rating:	150kW/187.5kVA
Amps Rating:	225amps

Automatic Transfer Switch Model	CTG150	CTG225
Serial Number:	TSA20219	TSA20224
ID Number:	KEN0002	KEN0003
Voltage:	277/480	277/480
Phase:	3 Phase	3 Phase
Amp Rating:	150amp	225amp
Controller:	MX150	MX150

Important Safety Information

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

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

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

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

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

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

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

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

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

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

⚠ WARNING

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

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

Table of Contents

Foreword 4

Safety Section

Safety Messages 6

Additional Messages 18

General Hazard Information 25

Burn Prevention 28

Fire Prevention and Explosion Prevention 28

Crushing Prevention and Cutting Prevention 31

Before Starting Engine 31

Engine Starting 31

Engine Stopping 32

Electrical System 32

Generator Isolating for Maintenance 33

Product Information Section

General Information 34

Model Views 35

Product Identification Information 36

Operation Section

Lifting and Storage 45

Installation 47

Features and Controls 48

Engine Starting 58

Engine Operation 60

Engine Stopping 61

Cold Weather Operation 62

Maintenance Section

Refill Capacities 65

Maintenance Interval Schedule (Prime Power Generator Sets) 70

Maintenance Interval Schedule (Standby Generator Sets) 72

Reference Information Section

Engine Ratings 104

Customer Service 106

Reference Materials 108

Index Section

Index 111

Foreword

Literature Information

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

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

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

Safety

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

Operation

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

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

Maintenance

The maintenance section is a guide to engine care. The illustrated, step-by-step instructions are grouped by 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 extremely severe, dusty, wet or freezing cold operating conditions, more frequent lubrication and maintenance than is specified in the Maintenance Interval Schedule may be necessary.

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

Maintenance Intervals

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

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

Overhaul

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

California Proposition 65 Warning

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

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

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. Please become familiar with all safety messages.

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

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

⚠ 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.

Illustrations 1 through 4 show one type of enclosed generator set.

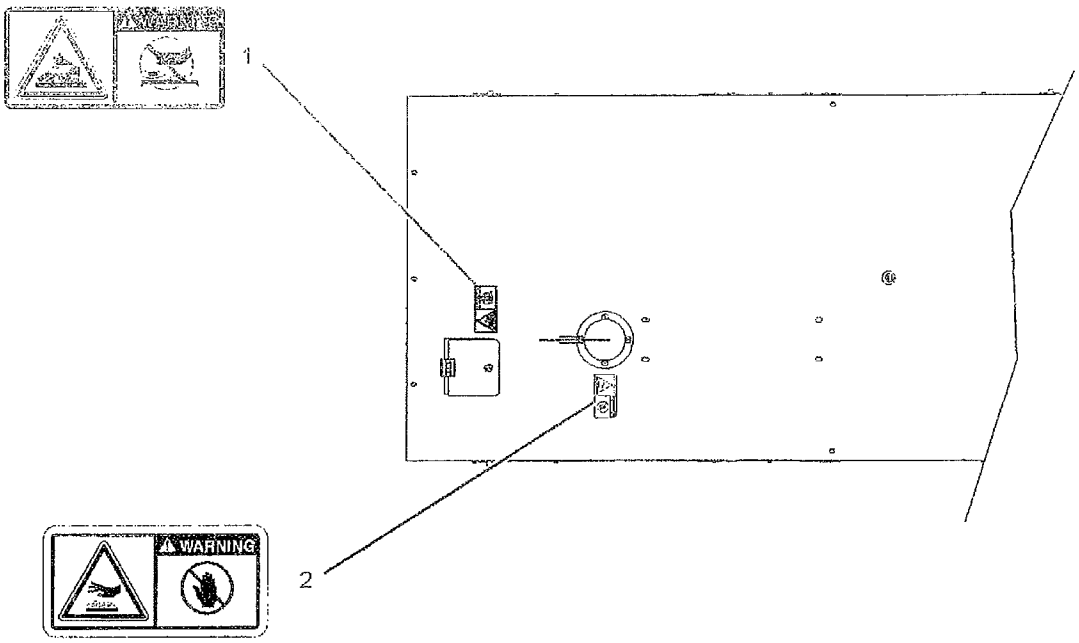


Illustration 1 g01218859

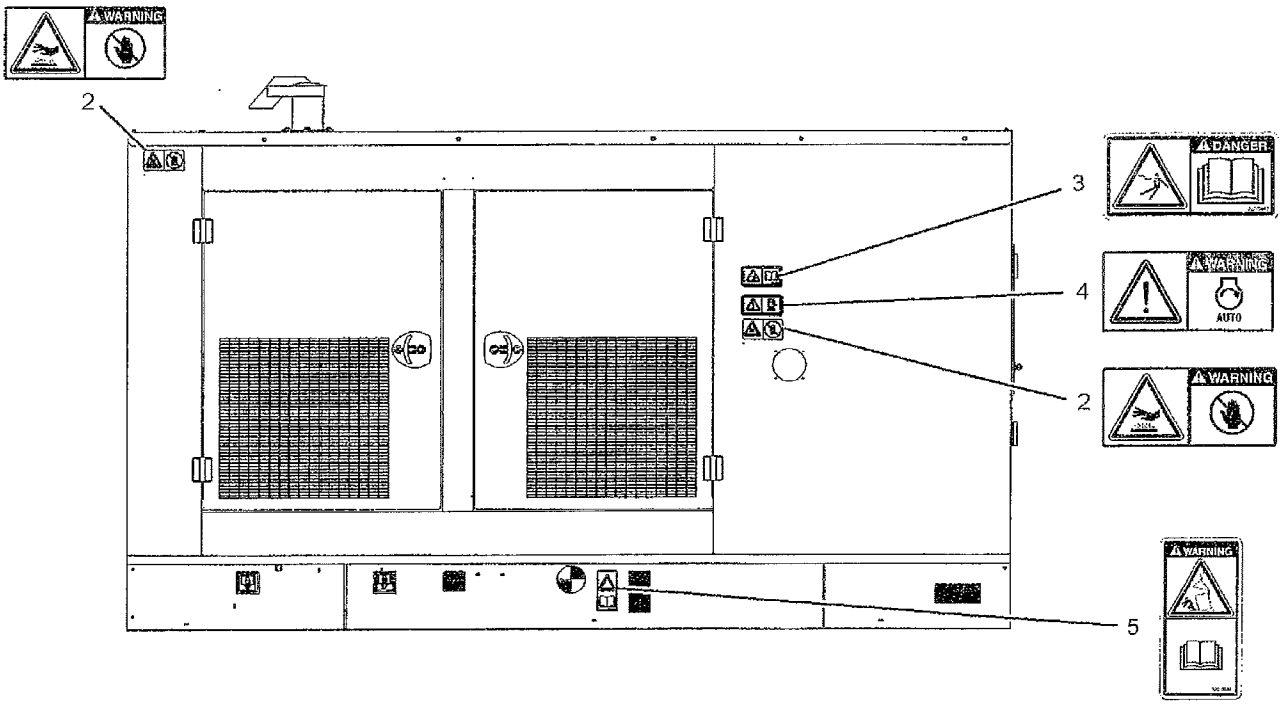
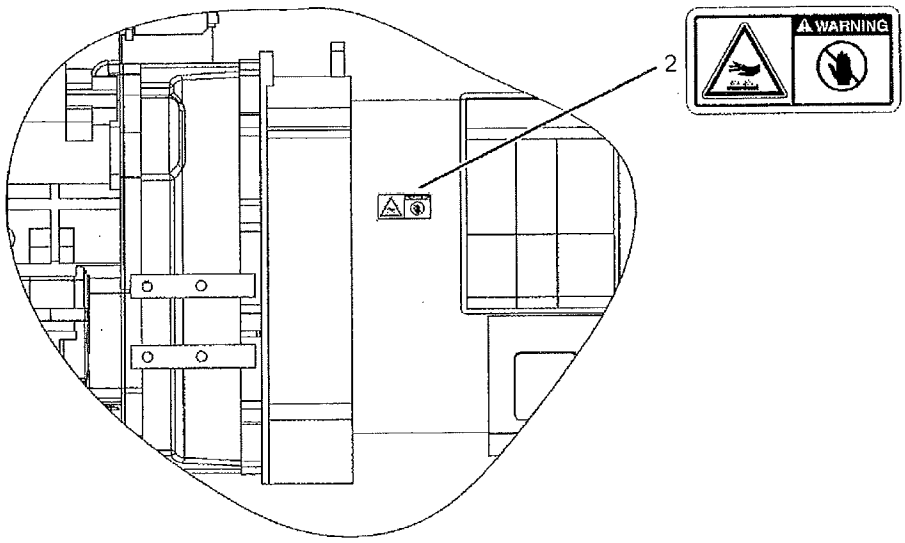


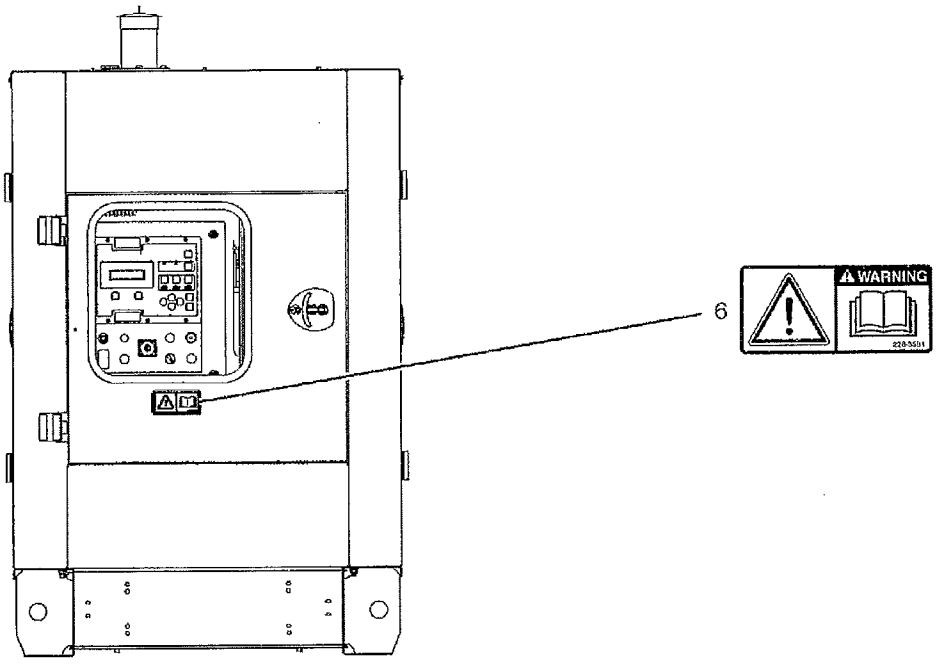
Illustration 2 g01219063



g01232868

Illustration 3

View of the inside of the enclosure



g01222980

Illustration 4

Illustrations 5 through 7 show another type of enclosed generator set.

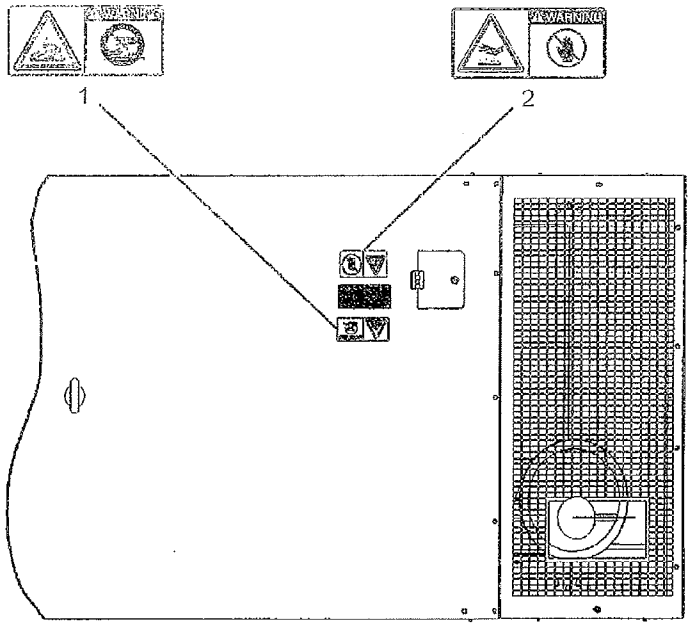


Illustration 5

g01221813

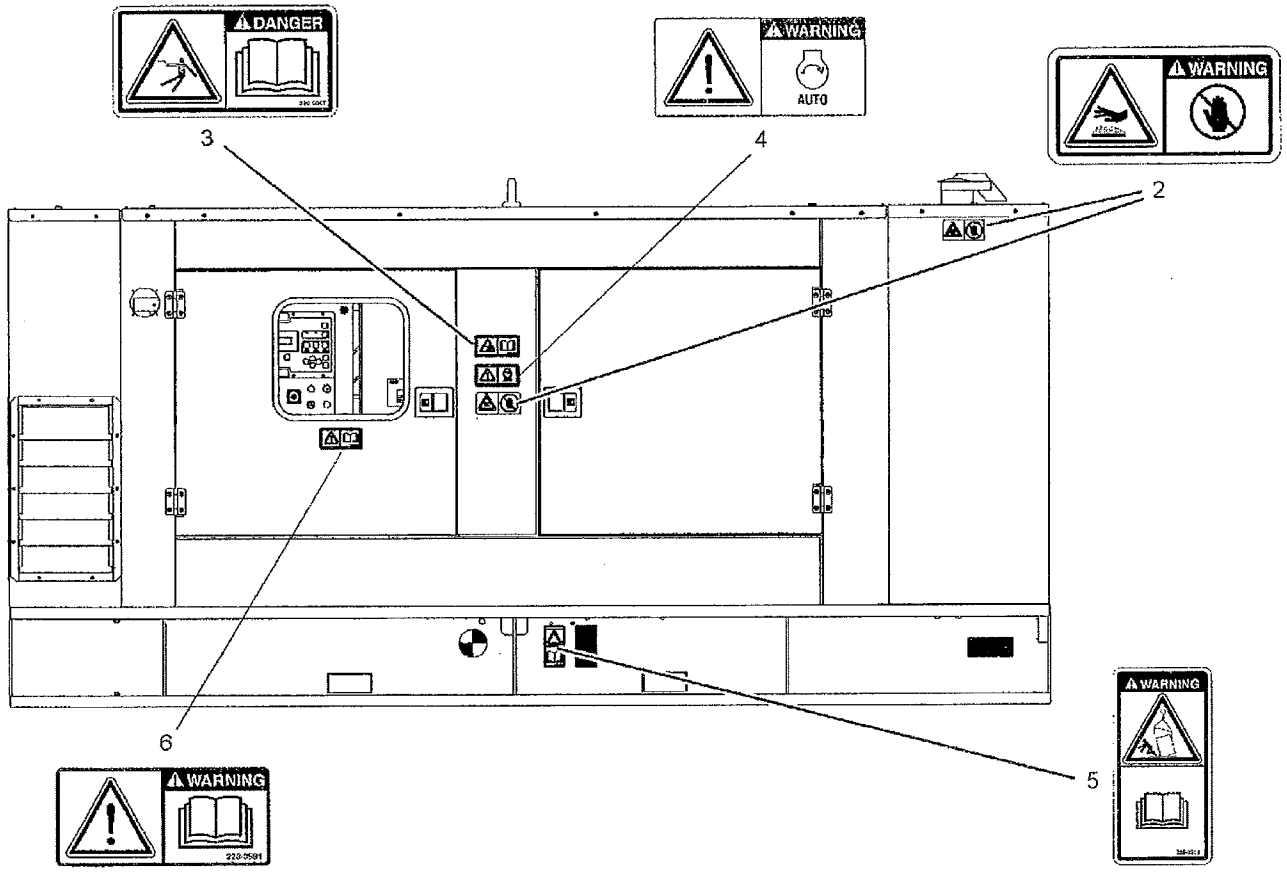


Illustration 6

g01221851

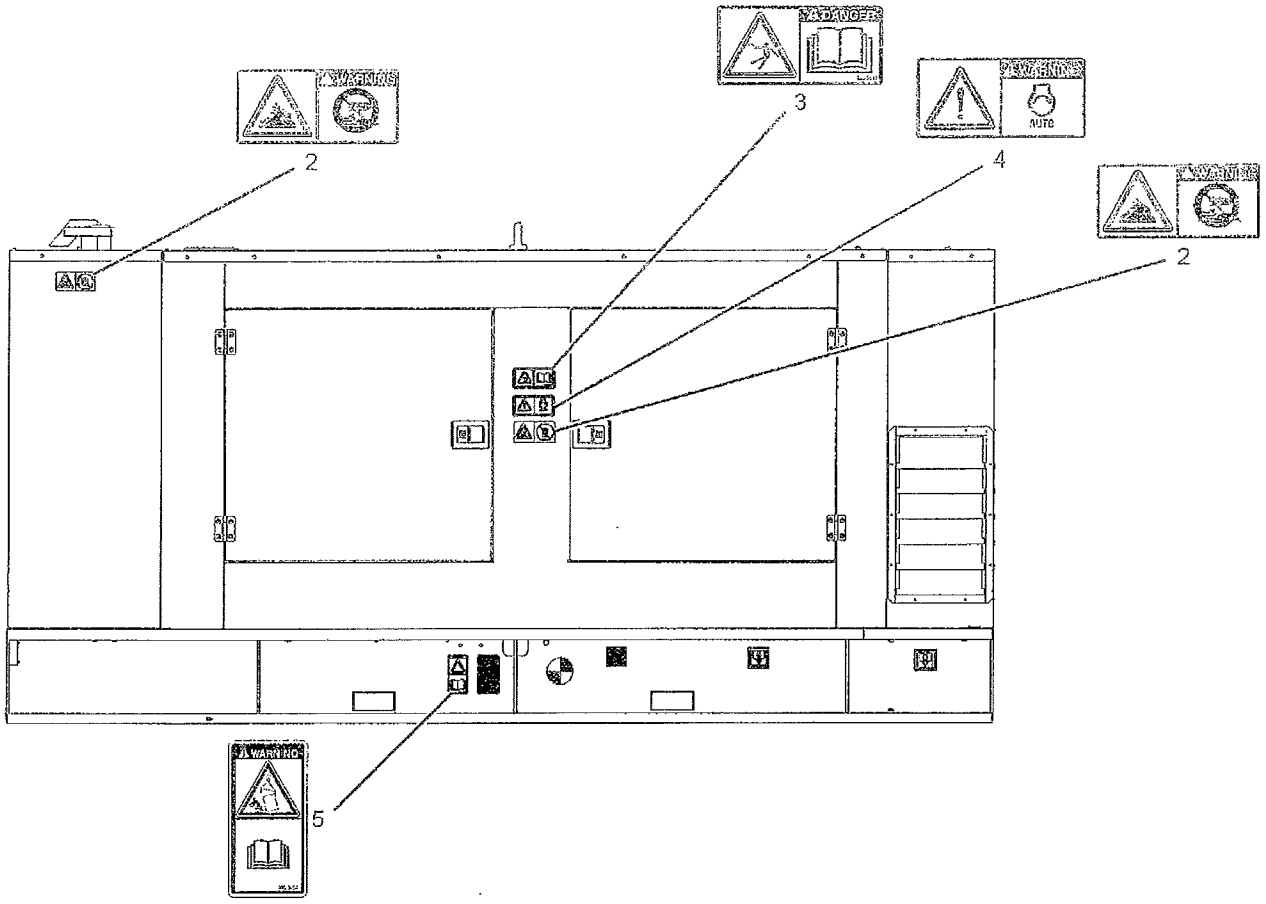


Illustration 7 g01222036

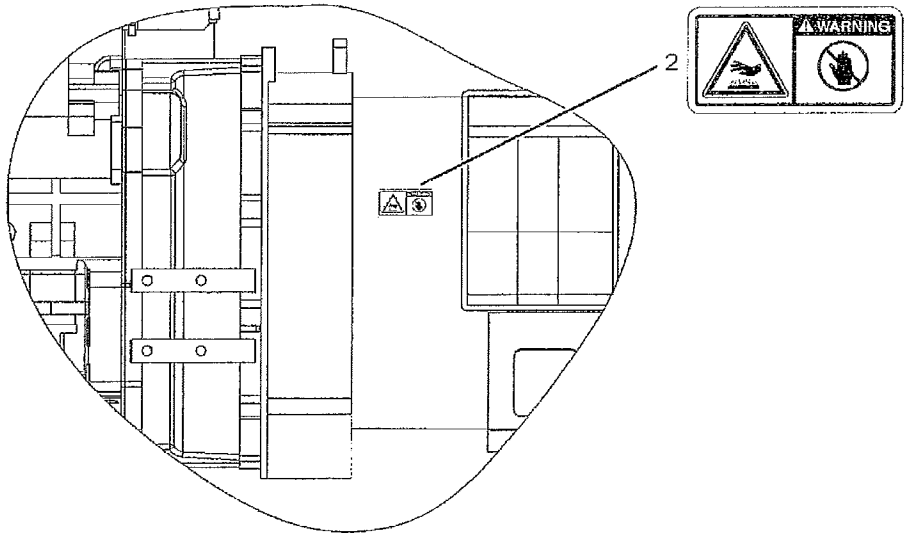


Illustration 8 g01232868

View of the inside of the enclosure

Illustrations 9 and 10 show an open generator set.

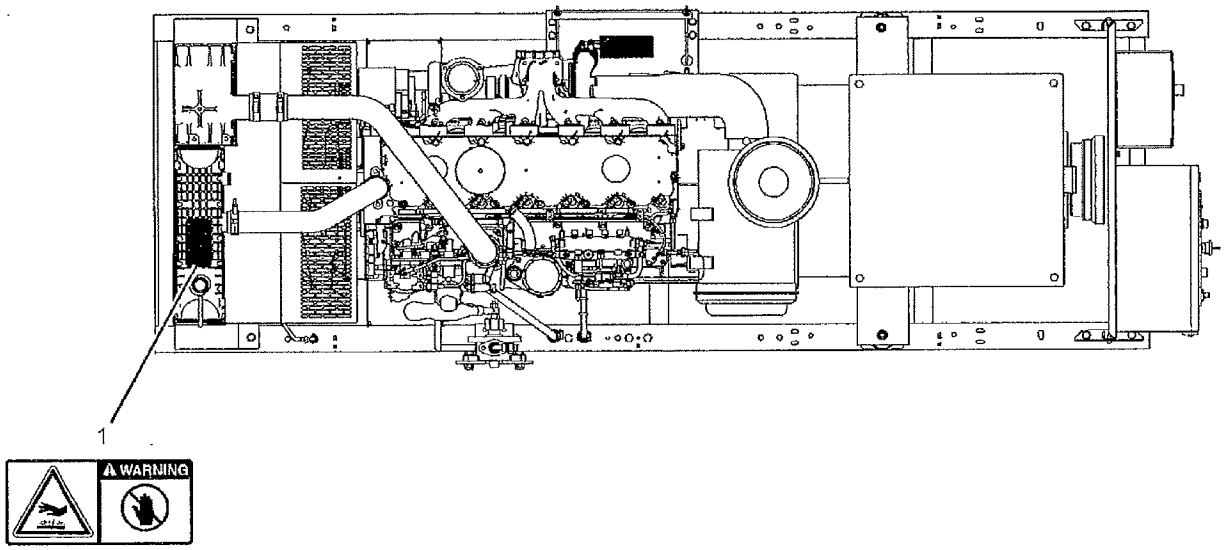


Illustration 9

g01222927

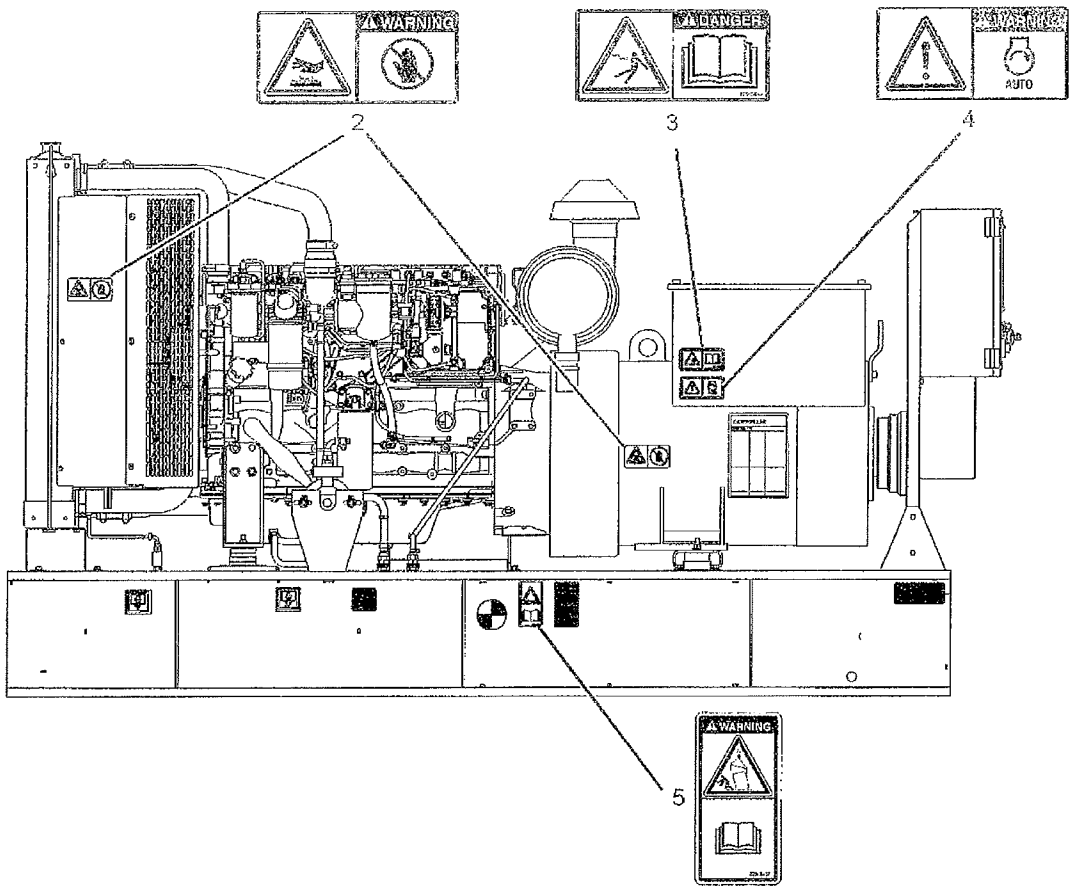


Illustration 10 g01222960

Illustration 11 shows the control panel and the distribution panel.

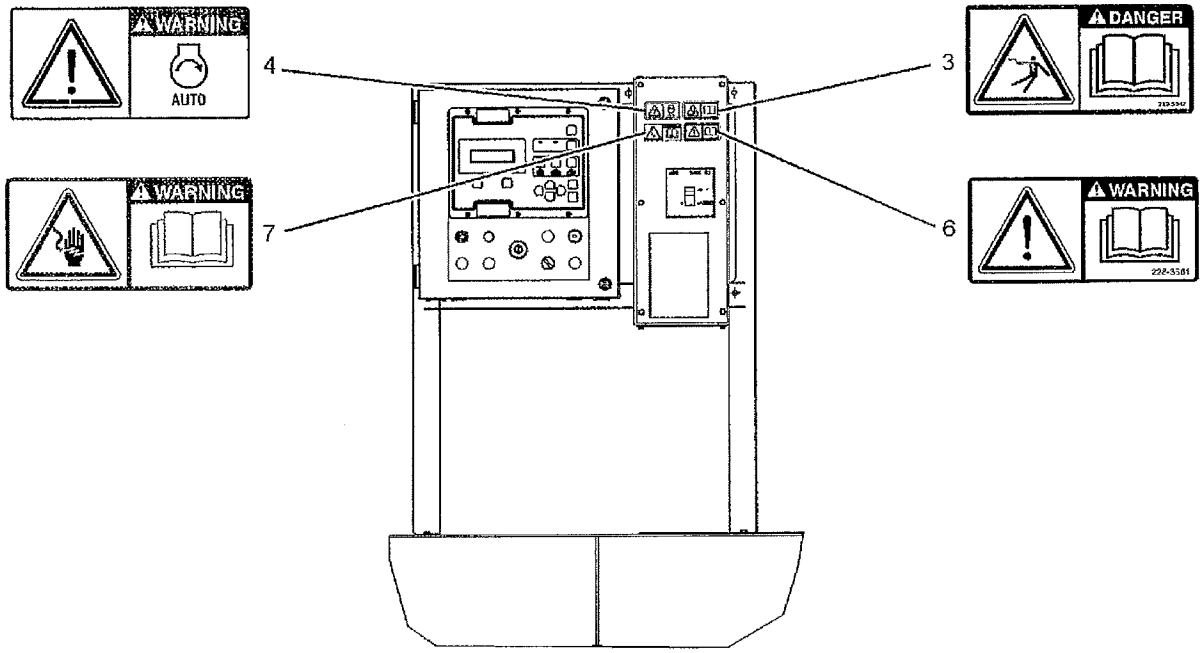
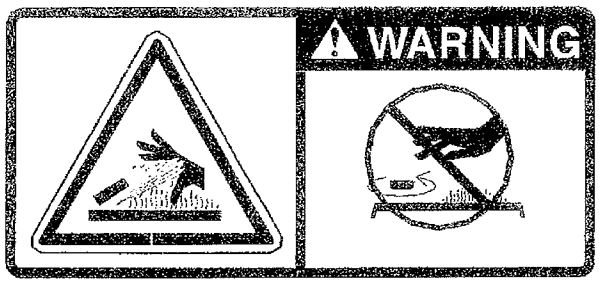


Illustration 11

g01223013

Hot Fluid Under Pressure (1)

This safety message is located on the top of the enclosure by the radiator cap access cover on enclosed generator sets. This safety message is located toward the top of the radiator by the filler neck on open generator sets.



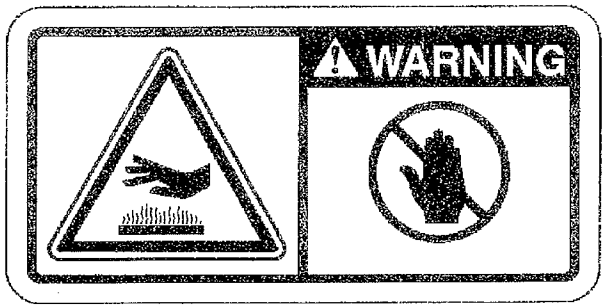
g00930639

WARNING

Pressurized system! Hot coolant can cause serious burns, injury or death. 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. Read and understand the Operation and Maintenance Manual before performing any cooling system maintenance.

Hot Surface (2)

This safety message is located on top of the enclosure, the sides of the enclosure and the sides of the generator on enclosed generator sets. This safety message is located on the sides of the radiator and the sides of the generator on open generator sets.



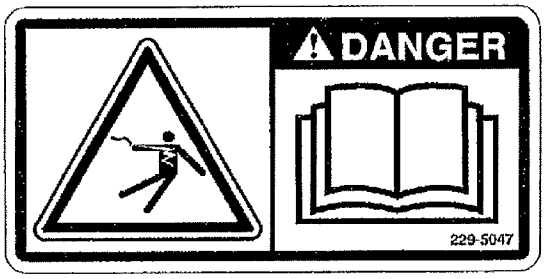
g01085603

WARNING

Hot surface! Do not touch!

Electrocution (3)

This safety message is located on the sides of the enclosure on enclosed generator sets. This safety message is located on the sides of the terminal box on open generator sets. This safety message is also located on the enclosure for the control panel and the distribution panel on open generator sets and enclosed generator sets.



g00928349

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.

Automatic Starting (4)

This safety message is located on the sides of the enclosure on enclosed generator sets. This safety message is located on the sides of the terminal box on open generator sets. This safety message is also located on the enclosure for the control panel and the distribution panel on open generator sets and enclosed generator sets.

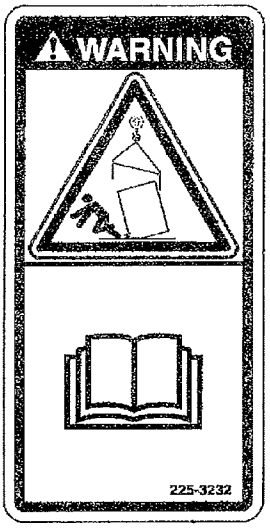
g01154070

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.

Lifting the Generator Set (5)

This safety message is located on the sides of the enclosure toward the bottom of the enclosure on enclosed generator sets. This safety message is located on the sides of the base on open generator sets.



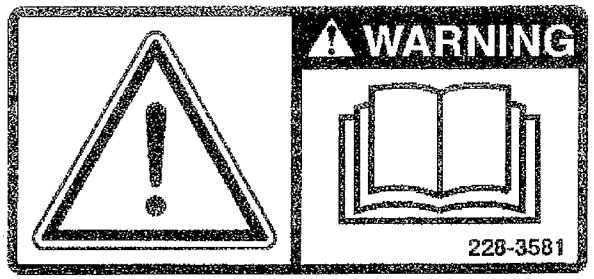
g00928085

WARNING

Crushing Hazard! Improper lifting could cause serious injury or death. Follow the lifting instructions in the Operation and Maintenance Manual for safe lifting procedures.

Universal Warning (6)

This safety message is located on the door for access to the control panel on enclosed generator sets. This safety message is located on the enclosure for the control panel and the distribution panel on open generator sets and enclosed generator sets.



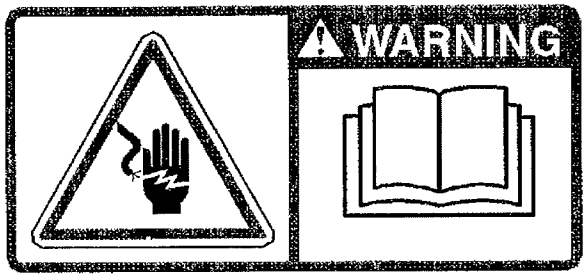
g00934493

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.

Electrical Shock (7)

The safety message for electrical shock is located on the enclosure for the control panel and the distribution panel on open generator sets and enclosed generator sets.



g01120247

⚠ WARNING

WARNING! Shock/Electrocution 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.

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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. Please become familiarized with all messages.

Make sure that all of 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.

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.

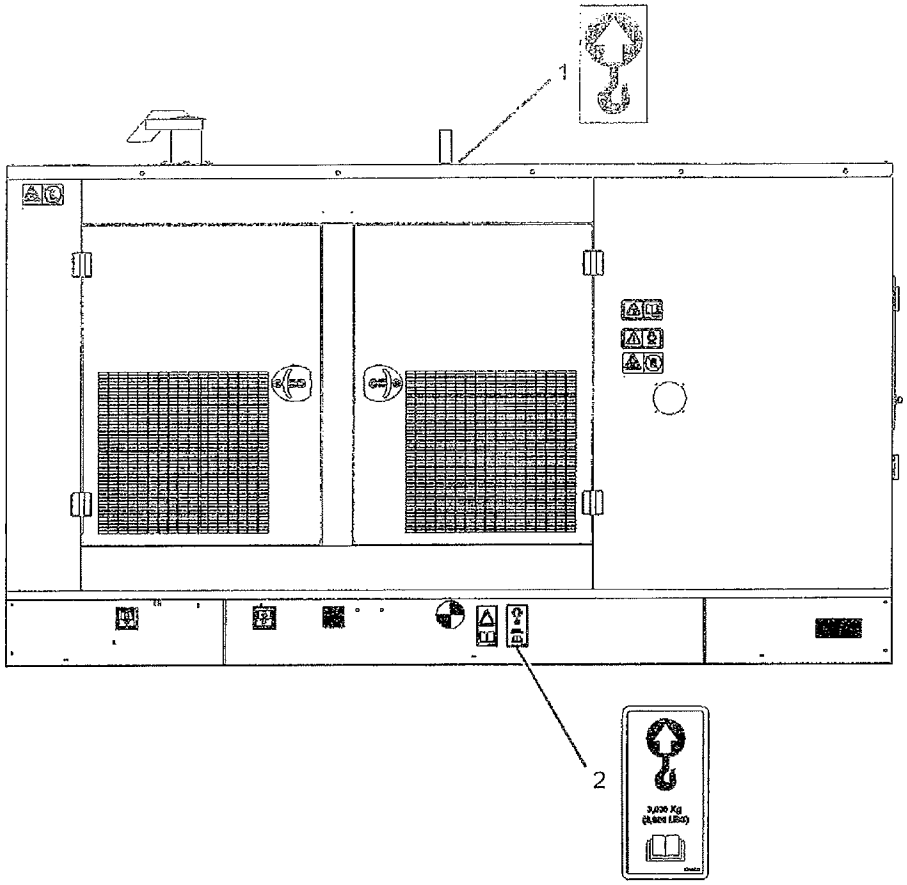
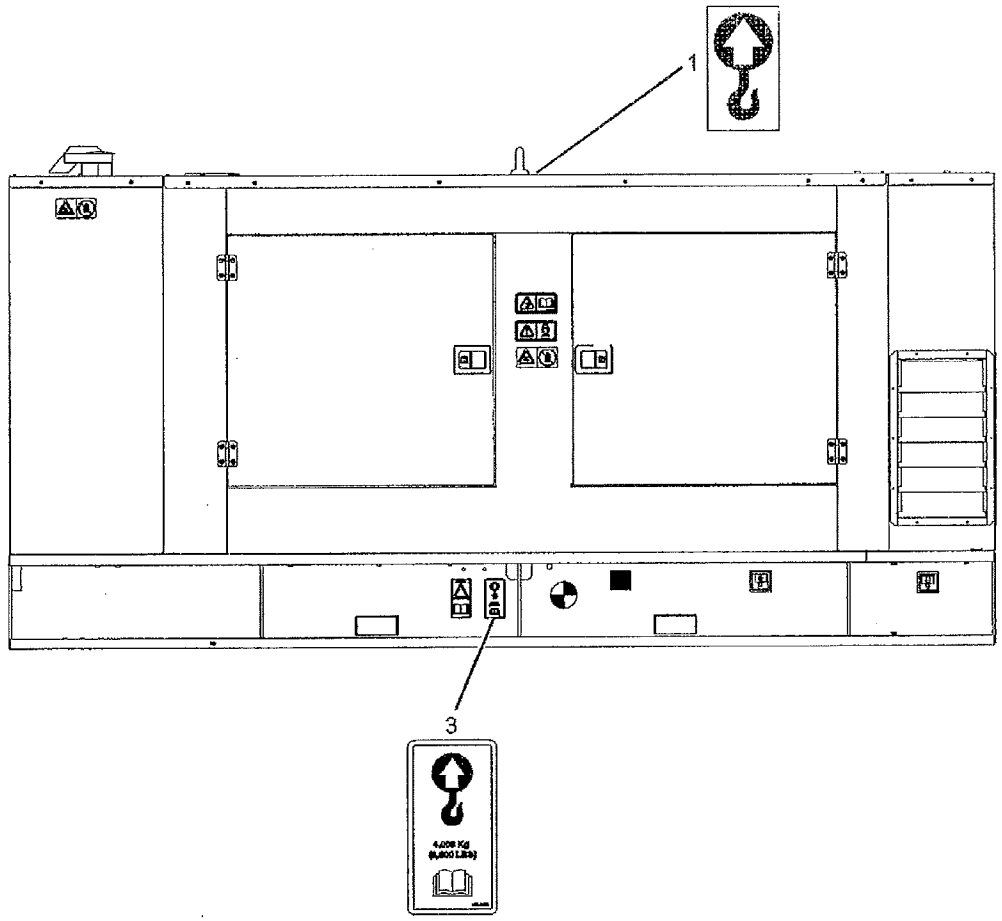


Illustration 12 g01233415

This illustration shows one type of enclosed generator set.



g01233280

Illustration 13

This illustration shows another type of enclosed generator set.

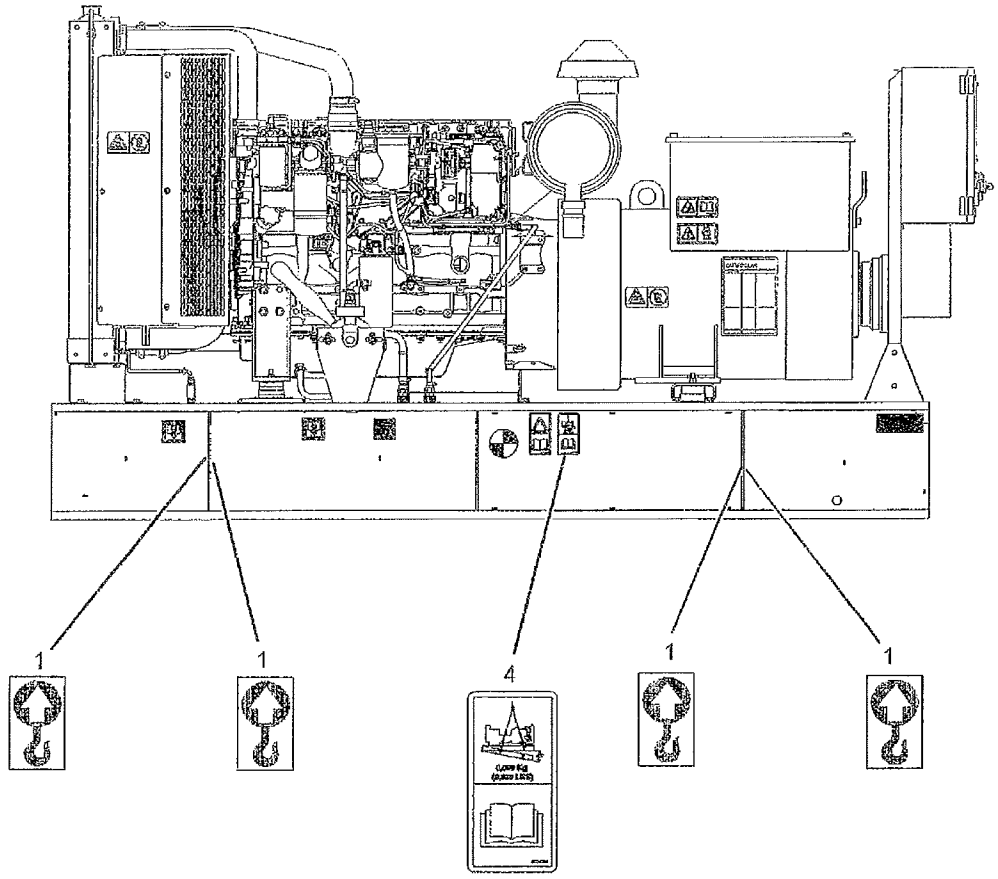


Illustration 14 g01233028

This illustration shows an open generator set.

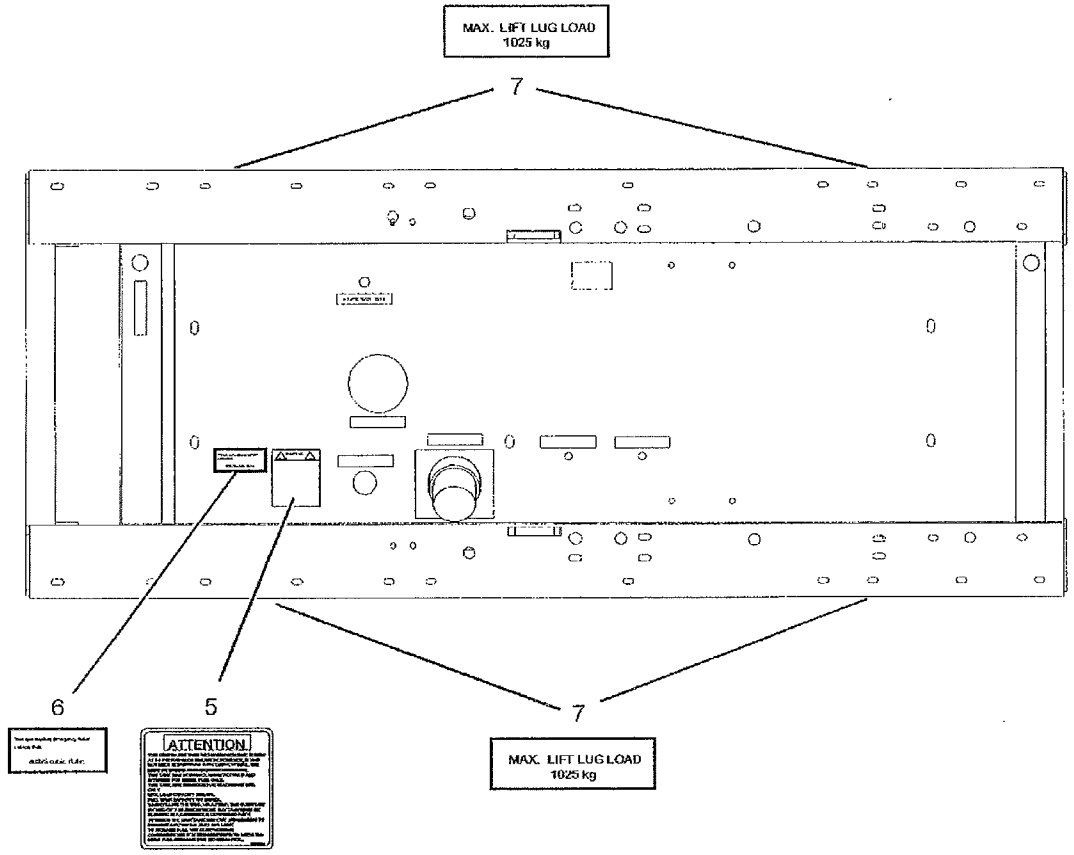


Illustration 15 g01239864

Typical example of a fuel tank

Lifting point (1)

Illustration 16 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 located on the side of the enclosure near the bottom of the enclosure.

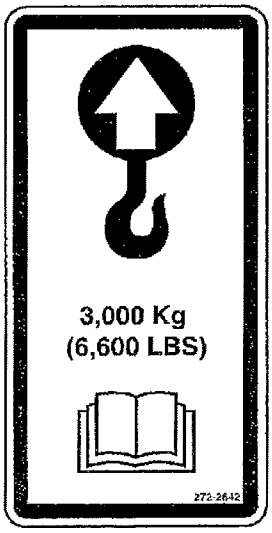


Illustration 17 g01233472

The lifting equipment that is used for lifting this type of generator set must be rated for a total weight of 3000 kg (6,600 lb).

Rating for lifting equipment (3)

This message is located on the side of the enclosure near the bottom of the enclosure.

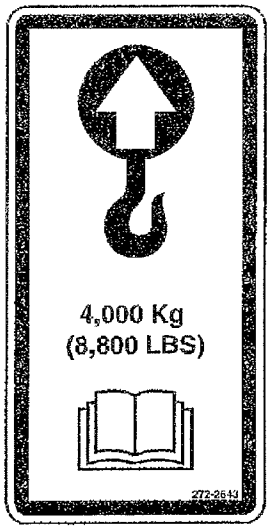


Illustration 18 g01233040

The lifting equipment that is used for lifting this type of generator set must be rated for a total weight of 4000 kg (8,800 lb).

Rating for lifting equipment (4)

This message is located on the side of open generator sets on the base.

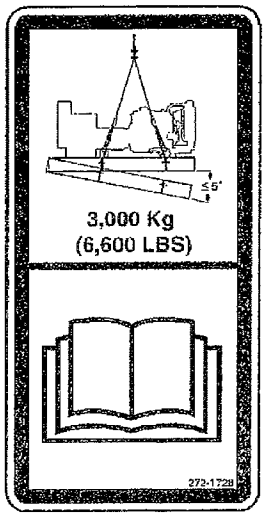


Illustration 19 g01233043

The lifting equipment that is used for lifting this type of generator set must be rated for a total weight of 3000 kg (6,600 lb).

Fuel tank vent (5)

This message is located on the fuel tank by the vent.

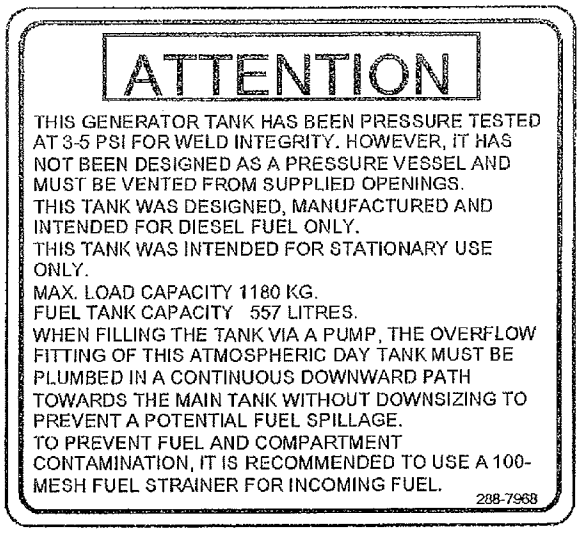


Illustration 20 g01239683

This generator tank has been pressure tested at 20.6 kPa (3 psi) to 34.5 kPa (5 psi) for weld integrity. However, it has not been designed as a pressure vessel and must be vented from supplied openings. This tank was designed, manufactured and intended for diesel fuel only. This tank was intended for stationary use only. Maximum load capacity 1180 kg (2601 lb) Fuel tank capacity 557 L (147 US gal). When filling the via a pump, the overflow fitting of this atmospheric day tank must be plumbed in a continuous downward path toward the main fuel tank without downsizing to prevent a potential fuel spillage. To prevent fuel and compartment contamination, it is recommended to use a 100 mesh fuel strainer for incoming fuel.

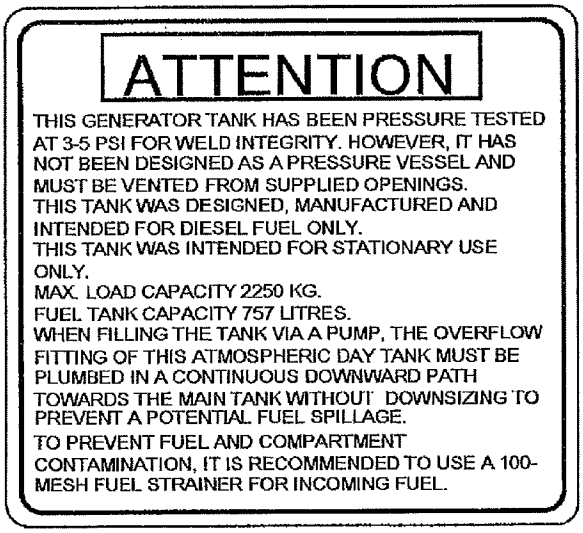


Illustration 21 g01239658

This generator tank has been pressure tested at 20.6 kPa (3 psi) to 34.5 kPa (5 psi) for weld integrity. However, it has not been designed as a pressure vessel and must be vented from supplied openings. This tank was designed, manufactured and intended for diesel fuel only. This tank was intended for stationary use only. Maximum load capacity 2250 kg (4960 lb). Fuel tank capacity 757 L (200 US gal). When filling the via a pump, the overflow fitting of this atmospheric day tank must be plumbed in a continuous downward path toward the main fuel tank without downsizing to prevent a potential fuel spillage. To prevent fuel and compartment contamination, it is recommended to use a 100 mesh fuel strainer for incoming fuel.

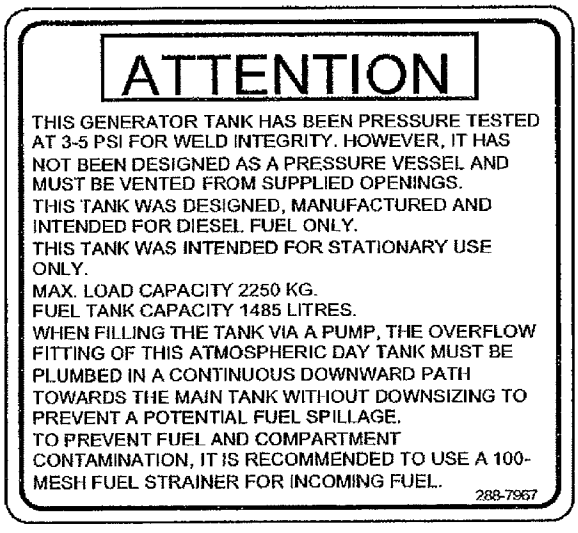


Illustration 22 g01239678

This generator tank has been pressure tested at 20.6 kPa (3 psi) to 34.5 kPa (5 psi) for weld integrity. However, it has not been designed as a pressure vessel and must be vented from supplied openings. This tank was designed, manufactured and intended for diesel fuel only. This tank was intended for stationary use only. Maximum load capacity 2250 kg (4960 lb). Fuel tank capacity 1485 L (392 US gal). When filling the via a pump, the overflow fitting of this atmospheric day tank must be plumbed in a continuous downward path toward the main fuel tank without downsizing to prevent a potential fuel spillage. To prevent fuel and compartment contamination, it is recommended to use a 100 mesh fuel strainer for incoming fuel.

Size of fuel tank vent (6)

This message is located on the fuel tank by the vent.

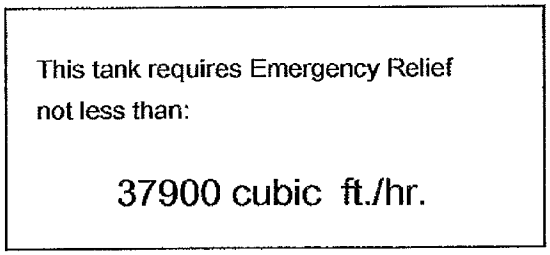


Illustration 23 g01239936

This tank requires emergency relief not less than 37900 cubic feet per hour.

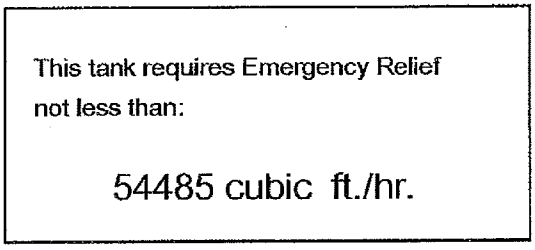


Illustration 24 g01239912

This tank requires emergency relief not less than 54485 cubic feet per hour.

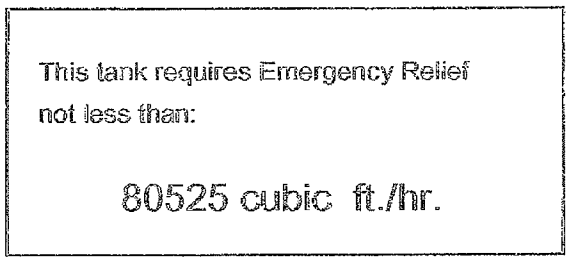


Illustration 25 g01239873

This tank requires emergency relief not less than 80525 cubic feet per hour.

Maximum Lift Lug Load (7)

This message is located on the fuel tank by the lifting points.

Illustration 26 g01239953

Maximum lift lug load 623 kg (1373 lb)

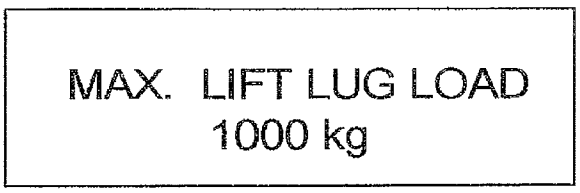


Illustration 27 g01239955

Maximum lift lug load 1000 kg (2205 lb)

Illustration 28 g01239958

Maximum lift lug load 1025 kg (2260 lb)

i02344741

General Hazard Information

SMCS Code: 1000; 7405

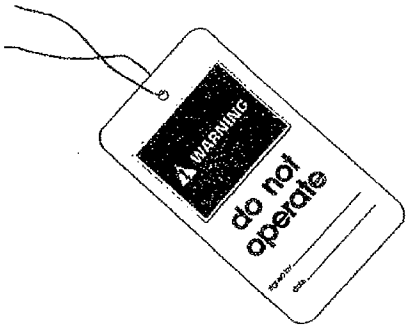


Illustration 29 g00104545

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

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

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

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

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

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

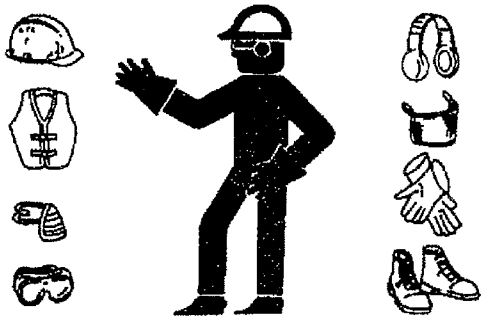


Illustration 30 g00702020

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

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

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

Pressurized Air and Water

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

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

Fluid Penetration

Pressure can be trapped in the hydraulic circuit long after the engine has been stopped. The pressure can cause hydraulic fluid or items such as pipe plugs to escape rapidly if the pressure is not relieved correctly.

Do not remove any hydraulic components or parts until pressure has been relieved or personal injury may occur. Do not disassemble any hydraulic components or parts until pressure has been relieved or personal injury may occur. Refer to the OEM information for any procedures that are required to relieve the hydraulic pressure.

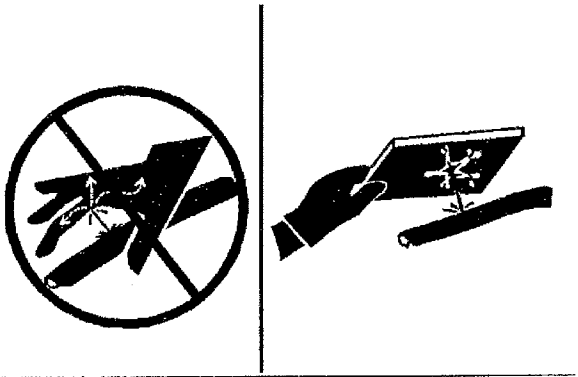


Illustration 31 g00687600

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

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

Refer to Special Publication, NENG2500, "Dealer Service Tool Catalog" for the following items:

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

Obey all local regulations for the disposal of liquids.

Asbestos Information

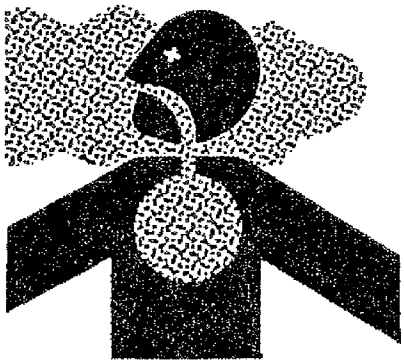


Illustration 32 g00702022

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

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

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

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

Dispose of Waste Properly

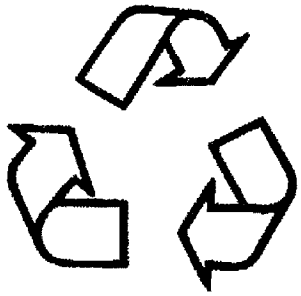


Illustration 33 g00706404

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

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

i02344742

Burn Prevention

SMCS Code: 1000; 7405

Do not touch any part of an operating engine. Allow the engine to cool before any maintenance is performed on the engine.

⚠ 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 60 seconds 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.

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.

Coolant

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

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

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

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

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

Oils

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

Batteries

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

i02328452

Fire Prevention and Explosion Prevention

SMCS Code: 1000; 7405

Illustration 34 g00704000

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

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

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

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

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

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

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

Do not expose the engine to any flame.

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

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

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

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

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

⚠ 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 60 seconds 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.

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

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

Illustration 35 g00704059

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

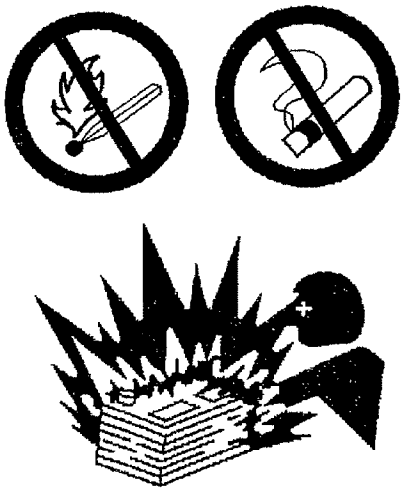


Illustration 36 g00704135

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

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

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

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

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

Fire Extinguisher

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

Ether

Ether is flammable and poisonous.

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

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

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

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

Lines, Tubes and Hoses

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

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

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

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

- 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 hoses are kinked.
- Outer covers have embedded armoring.
- End fittings are displaced.

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

i01359868

Crushing Prevention and Cutting Prevention

SMCS Code: 1000; 7405

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

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

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

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

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

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

i01805780

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.

Overspeed shutdown should occur automatically. If automatic shutdown does not occur, press the emergency stop button in order to cut the fuel and/or air to the engine.

Inspect the engine for potential hazards.

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

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 in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

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

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.

i02234878

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. Tighten all loose electrical connections before the engine is started. Repair all frayed electrical wires before the engine is started. See the Operation and Maintenance Manual for specific starting instructions.

Grounding Practices

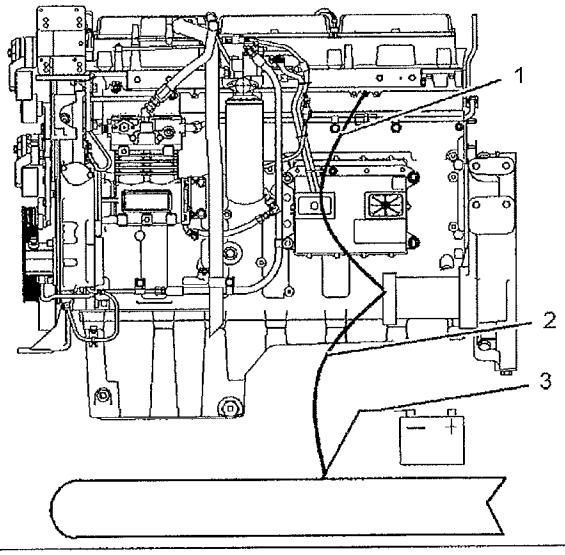


Illustration 37 g01162916

Typical example

(1) Starting motor to engine block
(2) Ground to starting motor
(3) Ground to battery

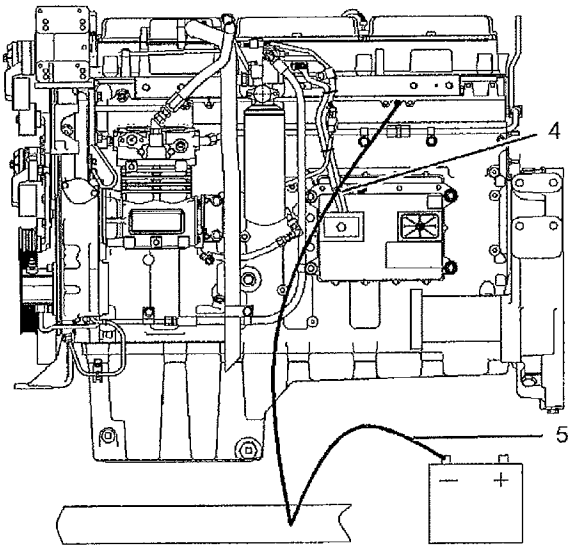


Illustration 38 g01162918

Typical example

(4) Ground to engine
(5) Ground to battery

Correct grounding for the engine electrical system is necessary for optimum engine performance and reliability. Incorrect grounding will result in uncontrolled electrical circuit paths and in unreliable electrical circuit paths.

Uncontrolled electrical circuit paths can result in damage to the crankshaft bearing journal surfaces and to aluminum components.

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

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

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

The power supply connections and the ground connections for the engine electronics should always be from the isolator to the battery.

i01489970

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.

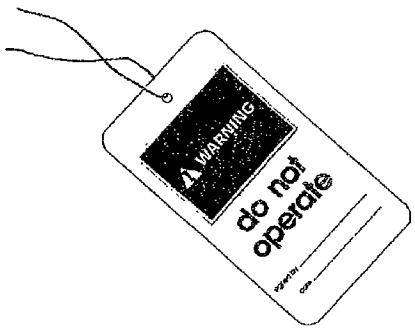


Illustration 39 g00104545

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 transformer's 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's terminal box.

8. Use an audio/visual proximity tester in order to verify that the generator is de-energized. This tester must be insulated for the proper voltage rating. Follow all guidelines in order 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

i02276735

Welding on Engines with Electronic Controls

SMCS Code: 1000

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

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

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

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

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

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

3. Disconnect the J1/P1 and J2/P2 connectors from the ECM. Move the harness to a position that will not allow the harness to accidentally move back and make contact with any of the ECM pins.

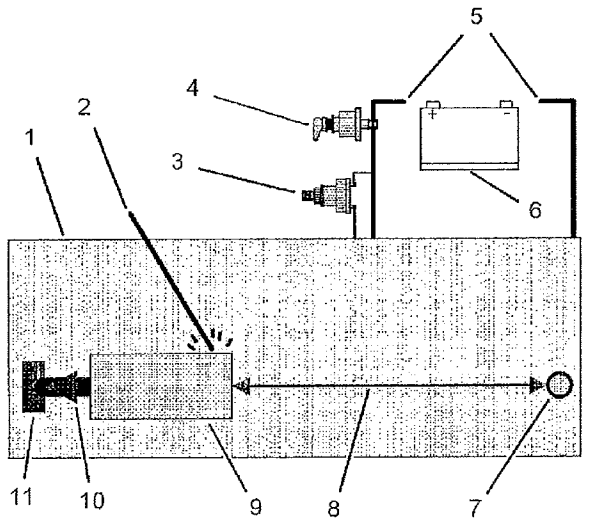


Illustration 40 g01075639

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

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

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

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

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

6. Use standard welding practices to weld the materials.

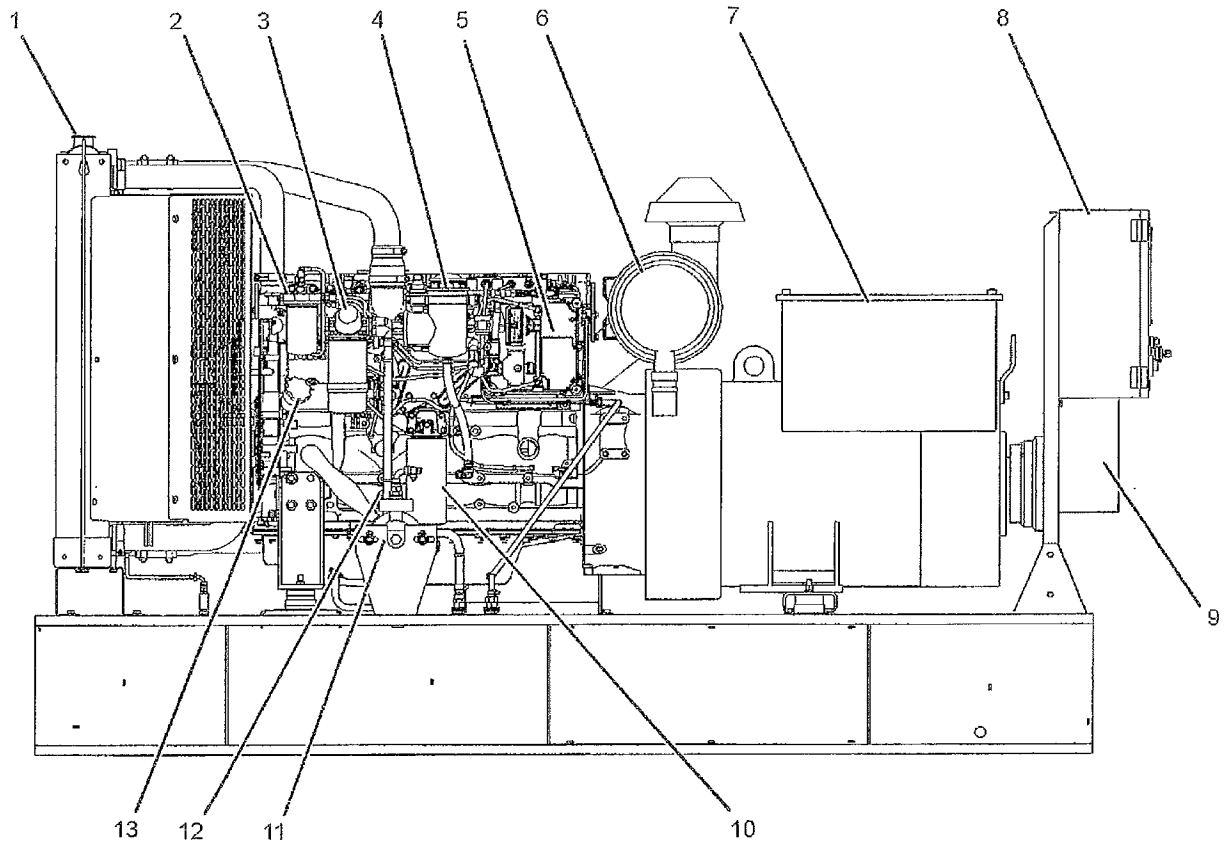
Model Views

i02450263

Model View Illustrations

SMCS Code: 1000

The following model views display typical features of the generator sets that are described in this manual. The operator should become familiar with the locations of these items. Due to individual applications, your generator set may appear different from the illustrations.



g01223275

Illustration 41

(1) Radiator filler cap
(2) Secondary fuel filter
(3) Primary fuel filter/water separator
(4) Breather canister
(5) Engine Control Module (ECM)
(6) Air Cleaner
(7) Generator terminal box
(8) Control panel
(9) Distribution panel
(10) Engine oil filter
(11) Manual sump pump for engine oil drain
(12) Engine oil level gauge (dipstick)
(13) Engine oil filler

Product Identification Information

i02299510

Engine Identification

SMCS Code: 1000

The engines are identified by a serial number. This number is shown on a serial number plate that is mounted on the left hand side of the engine block.

An example of an engine number is REU090001H.

RE _____Type of engine

U _____Built in the United Kingdom

0900001 _____Engine Serial Number

H _____Year of Manufacture

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

i02461803

Plate Locations and Film Locations

SMCS Code: 1000

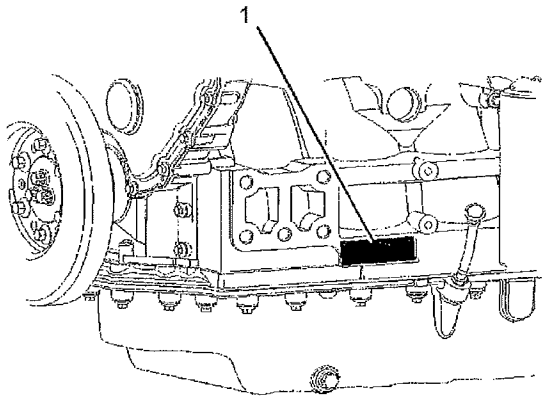


Illustration 42 g01144128

Location of the serial number plate

Serial Number Plate (1)

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

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

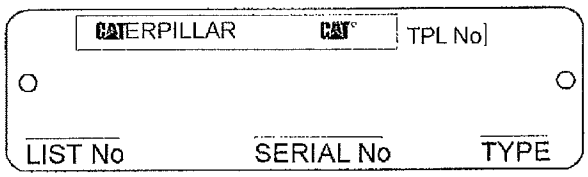


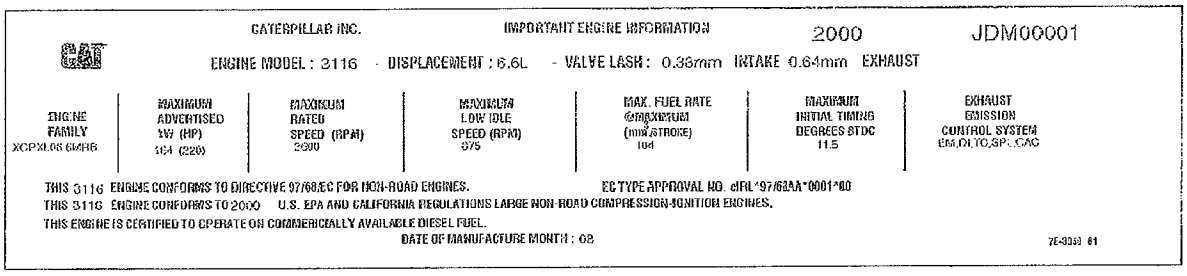
Illustration 43 g01159926

Serial number plate

Emissions Certification Film

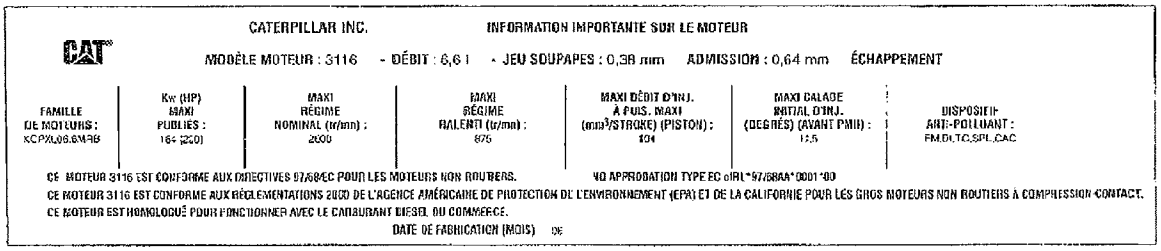
Note: This information is pertinent in the United States, in Canada and in Europe.

A typical example is shown.



FMT:3500

The EPA/EU Emissions Certification Film (if applicable) is located either on the side, the top, or the front of the engine.



Étiquette d'homologation anti-pollution

L'autocollant d'homologation du dispositif antipollution EPA/EU (selon équipement) est situé soit sur le côté du moteur, soit sur le dessus du moteur, soit sur le devant du moteur.

Illustration 44

g00776690

This information is pertinent in the United States and in Canada.

IMPORTANT ENGINE INFORMATION	CAT Manufacturer Perkins Engines Co. LTD	Engine Type
Engine Family: 5PKXL04.4RH2 List: Displacement: 4.4 List: RH37881	E11 Refer to Manufacturer	Factory setting | Reset if Applicable
EPA Family Max Values: Advertised kw:86. Fuel Rate: 85.0 mm3/stk Init. Timing:0 DEG ATDC idle RPM: ****	e11*97/68FA* 2001/63*0247*00	☐ 2372/2500 ☐ ☒ 2372/2500 ☐ ☐ ☐ ☐ ☐
Settings are to be made with engine at normal operating temperature with transmission in neutral. This engine conforms to 2004 U.S. EPA non - road and California off - road Regulations for large C.I. engines and is certified to operate on commercially available diesel fuel.		
Emission Control System: **** ** ECM	Valve Lash Cold (inch): Exhaust 0.*** Inlet 0.***	Engine Label
Hanger No.	position (**)	Label No. 3181A081
		Use Service Tool to verify current engine settings

g01159950

Illustration 45

Typical example

i02293163

Generator Lead Connections

SMCS Code: 4450

⚠ 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

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.**
- **Remove all fuses.**
- **Make sure the generator engine is stopped.**
- **Make sure all batteries are disconnected.**
- **Make sure all capacitors are discharged.**

Failure to do so could result in personal injury or death. Make sure residual voltage in the rotor, stator and the generator is discharged.

⚠ WARNING

Accidental engine starting can cause injury or death to personnel working on the equipment.

To avoid accidental engine starting, disconnect the battery cable from the negative (−) battery terminal. Completely tape all metal surfaces of the disconnected battery cable end in order to prevent contact with other metal surfaces which could activate the engine electrical system.

Place a Do Not Operate tag at the Start/Stop switch location to inform personnel that the equipment is being worked on.

Grounding the Frame

In any generator set installation, the frame of the generator must be positively connected to an earth ground. 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 mounting pads, the ground connection must be flexible in order to avoid possible breakage in later operation.

Ground connection cable or straps should have at least the current carrying capacity of the largest line lead to the connected load. Joints in cables or 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). Joints that are silver soldered and bolted are preferred.

Neutral Connections

The generators with a Wye Configuration usually have the neutral ground when the generator is installed. Grounding the neutral is for preventing damage to equipment.

If the neutral wire is grounded and one of the phase leads becomes grounded, the excessive current will open a load circuit breaker. Also, the excessive current will cause the generator voltage to collapse. The result depends on the following items: electrical characteristics of the generator , type of fault, and trip rating of the circuit breaker. An undervoltage device may be required in order to provide an adequate short circuit protection.

There are some cases when the neutral wire is not grounded. An ungrounded generator neutral lead is acceptable when the possibility of grounds to the phase leads has been eliminated. An example of such measures are ground fault protective circuits. Ground fault protection requires the entire group of distribution circuits to be treated as a system. The owner should contact a certified consultant if a new distribution system is being developed. The owner should also contact a certified consultant if an existing system should be modified for the ground fault protection.

Single Units

Each unit should be connected to a common ground.

In a three-phase, four-wire system, the neutral wire should be grounded according to local wiring codes.

Be sure to check your local wiring codes.

Connection Diagrams

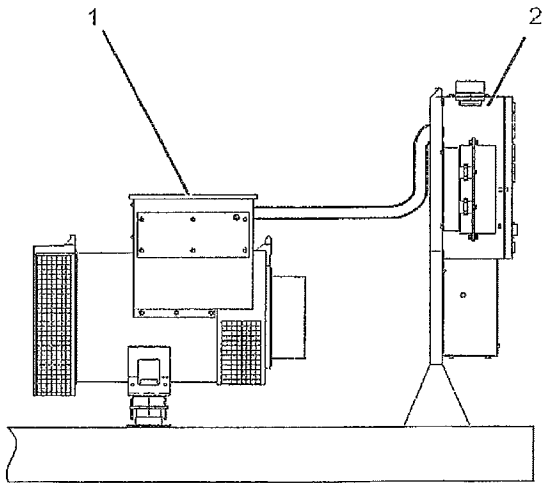


Illustration 46 g01148000

The generator lead connections are located in the terminal box on the generator or in the enclosure for the control panel.

(1) Terminal Box on the Generator
(2) Enclosure for the Control Panel

The generator lead connections are located in the terminal box on the generator or in the enclosure for the control panel.

Change the position of the wire terminals in order to modify the connection. The code for the winding is specified on the nameplate.

Wiring Code A for Three-Phase Configuration

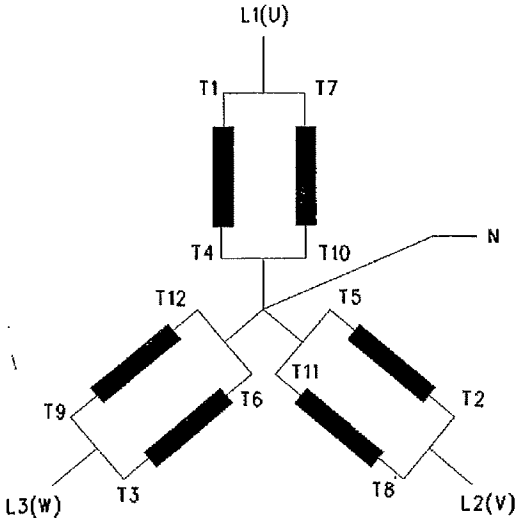


Illustration 47 g00952030

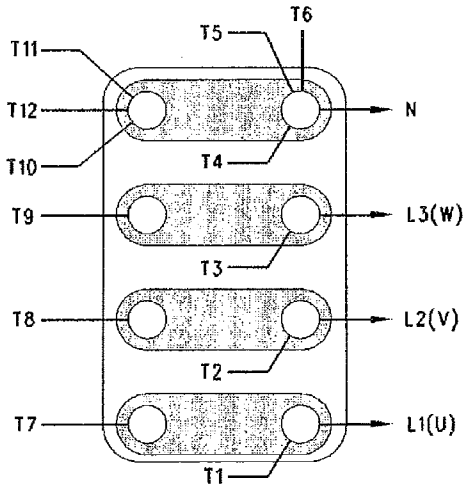


Illustration 48 g00952058

Factory connection for "A" wiring code

Table 1

L-L Voltage for Wiring Code A		
Winding	**50 Hz**	**60 Hz**
6	190-208	190-240
7	220-230	-
8	-	190-208

R 230 voltage sensing – 0 => (T8) / 110 V => (T11)

R 438 LS voltage sensing – 0 => (T3) / 220 V => (T2)

Wiring Code B for Single-Phase Configuration or Three-Phase Configuration

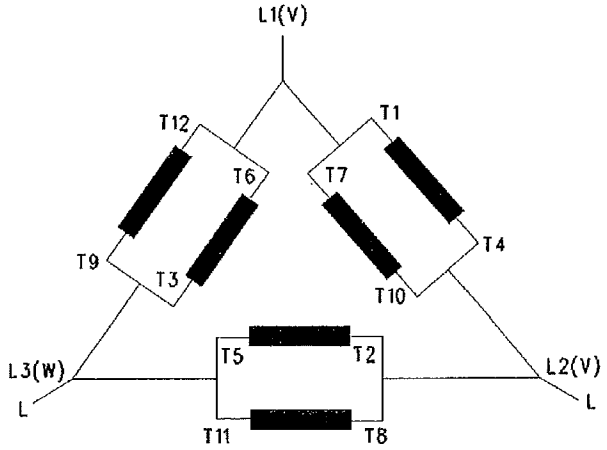


Illustration 49 g00952097

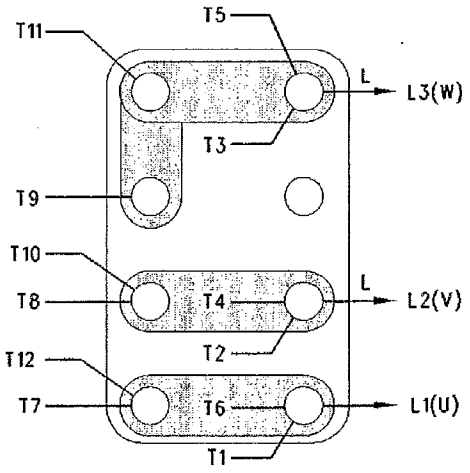


Illustration 50 g00952196

Factory connection for "B" wiring code

Table 2

L-L Voltage for Wiring Code B		
Winding	50 Hz	60 Hz
6	110-120	120
7	120-130	-
8	-	110-120

R 230 voltage sensing – 0 => (T8) / 110 V => (T11)

R 438 LS voltage sensing – 0 => (T3) / 110 V => (T2)

Wiring Code D for Three-Phase Configuration

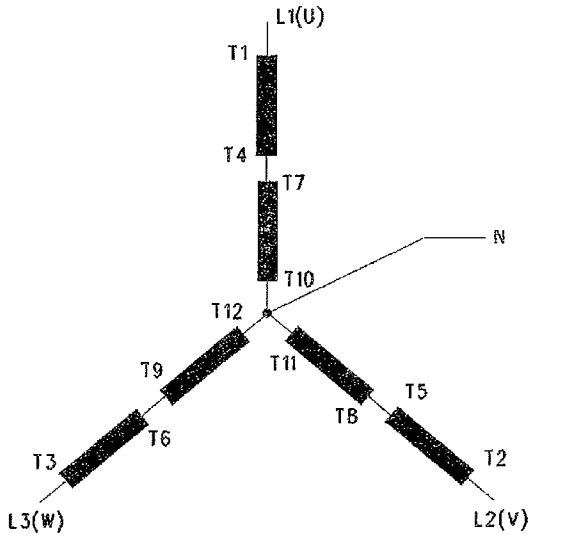


Illustration 51 g00952201

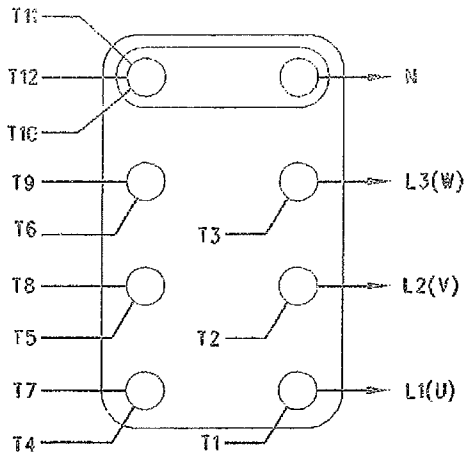


Illustration 52 g00952365

Factory connection for "D" wiring code

Table 3

L-L Voltage for Wiring Code D		
Winding	**50 Hz**	**60 Hz**
6	380-415	380-480
7	440-460	-
8	-	380-416

R 230 voltage sensing – 0 => (T8) / 110 V => (T11)

R 438 LS voltage sensing – 0 => (T3) / 380 V => (T2)

Wiring Code F for Single-Phase Configuration or Three-Phase Configuration

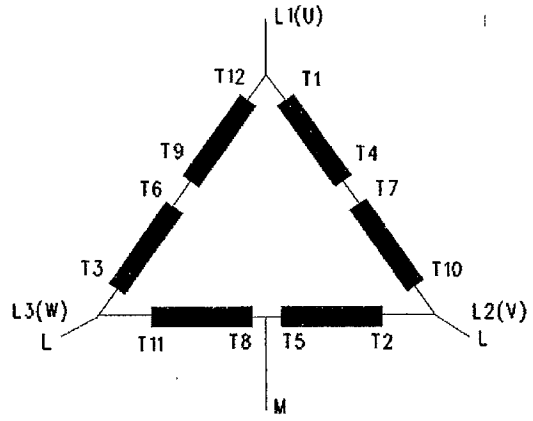


Illustration 53 g00952381

Voltage LM equals one half of voltage LL.

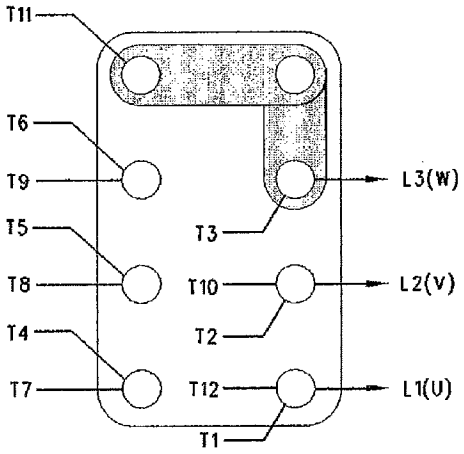


Illustration 54 g00952390

Factory connection for "F" wiring code

Table 4

L-L Voltage for Wiring Code F		
Winding	50 Hz	60 Hz
6	220-240	220-240
7	250-260	-
8	200	220-240

R 230 voltage sensing – 0 => (T8) / 110 V => (T11)

R 438 LS voltage sensing – 0 => (T3) / 220 V => (T2)

Wiring Code FF for Single-Phase Configuration

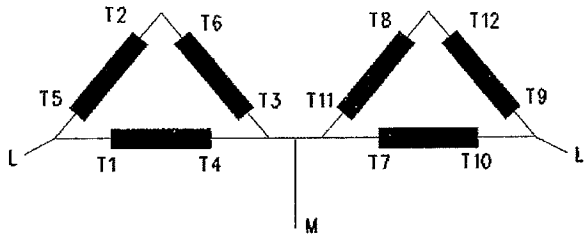


Illustration 55 g00952416

Voltage LM equals one half of voltage LL.

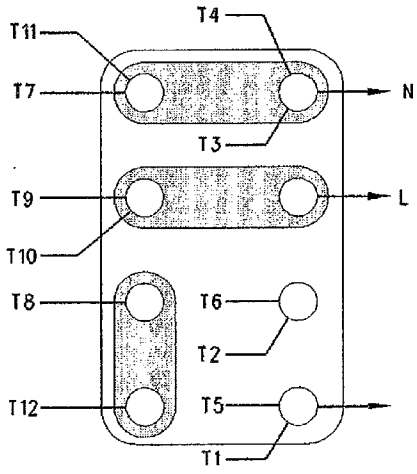


Illustration 56 g00952430

Factory connection for "FF" wiring code

Table 5

L-L Voltage for Wiring Code FF		
Winding	50 Hz	60 Hz
6	220-240	220-240
7	250-260	-
8	200	220-240

R 230 voltage sensing – 0 => (T1) / 110 V => (T4)

R 438 LS voltage sensing – 0 => (T10) / 220 V => (T1)

1000 Series Generators, Single Phase with 4 Leads, Winding Dedicated Type M or Type M1

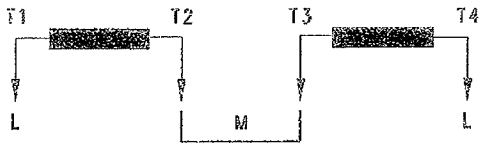


Illustration 57 g00952989

Wiring diagram for a connection in series

Table 6

Voltage at 50/60 Hz		Connect.	Output		
L-L	L-M		L	L	M
220	110	T2 - T3	T1	T4	T2 - T3
230	115				
240	120				

R 230 voltage sensing – 0 => (T1) / 110 V => (T2)

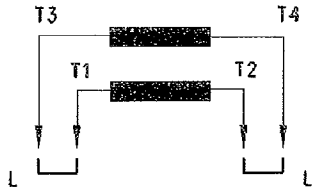


Illustration 58 g00953002

Wiring diagram for a parallel connection

Table 7

Voltage at 50/60 Hz		Connect.	Output		
L-L	L-M		L	L	M
110	-	T1 - T3 T2 - T4	T1 - T3	T2 - T4	-
115	-				
120	-				

R 230 voltage sensing – 0 => (T1) / 110 V => (T2)

2000/3000 SeriesConnections for Exciter Field

Connection for Series Arrangement (SHUNT)

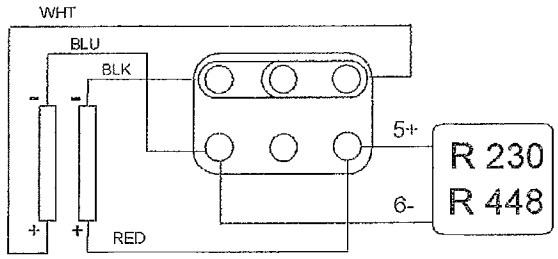


Illustration 59 g01147977

(WHT) White
(BLU) Blue
(BLK) Black
(RED) Red

Connection for Parallel Arrangement (AREP excitation and PMG excitation)

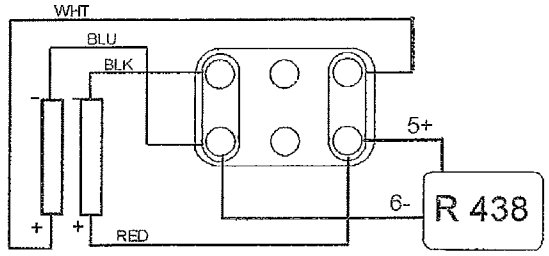


Illustration 60 g01147978

(WHT) White
(BLU) Blue
(BLK) Black
(RED) Red

R 791 T Interference Suppression

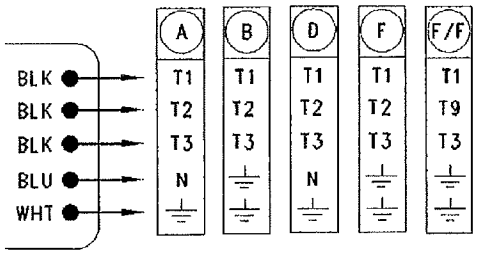


Illustration 61 g00953025

Connect the interference suppression, as shown. The letters in the circles represent the wiring codes for the generators.

(BLK) Black
(BLU) Blue
(WHT) White
(A) Wiring code "A"
(B) Wiring code "B"
(D) Wiring code "D"
(F) Wiring code "F"
(FF) Wiring code "FF"

Operation Section

Lifting and Storage

i02472970

Product Lifting

SMCS Code: 1000; 1404; 7002

Lifting of Generator Sets

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, if necessary. All supporting members (chains and cables) should be parallel to each other. The chains and cables should be perpendicular to the top of the object that is being lifted.

Some removals require lifting the fixtures in order to obtain proper balance and safety. Consult your Caterpillar dealer for information regarding fixtures for proper lifting of your complete package.

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

On some enclosed generator sets, it may be necessary to remove a top panel of the enclosure in order to access the lifting eye.

Illustration 62 g01034418

The lifting labels are located on the lifting eyes. These labels designate the proper lifting locations for the generator set. Some generator sets may be lifted at the base of the generator set and other generator sets may have a single lifting point on top of the generator set.

Engine Lifting with a Fuel Tank

Do not lift the unit with fuel in the fuel tank.

i02283885

Product Storage

SMCS Code: 1000; 1404; 7002

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

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

- Complete all of the lubrication recommendations that are listed in this Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).
- If freezing temperatures are expected, check the cooling system for adequate protection against freezing. See this Operation and Maintenance Manual, "Refill Capacities and Recommendations" (Maintenance Section).

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

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 in order 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 Operation and Maintenance Manual, "Insulation - Test". Dry the generator if the insulation is not acceptable. refer to this Operation and Maintenance Manual, "Generator - Dry".

Installation

i02290564

Generator Set Installation

SMCS Code: 7002

Receiving Inspection

If the generator is received during cold weather, allow the unit to reach room temperature before you remove the protective packing material. Warming the generator to room temperature will prevent the following problems:

- Water condensation on cold surfaces
- Early failures due to wet windings
- Early failures due to wet insulating materials

Unpacking

Moving the Generator

⚠ WARNING

Improper lift rigging can allow unit to tumble causing injury and damage.

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

Unpack the equipment with care in order to avoid scratching painted surfaces. Move the unit to the mounting location. The unit can be moved by either of the following methods:

- Attach an overhead crane to the lifting eye that is installed on the generator package.
- Use a lift truck in order to lift the generator.

The hoist and the hoist cables should have a rating that is greater than the weight of the generator. When the unit is moved, ensure that the generator is completely supported by the lift truck's fork tines. Also ensure that the generator is balanced on the lift truck's fork tines. Slide the fork tines beneath the attached skid in order to lift the generator.

Location

The location of the generator must comply with all local regulations. The location of the generator must also comply with all special industrial regulations. Locate the generator in an area that meets the following requirements:

- Clean
- Dry
- Well ventilated
- Easily accessible for inspection and maintenance

Do not obstruct air inlet openings. Do not obstruct discharge openings. Coolant flow must reach these openings. If the generator is exposed to harsh environmental conditions, the generator can be modified in the field in order to add filters and space heaters. In addition, a more rigid periodic maintenance schedule should be established.

Remote Fuel Tanks and Auxiliary Fuel Tanks

Connect the generator to a remote fuel tank or an auxiliary fuel tank, if necessary. The tank should have good clean fuel and there should be provisions for draining water and sediment from the fuel tank. Refer to this Operation and Maintenance Manual, "Fuel Tank Water and Sediment - Drain".

Connect the tank to the fuel supply fitting and the fuel return fitting on the generator set.

Electrical Measurements

Measure the insulation resistance of each winding if the generator was exposed to the following conditions:

- Rapid changes in temperature
- Freezing
- Wet climate during shipment
- Wet climate during storage

Refer to this Operation and Maintenance Manual, "Insulation - Test".

Note: These tests should be conducted prior to any power connections or control connections that are being made.

Features and Controls

i02353372

Control Panel

SMCS Code: 7451

This section describes basic operation of the control panel. For more information, refer to Systems Operation/Testing and Adjusting, RENR7902, "EMCP 3".

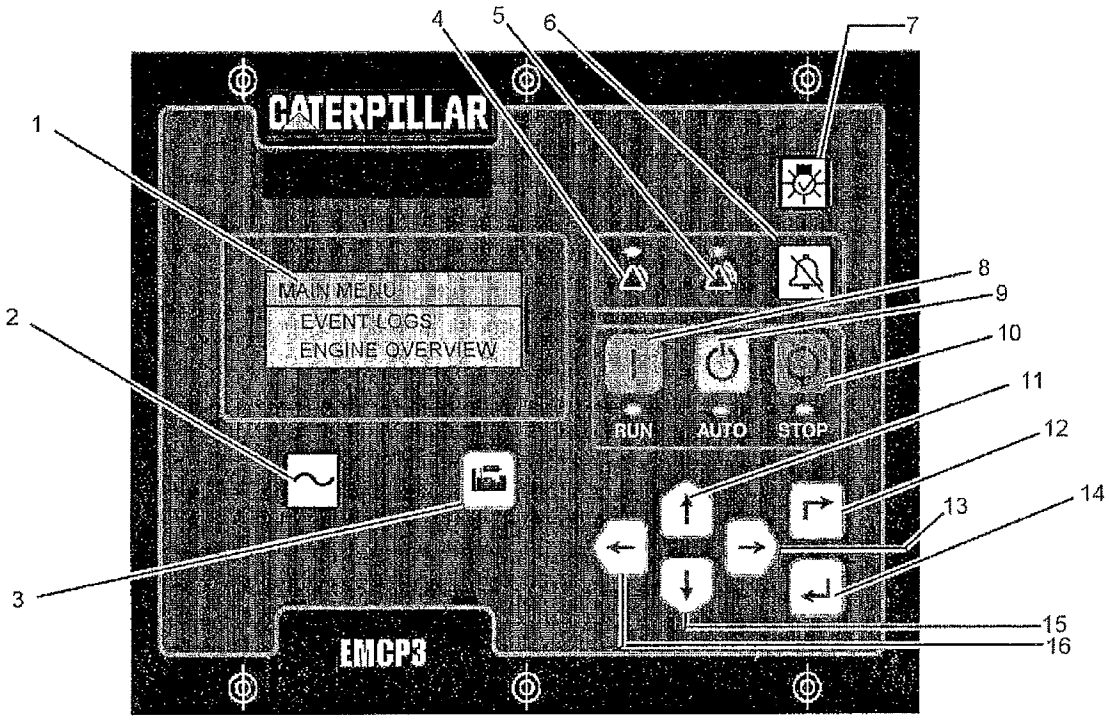


Illustration 63 g01045431

(1) Display Screen
(2) AC Overview Key
(3) Engine Overview
(4) Yellow Warning Lamp
(5) Red Shutdown Lamp
(6) Alarm Acknowledge/Silence Key
(7) Lamp Test Key
(8) Run Key
(9) Auto Key
(10) Stop Key
(11) Scroll Up Key
(12) Escape Key
(13) Scroll Right Key
(14) Enter Key
(15) Scroll Down Key
(16) Scroll Left Key

Navigation Keys

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

Engine Overview – The Key for Engine Overview (3) will navigate the display to the first screen of engine information. The engine information contains various engine parameters that summarize the operation of the generator set.

Alarm Acknowledge/Silence – Pressing the key for Alarm Acknowledge/Silence (6) will cause the output for the horn relay to turn off. This will silence the horn. Pressing the key will also cause any yellow or red flashing lights to turn off or pressing the key will cause the lights to illuminate depending on the active status of the alarms. The key for Alarm Acknowledge/Silence may also be configured to send a signal for global alarm silence on the J1939 Data Link which will silence horns on annunciators.

Lamp Test – Pressing and holding the Lamp Test Key (7) will cause all of the LED indicators and the display screen pixels to illuminate until the key is released.

RUN – Pressing the "RUN" Key (8) will cause the engine to enter the "RUN" mode.

AUTO – Pressing the "AUTO" Key (9) will cause the engine to enter the "AUTO" mode.

STOP – Pressing the "STOP" Key (10) will cause the engine to enter the "STOP" mode.

Scroll Up Key – The"Scroll Up Key" (11) is used to navigate through the various menus or the screens for monitoring. The Scroll Up Key is also used during entering setpoints. When data is entered, the Scroll Up Key is used in order to increment the digits 0 through 9. If the setpoint requires selection from a list, the Scroll Up Key is used to navigate through the list.

Escape – The Escape Key (12) is used for navigating through the menus. Use the escape Key in order to navigate through the menus and the submenus. Each keystroke causes the user to move upward through the menus. The Escape Key is also used in order to cancel out the screens that are used to enter the data for the setpoints. If the Escape Key is pressed during the programming of setpoints, none of the changes that have been made on the screen will be saved to the memory.

Scroll Right Key – The Scroll Right Key (13) is used during setpoint adjustment. The Scroll Right Key is used to edit the digits when data is being entered into the system. The Scroll Right Key is also used during certain setpoint adjustments in order to select a check box or the Scroll Right Key is used to unselect a check box. If a box has a check mark that is inside the box, pressing the Scroll Right Key will cause the check mark to disappear. This will disable the function. If the box does not have a check mark inside the box, pressing the Scroll Right Key will cause a check mark to appear. This will enable the function.

Enter – The Enter Key (14) is used in order to navigate forward in the menus and the submenus. The Enter Key is also used during the programming of setpoints in order to save changes to the setpoints. Pressing the Enter Key during the programming of the setpoints causes the changes to the setpoints to be saved to memory.

Down – The Down Key (15) is used in order to navigate through the various menus and monitoring screens. The Down Key is also used during the programming of setpoints. The Down Key is used in order to decrement "0" through "9" when the data is entered into the system. The Down Key is used in order to move downward through the list for selecting an item for the setpoint.

Scroll Left Key – The Scroll Left Key (16) is used during setpoint adjustment. The Scroll Left Key is used to choose the digit that is edited when the data is entered into the system. The Scroll Left Key is also used during certain adjustments to setpoints in order to select a check box or the Scroll left key is used to unselect a check box. If a box has a check mark inside the box, pressing the Scroll Left Key will cause the check mark to disappear. This will disable the function. If the box does not have a check mark inside the box, pressing the Scroll Left Key will cause a check mark to appear. This will enable the function.

Alarm Indicators

Yellow Warning Lamp – A flashing yellow lamp indicates that there are active warnings that have not been acknowledged. A solid yellow lamp indicates that there are active warnings that have not been acknowledged. If there are any active warnings, the yellow lamp will change from flashing yellow to solid yellow after the key for Alarm Acknowledge/Silence (6) is pressed. If there are no longer any active warnings, the yellow lamp will turn off after the Key for Alarm Acknowledge/Silence (6) is pressed.

Red Shutdown Lamp – A flashing red lamp indicates that there are active shutdown conditions that have not been acknowledged. A solid red lamp indicates that there are acknowledged shutdown conditions that are active. If there are any active shutdown conditions the red lamp will change from flashing red to solid red after the key for Alarm Acknowledge/Silence (6) is pressed. Any condition that has caused a shutdown condition must be manually reset. If there are no longer any active shutdown conditions, the red lamp will turn off.

Basic Operation

Engine Starting Sequence

1. The EMCP 3 receives an engine start signal. The signal will be one of three.
   - The operator presses the "RUN" Key.
   - The control is in "AUTO" and the remote initiate input becomes active.

- The operator presses the "AUTO" Key and a start command is sent via the RS-485 SCADA Data Link.

2. The EMCP 3 checks the system before the crank cycle begins. The EMCP 3 checks that no system faults are present. The EMCP 3 checks that all previous shutdown faults have been reset. The EMCP 3 also checks that the engine is not already running. If the engine is equipped with prelube, the EMCP 3 checks the status of the prelube. If the prelube is not complete, the EMCP 3 will not crank the engine.

3. The EMCP 3 begins the crank cycle.

4. The EMCP 3 cranks the engine until the cycle crank time reaches the setpoint for total crank time or until the engine starts.

5. The EMCP 3 deactivates the starting motor relay (SMR) when the engine speed reaches the setpoint for crank terminate speed.

Engine Stopping Procedure

1. The EMCP 3 will receive an engine stop signal. The signal will be one of three.

   - The operator presses the "STOP" Key.
   - The control is in "AUTO" and the remote initiate input becomes inactive.
   - The operator presses the "AUTO" Key and a stop command is sent via the RS-485 SCADA Data Link.

2. After receiving the signal to stop, the EMCP 3 checks that there are no present system faults.

3. The EMCP 3 begins the cooldown period. In order to bypass the cooldown period, hold down the "STOP" Key. "PRESS ENTER TO BYPASS PRESS ESCAPE TO CONTINUE" will be shown on the display. Press the Enter Key in order to bypass the cooldown period or press the Escape Key in order to continue the cooldown period.

4. After the cooldown period, the EMCP 3 initiates a engine shutdown by turning off the fuel supply.

   a. The EMCP 3 deactivates the fuel control relay (FCR), which will stop the engine.

Viewing Events

Information from the EMCP 3 is displayed on the display screen (1). The arrow keys on the keypad are used in order to navigate through the main menu. Press the UP key (11) or the DOWN key (15) in order to highlight the main menu options.

Press the "Enter" key (14) in order to select one of the main menu options. The arrow keys are used in order to view one of the setpoints.

The EMCP 3 will power up to the screen with the main menu. If the EMCP 3 is already powered up, press the "Escape" key (12) in order to return to the main menu.

The event monitoring system uses the following terms to describe the status of an Event:

PRESENT – The condition that caused the event is present and the condition is affecting the behavior of the system.

ACTIVE – The event was previously present but the condition is no longer present. The condition has been recorded by the event monitoring system and the event monitoring system needs to be reset before the engine can be restarted.

INACTIVE – The event was active at some time but the event is no longer active. The condition is not affecting the behavior of the system.

Perform the following steps in order to view one of the events.

1. From the main menu, highlight "Event Log".

2. Press the "ENTER" key (14).

3. Select an ECM and press the "ENTER" key (14).

4. In order to scroll through the Events, use the "UP" and "DOWN" keys.

5. Press "ENTER" after highlighting an event in order to see additional information such as SPN, FMI, time and the date of the first occurrence, time and date of the last occurrence, engine hours at the first occurrence, and engine hours at the last occurrence.

Resetting Events

A flashing red shutdown lamp indicates that there is an engine shutdown event that has not been acknowledged. The red shutdown lamp will change from flashing red to solid red when the Alarm Acknowledge/Silence key is pressed. Use the following procedure in order to reset the event.

1. Press the STOP Key (10). Enter the "EVENT LOG" option from the main menu.
2. Select an ECM from the list.
3. Scroll through the events in order to highlight the active events.
4. Make sure that the condition that caused the event is no longer present.
5. Press the Enter Key.
6. "RESET" will be highlighted if the condition is no longer present and the control is in "STOP".
7. Press the Enter Key again.

   The fault will be cleared and the red shutdown lamp will be turned off, if there are no other active shutdown conditions.
8. Press the Escape Key 3 times in order to get back to the main menu.

i02398069

Voltage Regulators

SMCS Code: 4467

⚠ 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

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.**
- **Remove all fuses.**
- **Make sure the generator engine is stopped.**
- **Make sure all batteries are disconnected.**
- **Make sure all capacitors are discharged.**

Failure to do so could result in personal injury or death. Make sure residual voltage in the rotor, stator and the generator is discharged.

⚠ WARNING

Accidental engine starting can cause injury or death to personnel working on the equipment.

To avoid accidental engine starting, disconnect the battery cable from the negative (−) battery terminal. Completely tape all metal surfaces of the disconnected battery cable end in order to prevent contact with other metal surfaces which could activate the engine electrical system.

Place a Do Not Operate tag at the Start/Stop switch location to inform personnel that the equipment is being worked on.

The voltage regulator is located in the enclosure for the control panel or in the terminal box on the generator.

The voltage regulator is powered by two auxiliary windings. These windings are independent from the circuit for detection of voltage. The first winding is labelled as "X1" and "X2". This winding has a voltage that is proportional with the output voltage of the generator. The second winding is labelled as "Z1" and "Z2". This winding has a voltage that is proportional to the current of the stator. The voltage from the power supply is rectified and filtered before being used by the regulator monitoring transistor. This principle ensures that regulation is not affected by interference that is generated by the load.

These voltage regulators may have an optional remote potentiometer for voltage adjustment. This potentiometer is 450 ohms 0.5 W minimum. The adjustment range is 5%. The voltage range is limited by the internal potentiometer "P2". Remove "ST4" in order to connect the potentiometer. A 1000 ohm potentiometer can also be used to extend the adjustment range.

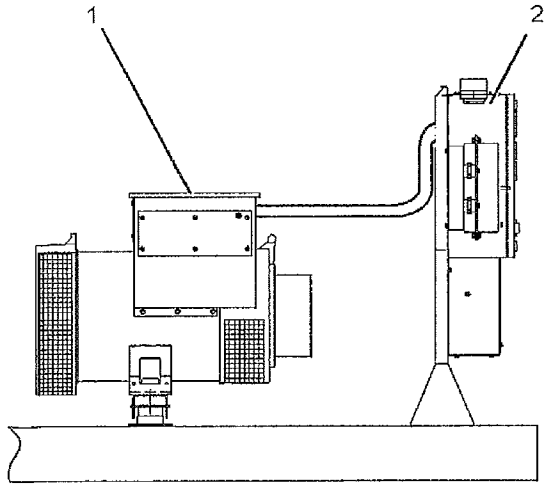


Illustration 64 g01148000

The voltage regulator is located in the terminal box on the generator or in the enclosure for the control panel.

(1) Terminal Box on the Generator
(2) Enclosure for the Control Panel

R230 Adjustments

Table 8

R230 Regulator	
Voltage regulation	±0.5%
Voltage detection range	85 to 139 V (50/60 Hz)
Rapid response time for a transient voltage variation amplitude of ±20%	500 ms
Voltage setting	"P1"
Stability setting	"P2"
8 Amp Fuse for protection of the power supply	10 amperes for 10 seconds
50 or 60 Hz selection with jumper "ST3"(1).	
Underspeed protection and adjustment of frequency threshold via potentiometer "P3"	

(1) The engine speed setting must be changed in order to change the frequency of the generator set.

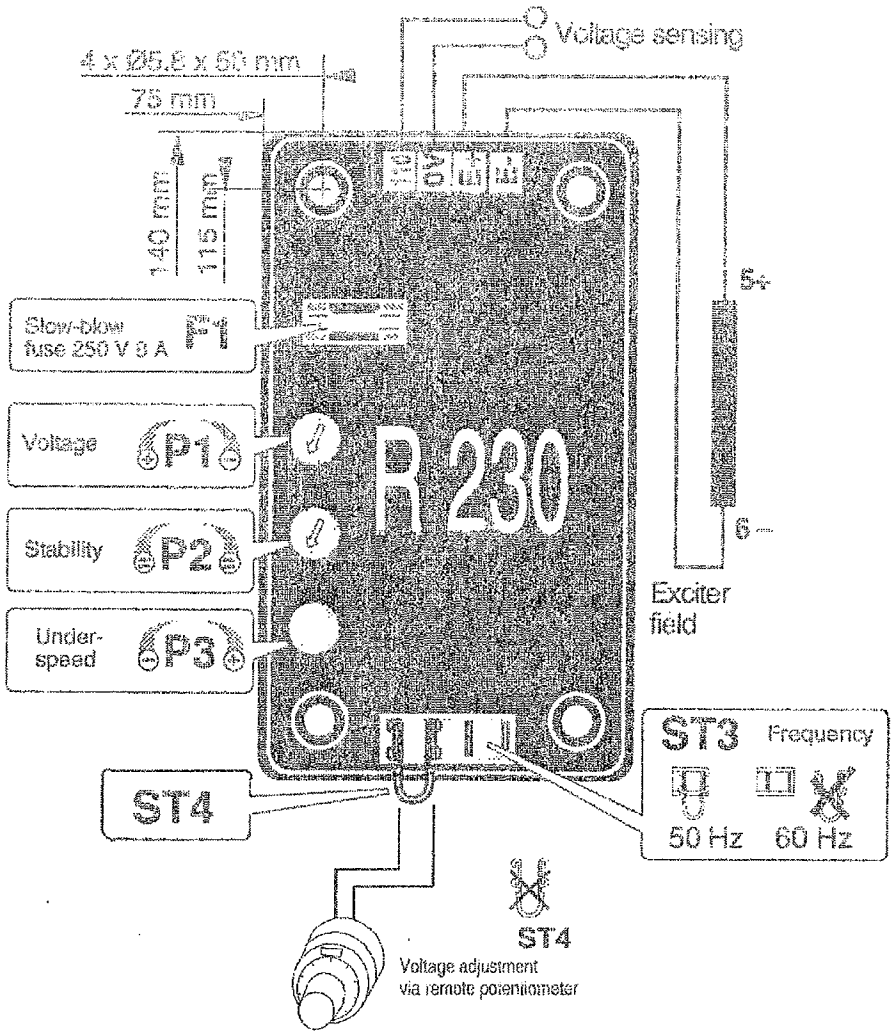


Illustration 65 g00952495

R230 Voltage Regulator with components

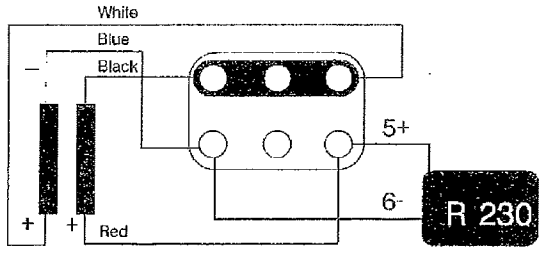


Illustration 66 g00952510

R230 connections

Use the following procedure to adjust the R230 voltage regulator.

1. Make sure that the ST3 wire is connected for 50 Hz applications. Remove the ST3 wire for 60 Hz applications. Also, the engine speed must be changed from the factory setting in order to change the frequency of the generator.

2. Turn potentiometer P1 to the full counterclockwise position.

3. Turn the potentiometer ST4 to the middle of the total rotation for the potentiometer ,if equipped. Run the generator at the rated speed. If the voltage does not increase, the field may need to be energized. Refer to the "Special Use" section.

4. Turn potentiometer P1 until the rated output voltage is obtained.

5. Adjust the stability with potentiometer P2.

6. The sealed potentiometer P3 is set at the factory for 50 Hz or 60 Hz.

R438 and R448 Adjustments

NOTICE
ST9 must be closed for AREP excitation.

Table 9

R438 and R448 Automatic Voltage Regulators	
Maximum current for short circuit	3 x In for 10 seconds
Standard power supply	Two auxiliary windings
Supply for shunt	max 48 VAC at 50/60 Hz
Rated overload current	8 amperes for 10 seconds
Electronic protection for overload and short circuit opening on voltage sensing	Excitation ceiling current for 10 seconds and return to approximately 1 ampere **THE GENERATOR MUST BE STOPPED IN ORDER TO RESET THE PROTECTION.**
Fuse "F1" on input side	"X1" and "X2"
Fuse "F2" on output side	"E+" and "E-"
Voltage sensing	5 VAC that is isolated by the transformer
Terminals for 0 to 110 VAC	95 to 140 ACV
Terminals for 0 to 220 VAC	170 to 260 ACV
Terminals for 0 to 380 VAC	340 to 520 VAC
Voltage regulation	±1%
Rapid response time or normal response time from the location of jumper "ST2"	
Voltage adjustment via potentiometer "P2"(other voltages via the step down transformer)	
Underspeed protection and adjustment of frequency threshold via potentiometer "P4"	
Maximum adjustment for excitation via potentiometer "P5" (4.5 to 10 amperes)	
50 or 60 Hz selection with jumper "ST3"(1).	

(1) The engine speed setting must be changed in order to change the frequency of the generator set.

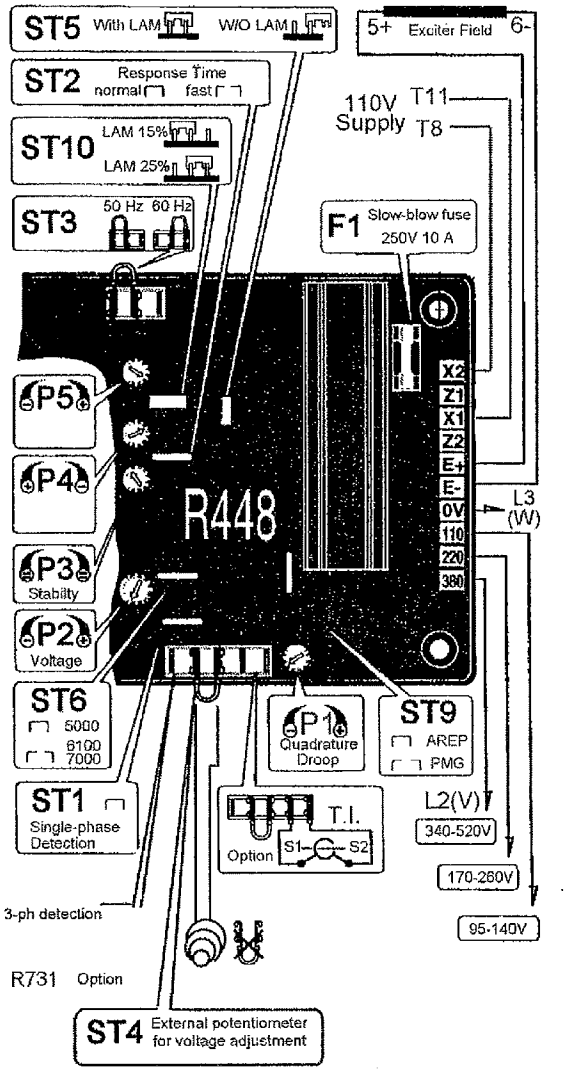


Illustration 67 g01144712

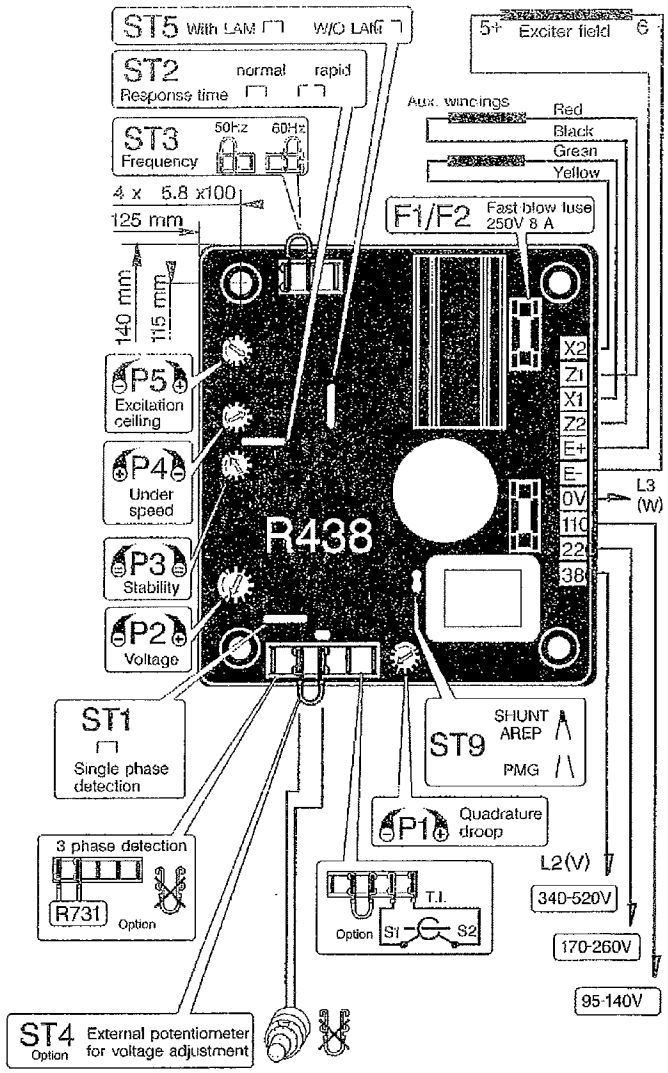


Illustration 68

g00952512

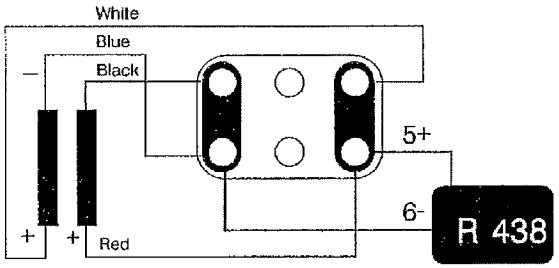


Illustration 69 g00952515

R438 connections

Use the following procedure to adjust the R438 voltage regulator.

1. Remove wire ST4.
2. Connect an analog voltmeter that is calibrated for 50 VDC on terminal E+ and terminal E-.
3. Connect a voltmeter that is calibrated for 300 VAC to 500 VAC or 1000 VAC.
4. Make sure that the ST3 wire is positioned on the desired frequency. Also, the engine speed must be changed from the factory setting in order to change the frequency of the generator.
5. Turn potentiometer (P2) to a full counterclockwise position.
6. Turn potentiometer (P4) to a full clockwise position.
7. Turn potentiometer (P3) counterclockwise to about 1/3 of the total rotation for the potentiometer.
8. Start the engine and set the engine speed to a frequency of 48 Hz for 50 Hz or 58 Hz for 60 Hz.
9. Adjust the output voltage to the correct value with potentiometer P2. This voltage should be the rated voltage UN for single operation or UN plus 2% to 4% for parallel operation. Use potentiometer P3 to make adjustments if the voltage oscillates. Adjust potentiometer P3 in both directions while you observe the voltage between E+ and E-. The voltage between E+ and E- should be approximately 10 VDC. The best response times are obtained at the limit of the instability. Try cutting or replacing the wire ST2 if no stable position can be obtained.
10. Check the LAM operation. ST5 must be closed.
11. Turn potentiometer (P4) slowly counterclockwise until there is a significant voltage drop. The voltage drop should be approximately 15 %.
12. Vary the frequency of both parts between 48 Hz or 58 Hz according to the operating frequency. Check the change in the voltage that was previously observed.

Use the following procedure in order to run the generator set in parallel operation.

1. Preset the unit for parallel operation by connecting the current transformer to S1 and S2 of the connector J2. Set potentiometer P1 for quadrature droop in the center position. Apply the rated load. The voltage should drop for 2% to 3%. Switch the positions of the two incoming secondary wires of the current transformer if the voltage increases.
2. The no-load voltages should be identical for all the generators that are operating in parallel. Connect the generators in parallel. Try to obtain a 0 kW power exchange by adjusting the speed of the generator. Try to minimize the circulating currents between generators by altering the voltage setting with potentiometer P2 or Rhe on one of the generators.

Note: Do not change the voltage settings after this step.

3. Apply the available load. The setting is correct only if a reactive load is available. Equalize the Kilowatts or divide the rated power of the units proportionally by altering the speed. Equalize or divide the currents by altering the quadrature droop potentiometer.

R438 and R448 Adjustment for Maximum Excitation

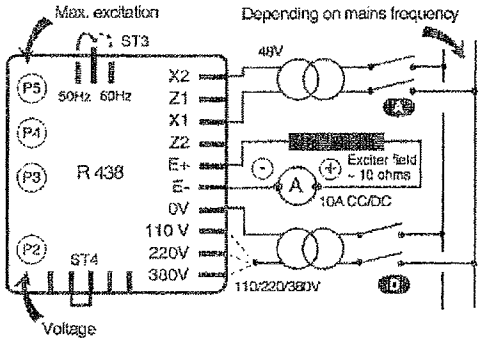


Illustration 70 g00952800

The factory setting corresponds to an excitation current that is required to obtain a three-phase short circuit current of 3 X IN at 50 Hz for industrial power, unless this is specified otherwise.

The maximum level of excitation may be reduced by a static method. The static method is safer for the generator and the network. Use the following steps to reduce the maximum excitation level.

1. Disconnect the power supply wires X1, X2, Z1 and Z2.
2. Disconnect sensing leads 0V, 110V, 220V and 380V on the generator.
3. Connect the main power supply 200V-240V, as shown. X1,X2:120V
4. Install a 10 Amp DC ammeter in series with the exciter field.
5. Turn potentiometer P5 to a full counterclockwise position and activate the power supply. If there is no output current from the voltage regulator, turn potentiometer P2 clockwise until the ammeter indicates a stable current.
6. Switch off the power supply. Switch on the power supply. Turn potentiometer P5 until the required maximum current is obtained. The maximum current must not be greater than 10 Amperes.

Use the following steps in order to check the internal protection.

1. Open switch D. The excitation current should increase up to the preset maximum value and the excitation current should remain at the preset maximum value for approximately 10 seconds. The current will decrease to less than 1 Amp.
2. Open switch A in order to reset the internal protection.

Note: The voltage must be adjusted after the maximum excitation current has been set.

Special Use

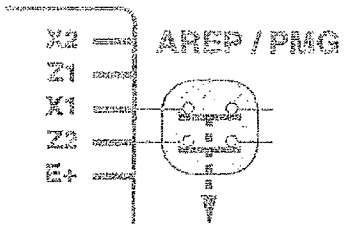


Illustration 71 g00952821

The exciter is switched off by disconnecting the power supply to the voltage regulator. The connection is identical for resetting the internal protection for the voltage regulator.

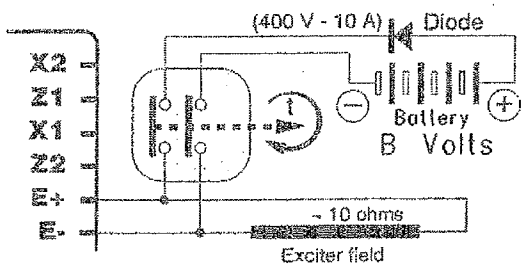


Illustration 72 g00952830

Use a 12 VDC power source in order to energize the field, if necessary. Refer to the following table.

Table 10

Applications	B Volts	Time
Voltage build up	12 (1A)	1 - 2 seconds
De-energized parallel operation	12 (1A)	1 - 2 seconds
Standby parallel operation	24 (2A)	5 - 10 seconds
Battery starting	48 (4A)	5 - 10 seconds
Voltage that is sustained at overload	48 (4A)	5 - 10 seconds

Engine Starting

i02322203

Starting the Engine

SMCS Code: 1000; 1450

Note: Do not adjust the engine speed control during start-up. The electronic control module (ECM) will control the engine speed during start-up.

Starting the Engine

1. Disengage any equipment that is driven by the engine.

2. Turn the keyswitch to the RUN position. Leave the keyswitch in the RUN position until the warning light for the glow plugs is extinguished.

3. When the warning light for the glow plugs is extinguished turn the keyswitch to the START position in order to engage the electric starting motor and crank the engine.

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.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again.

4. Allow the keyswitch to return to the RUN position after the engine starts.

5. Repeat step 2 through step 4 if the engine fails to start.

i02344933

Starting with Jump Start Cables

SMCS Code: 1000; 1401; 1402; 1900

⚠ WARNING

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

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

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

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

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

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

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

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

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

1. Turn the start switch on the stalled engine to the OFF position. Turn off all the engine's 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 fully recharge batteries that are severely discharged. 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

i01646252

Engine Operation

SMCS Code: 1000

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

The time that is needed for the engine to reach normal operating temperature can be less than the time 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.

i01457002

Fuel Conservation Practices

SMCS Code: 1000; 1250

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

- Avoid spilling fuel.

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

- Be aware of the properties of the different fuels. Use only the recommended fuels. 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. This will consume excess power and excess fuel.

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

- Ensure that all of the connections of the hoses are tight. The connections should not leak.

- Ensure that the driven equipment is in good working order.

- Cold engines consume excess fuel. Utilize heat from the jacket water system and the exhaust system, when possible. Keep cooling system components clean and keep cooling system components in good repair. Never operate the engine without water temperature regulators. All of these items will help maintain operating temperatures.

Engine Stopping

i02334873

Stopping the Engine

SMCS Code: 1000; 7000

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

Avoid accelerating the engine prior to shutting it down.

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

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

1. Remove the load from the engine. Reduce the engine speed (rpm) to low idle. Allow the engine to idle for five minutes in order to cool the engine.

2. Stop the engine after the cool down period according to the shutoff system on the engine and turn the ignition key switch to the OFF position. If necessary, refer to the instructions that are provided by the OEM.

Cold Weather Operation

i02525190

Cold Weather Operation

SMCS Code: 1000; 1250

Caterpillar Diesel Engines can operate effectively in cold weather. During cold weather, the starting and the operation of the diesel engine is dependent on the following items:

- The type of fuel that is used
- The viscosity of the engine oil
- The operation of the glow plugs
- Optional Cold starting aid
- Battery condition

Refer to Special Publication, SEBU5898, "Cold Weather Recommendations for Caterpillar Machines".

This section will cover the following information:

- Potential problems that are caused by cold weather operation
- Suggest steps which can be taken in order to minimize starting problems and operating problems when the ambient air temperature is between 0° to −40 °C (32° to 40 °F).

The operation and maintenance of an engine in freezing temperatures is complex . This is because of the following conditions:

- Weather conditions
- Engine applications

Recommendations from your Carerpillar dealer are based on past proven practices. The information that is contained in this section provides guidelines for cold weather operation.

Hints for Cold Weather Operation

- If the engine will start, operate the engine until a minimum operating temperature of 81 °C (177.8 °F) is achieved. Achieving operating temperature will help prevent the intake valves and exhaust valves from sticking.
- The cooling system and the lubrication system for the engine do not lose heat immediately upon shutdown. This means that an engine can be shut down for a period of time and the engine can still have the ability to start readily.
- Install the correct specification of engine lubricant before the beginning of cold weather.
- Check all rubber parts (hoses, fan drive belts, etc) weekly.
- Check all electrical wiring and connections for any fraying or damaged insulation.
- Keep all batteries fully charged and warm.
- Fill the fuel tank at the end of each shift.
- Check the air cleaners and the air intake daily. Check the air intake more often when you operate in snow.
- Ensure that the glow plugs are in working order. Refer to Testing and Adjusting Manual, "Glow Plug - Test".

⚠ WARNING

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

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

⚠ WARNING

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

- For jump starting with cables in cold weather, refer to the Operation and Maintenance Manual, "Starting with Jump Start Cables." for instructions.

Viscosity of the Engine Lubrication Oil

Correct engine oil viscosity is essential. Oil viscosity affects the amount of torque that is needed to crank the engine. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for the recommended viscosity of oil.

Recommendations for the Coolant

Provide cooling system protection for the lowest expected outside temperature. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for the recommended coolant mixture.

In cold weather, check the coolant often for the correct glycol concentration in order to ensure adequate freeze protection.

Engine Block Heaters

Engine block heaters (if equipped) heat the engine jacket water that surrounds the combustion chambers. This provides the following functions:

- Startability is improved.
- Warm up time is reduced.

An electric block heater can be activated once the engine is stopped. An effective block heater is typically a 1250/1500 W unit. Consult your Caterpillar dealer for more information.

Idling the Engine

When idling after the engine is started in cold weather, increase the engine rpm from 1000 to 1200 rpm. This will warm up the engine more quickly. Maintaining an elevated low idle speed for extended periods will be easier with the installation of a hand throttle. The engine should not be "raced" in order to speed up the warm up process.

While the engine is idling, the application of a light load (parasitic load) will assist in achieving the minimum operating temperature. The minimum operating temperature is 82 °C (179.6 °F).

Recommendations for Coolant Warm Up

Warm up an engine that has cooled below normal operating temperatures due to inactivity. This should be performed before the engine is returned to full operation. During operation in very cold temperature conditions, damage to engine valve mechanisms can result from engine operation for short intervals. This can happen if the engine is started and the engine is stopped many times without being operated in order to warm up completely.

When the engine is operated below normal operating temperatures, fuel and oil are not completely burned in the combustion chamber. This fuel and oil causes soft carbon deposits to form on the valve stems. Generally, the deposits do not cause problems and the deposits are burned off during operation at normal engine operating temperatures.

When the engine is started and the engine is stopped many times without being operated in order to warm up completely, the carbon deposits become thicker. This will cause the following problems:

- Free operation of the valves is prevented.
- Valves become stuck.
- Pushrods are bent.
- Other damage to valve train components can result.

For this reason, when the engine is started, the engine must be operated until the coolant temperature is 71 °C (160 °F) minimum. Carbon deposits on the valve stems will be kept at a minimum and the free operation of the valves and the valve components will be maintained.

In addition, the engine must be thoroughly warmed in order to keep other engine parts in better condition and the service life of the engine will be generally extended. Lubrication will be improved. There will be less acid and less sludge in the oil. This will provide longer service life for the engine bearings, the piston rings, and other parts. However, limit unnecessary idle time to ten minutes in order to reduce wear and unnecessary fuel consumption.

The Water Temperature Regulator and Insulated Heater Lines

The engine is equipped with a water temperature regulator. When the engine coolant is below the correct operating temperature jacket water circulates through the engine cylinder block and into the engine cylinder head. The coolant then returns to the cylinder block via an internal passage that bypasses the valve of the coolant temperature regulator. This ensures that coolant flows around the engine under cold operating conditions. The water temperature regulator begins to open when the engine jacket water has reached the correct minimum operating temperature. As the jacket water coolant temperature rises above the minimum operating temperature the water temperature regulator opens further allowing more coolant through the radiator to dissipate excess heat.

The progressive opening of the water temperature regulator operates the progressive closing of the bypass passage between the cylinder block and head. This ensures maximum coolant flow to the radiator in order to achieve maximum heat dissipation.

Note: Caterpillar discourages the use of all air flow restriction devices such as radiator shutters. Restriction of the air flow can result in the following: high exhaust temperatures, power loss, excessive fan usage, and reduction in fuel economy.

A cab heater is beneficial in very cold weather. The feed from the engine and the return lines from the cab should be insulated in order to reduce heat loss to the outside air.

Insulating the Air Inlet and Engine Compartment

When temperatures below −18 °C (−0 °F) will be frequently encountered, an air cleaner inlet that is located in the engine compartment may be specified. An air cleaner that is located in the engine compartment may also minimize the entry of snow into the air cleaner. Also, heat that is rejected by the engine helps to warm the intake air.

Additional heat can be retained around the engine by insulating the engine compartment.

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Fuel and the Effect from Cold Weather

SMCS Code: 1000; 1250

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

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

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

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

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

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

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

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

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

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

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

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

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

Maintenance Section

Refill Capacities

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Refill Capacities and Recommendations

SMCS Code: 1348; 1395; 7560

Engine Oil

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

Cat DEO (Diesel Engine Oil)

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

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

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

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

Cat DEO Multigrade is available in various viscosity grades that include SAE 10W-30 and SAE 15W-40. To choose the correct viscosity grade for the ambient temperature, see Table 11. Multigrade oils provide the correct viscosity for a broad range of operating temperatures. Multigrade oils are also effective in maintaining low oil consumption and low levels of piston deposits.

Cat DEO Multigrade can be used in other diesel engines and in gasoline engines. See the engine manufacturer's guide for the recommended specifications. Compare the specifications to the specifications of Cat DEO Multigrade. The current industry standards for Cat DEO are listed on the product label and on the data sheets for the product.

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

Note: Cat DEO in SAE 15W-40 exceeds the performance requirements for the following API categories: CI-4, CH-4, CG-4, CF-4, and CF. Cat DEO Multigrade exceeds the requirements of the Caterpillar Engine Crankcase Fluid-1 (ECF-1) specification. Cat DEO in SAE 15W-40 passes the following proprietary tests: sticking of the piston ring, oil control tests, wear tests, and soot tests. Proprietary tests help ensure that Caterpillar multigrade oil provides superior performance in Caterpillar Diesel Engines. In addition, Cat DEO Multigrade exceeds many of the performance requirements of other manufacturers of diesel engines. Therefore, this oil is an excellent choice for many mixed fleets. **True high performance oil is produced with a combination of the following factors: industry standard tests, proprietary tests, field tests, and prior experience with similar formulations. The design and the development of Caterpillar lubricants that are both high performance and high quality are based on these factors.**

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

Commercial Oils

Engine Crankcase Fluid Recommendations for all Caterpillar 3500 Series and smaller direct injection (DI) diesel engines

Note: If Cat DEO Multigrade is not used, use only commercial oils that meet the following categories.

- API CH-4 multigrade oils and API CI-4 multigrade oils are acceptable if the requirements of Caterpillar's ECF-1 specification are met. CH-4 oils and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 specification may cause reduced engine life.
- API CG-4 multigrade oils are acceptable for all Caterpillar diesel engines. When the API CG-4 oils are used, the oil drain interval should not exceed the standard oil drain interval for your engine.

Note: When oil meets more than one API category, the applicable footnote is determined by the highest API category that is met.

Example – An oil meets both the API CH-4 and the API CF oil categories. In this case, the API CH-4 applies.

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

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

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

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

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

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

Note: Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for additional information that relates to lubrication for your engine.

Lubricant Viscosity Recommendations

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

Refer to Table 11 (minimum temperature) in order to determine the required oil viscosity for starting a cold engine.

Refer to Table 11 (maximum temperature) in order to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

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

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

Table 11

Engine Oil Viscosities for Ambient Temperatures		
	Ambient Temperature	
Viscosity Grade	Minimum	Maximum
SAE 0W-20	−40 °C (−40 °F)	10 °C (50 °F)
SAE 0W-30	−40 °C (−40 °F)	30 °C (86 °F)
SAE 0W-40	−40 °C (−40 °F)	40 °C (104 °F)
SAE 5W-30	−30 °C (−22 °F)	30 °C (86 °F)
SAE 5W-40	−30 °C (−22 °F)	50 °C (122 °F)
SAE 10W-30	−18 °C (0 °F)	40 °C (104 °F)
SAE 10W-40	−18 °C (0 °F)	50 °C (122 °F)
SAE 15W-40	−9.5 °C (15 °F)	50 °C (122 °F)

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

S·O·S Oil Analysis

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

- Wear Analysis
- Oil condition
- Additional tests

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

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

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

Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" or contact your local Caterpillar dealer for additional information concerning the S·O·S Oil Analysis program.

Lubrication System

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

Table 12

Engine Refill Capacities		
Compartment or System	**Minimum**	**Maximum**
Crankcase Oil Sump(1)	13.5 L (14.2653 qt)	16.5 L (17.4354 qt)

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

Lubricating Grease

Caterpillar provides a range of moderate greases to extremely high performance greases in order to service the entire line of Caterpillar products that operate throughout the wide variety of climates. You will always be able to find a grease that will meet your machine's requirements for a certain application. Caterpillar grease products often exceed Caterpillar specifications.

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

- Performance specifications
- Available sizes of containers
- Part numbers

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

If it is necessary to choose a single grease for use on all of the equipment at one site, always choose a grease that meets the requirements of the most demanding application. A product that barely meets the minimum performance requirements will shorten the life of the part. Use the grease that yields the least total operating cost. Base this cost on an analysis that includes the costs of the parts, the labor, the downtime, and the cost of the grease that is used.

Some greases are not chemically compatible. Consult your supplier in order to determine if two or more greases are compatible.

Purge the grease from a joint at the following times:

- Switching from one grease to another grease
- Switching from one supplier to another supplier

If in doubt, Purge!

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

Note: Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for additional information that relates to lubrication for your engine.

Fuel

Diesel fuels that meet the Caterpillar Specification for Distillate Diesel Fuel are recommended. These fuels will help to provide maximum engine service life and performance. In North America, diesel fuel that is identified as No. 1-D or No. 2-D in "ASTM D975" generally meet the specifications. Diesel fuels from other sources could exhibit detrimental properties that are not defined or controlled by this specification.

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

Note: Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for the Caterpillar Specification for distillate fuel and for additional information that relates to fuel for your engine.

Refill Capacities (Fuel System)

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

Coolant

The following two coolants are used in Caterpillar diesel engines:

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

Acceptable – A Cat DEAC (Diesel Engine Antifreeze/Coolant) or a commercial heavy-duty antifreeze that meets "ASTM D4985" or "ASTM D5345" specifications

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

Use only the coolant/antifreeze that is recommended.

Caterpillar recommends a 1:1 mixture of water and glycol. This mixture of water and glycol will provide optimum heavy-duty performance as a antifreeze.

Note: Cat DEAC does not require a treatment with an SCA at the initial fill. Commercial heavy-duty antifreeze that meets "ASTM D4985" or "ASTM D5345" specifications MAY require a treatment with an SCA at the initial fill. Read the label or the instructions that are provided by the OEM of the product.

In stationary engine applications that do not require anti-boil protection or freeze protection, a mixture of SCA and water is acceptable. Caterpillar recommends a six percent to eight percent concentration of SCA in those cooling systems. Distilled water or deionized water is preferred. Water which has the recommended properties may be used.

NOTICE
All Caterpillar diesel engines equipped with air-to-air aftercooling (ATAAC) require a minimum of 30 percent glycol to prevent water pump cavitation.

Table 13

Coolant Service Life	
Coolant Type	**Service Life**
Cat ELC	6000 Service Hours or Six Years
Cat DEAC	3000 Service Hours or Three Years
Commercial Heavy-Duty Antifreeze that meets "ASTM D5345"	3000 Service Hours or Two Years
Commercial Heavy-Duty Antifreeze that meets "ASTM D4985"	3000 Service Hours or One Year
Caterpillar SCA and Water	3000 Service Hours or Two Years
Commercial SCA and Water	3000 Service Hours or One Year

Note: Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for additional information that relates to coolant for your engine.

S·O·S Coolant Analysis

Table 14

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

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

S·O·S Coolant Analysis (Level 1)

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

The following properties of the coolant are tested:

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

The results are reported, and appropriate recommendations are made.

Refer to the Maintenance Interval Schedule in this Operation and Maintenance Manual in order to find the maintenance interval for collecting the coolant samples.

S·O·S Coolant Analysis (Level 2)

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

The S·O·S Coolant Analysis has the following features:

- Full coolant analysis (Level 1)
- Identification of the source of metal corrosion and of contaminants
- Water hardness
- Identification of buildup of the impurities that cause corrosion
- Identification of buildup of the impurities that cause scaling

The results are reported, and appropriate recommendations are made.

Refer to the Maintenance Interval Schedule in this Operation and Maintenance Manual, "Cooling System Coolant Sample (Level 2) - Obtain" for the maintenance interval for collecting the coolant samples.

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

Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for additional information.

Refill Capacity

Table 15

Engine Refill Capacities	
Compartment or System	**Liters**
Engine Only	9 L (9.5102 qt)
External System Per OEM(1)	

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.

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Maintenance Interval Schedule (Prime Power Generator Sets)

SMCS Code: 1000; 7500

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed.

The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, filters, and the replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

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

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

When Required

Battery - Replace 73
Battery or Battery Cable - Disconnect 74
Engine - Clean 79
Fuel System - Prime 86
Generator - Dry 91
Generator Set - Test 94
Rotating Rectifier - Test 100

Daily

Cooling System Coolant Level - Check 77
Electrical Connections - Check 79
Engine Air Cleaner Service Indicator - Inspect 80
Engine Oil Level - Check 82
Fuel System Primary Filter/Water Separator - Drain 89
Generator Load - Check 93
Walk-Around Inspection 101

Every Week

Generator - Inspect 92

Every 50 Service Hours or Weekly

Fuel Tank Water and Sediment - Drain 90

Every 100 Service Hours or 3 Months

Insulation - Test 95

Every 250 Service Hours

Cooling System Coolant Sample (Level 1) - Obtain 77
Engine Oil Sample - Obtain 82

Initial 500 Service Hours

Engine Valve Lash - Inspect/Adjust 86

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

Cooling System Coolant Sample (Level 2) - Obtain 78

Every 500 Service Hours

Alternator and Fan Belts - Inspect 73

Every 500 Service Hours or 1 Year

Battery Electrolyte Level - Check 74
Engine Air Cleaner Element (Single Element) - Replace 79
Engine Crankcase Breather Element - Replace ... 81
Engine Oil and Filter - Change 83
Fuel System Primary Filter (Water Separator) Element - Replace 88
Fuel System Secondary Filter - Replace 90
Hoses and Clamps - Inspect/Replace 94

Every 1000 Service Hours

Engine Valve Lash - Inspect/Adjust 86

Every 1000 Service Hours or 1 Year

Rotating Rectifier - Check 99

Every 2000 Service Hours

Engine Mounts - Inspect 82
Starting Motor - Inspect 100
Turbocharger - Inspect 100

Every 2000 Service Hours or 1 Year

Alternator - Inspect 73
Engine Mounts - Inspect 82

Every Year

Cooling System Coolant Sample (Level 2) - Obtain 78

Every 3000 Service Hours or 2 Years

Cooling System Water Temperature Regulator - Replace 78
Water Pump - Inspect 102

Every 6000 Service Hours or 3 Years

Cooling System Coolant Extender (ELC) - Add 76

Every 12 000 Service Hours or 6 Years

Cooling System Coolant (ELC) - Change 75

Overhaul

Overhaul Considerations 97

i02549570

Maintenance Interval Schedule (Standby Generator Sets)

SMCS Code: 1000; 7500

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed.

The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, filters, and the replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

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

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

When Required

Battery or Battery Cable - Disconnect 74
Fuel System - Prime 86
Generator - Dry 91
Generator Load - Check 93
Generator Set - Test 94
Rotating Rectifier - Test 100

Every Week

Battery Electrolyte Level - Check 74
Cooling System Coolant Level - Check 77
Electrical Connections - Check 79
Engine Air Cleaner Service Indicator - Inspect 80
Engine Oil Level - Check 82
Fuel System Primary Filter/Water Separator - Drain 89
Fuel Tank Water and Sediment - Drain 90
Generator - Inspect 92

Every 500 Service Hours

Engine Crankcase Breather Element - Replace ... 81

Every Year

Alternator - Inspect 73
Alternator and Fan Belts - Inspect 73
Cooling System Coolant Sample (Level 2) - Obtain 78
Engine - Clean 79
Engine Air Cleaner Element (Single Element) - Replace 79
Engine Mounts - Inspect 82
Engine Oil Sample - Obtain 82
Engine Oil and Filter - Change 83
Fuel System Primary Filter (Water Separator) Element - Replace 88
Fuel System Secondary Filter - Replace 90
Hoses and Clamps - Inspect/Replace 94
Insulation - Test 95
Rotating Rectifier - Check 99
Starting Motor - Inspect 100
Water Pump - Inspect 102

Every 3 Years

Battery - Replace 73
Cooling System Coolant Extender (ELC) - Add 76
Cooling System Water Temperature Regulator - Replace 78

Every 6 Years

Cooling System Coolant (ELC) - Change 75

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Alternator - Inspect

SMCS Code: 1405-040

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

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

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Alternator and Fan Belts - Inspect

SMCS Code: 1357-040

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 of cracks, splits, glazing, grease, and splitting.

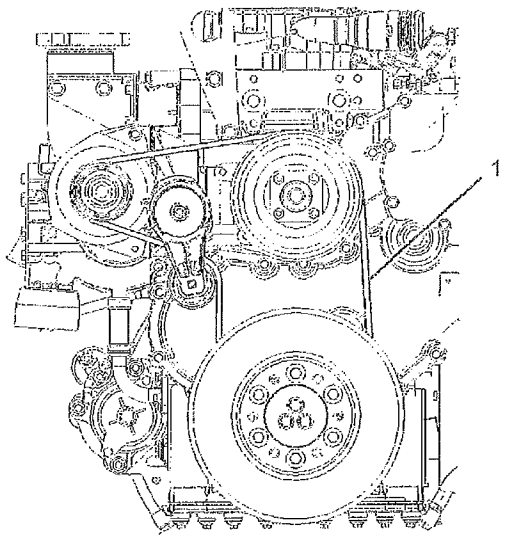

Illustration 73 g01155963
Typical example

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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.

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Battery Electrolyte Level - Check

SMCS Code: 1401-535

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

⚠ WARNING

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

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

   If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

2. Check the condition of the electrolyte with the 245-5829 Coolant Battery Tester Refractometer.

3. Keep the batteries clean.

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

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

   Thoroughly rinse the battery case with clean water.

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

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Battery or Battery Cable - Disconnect

SMCS Code: 1402-029

⚠ WARNING

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

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

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

2. Disconnect the negative battery terminal. 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 in order to help prevent accidental starting.

7. Proceed with necessary system repairs.

8. In order to connect the battery, connect the positive connection before the negative connector.

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Cooling System Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

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

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

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

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

Drain

⚠ WARNING

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

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

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

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

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

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

Flush

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

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

NOTICE
Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

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 Torque Specifications, SENR3130 for more information on the correct torques.

Fill

NOTICE
Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

1. Fill the cooling system with Extended Life Coolant (ELC). Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.

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

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

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

5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i02482066

Cooling System Coolant Extender (ELC) - Add

SMCS Code: 1352-045; 1395-081

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 only needs to be added once.

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

Dispose of all fluids according to local regulations and mandates.

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

2. It may be necessary to 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 your engine's cooling system capacity. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" article 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.

i01197563

Cooling System Coolant Level - Check

SMCS Code: 1395-082

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

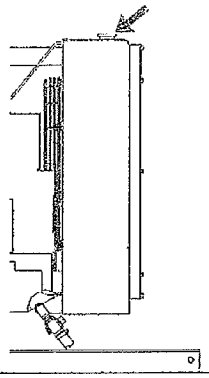


Illustration 74 g00285520

Cooling system filler cap

⚠ WARNING

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

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

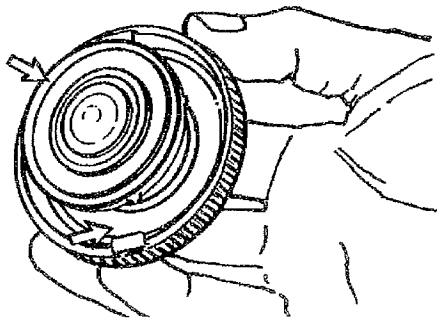


Illustration 75 g00103639

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.

i02326688

Cooling System Coolant Sample (Level 1) - Obtain

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

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

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

Table 16

Recommended Interval		
Type of Coolant	**Level 1**	**Level 2**
Cat DEAC	Every 250 Hours(1)	Yearly(1)(2)
Cat ELC	Optional(2)	Yearly(2)

(1) This is the recommended interval for coolant samples for all conventional heavy-duty coolant/antifreeze. This is also the recommended interval for coolant samples of commercial coolants that meet the Cat EC-1 specification for engine coolant.

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

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

NOTICE

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

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

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

Use the following guidelines for proper sampling of the coolant:

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

Submit the sample for Level 1 analysis.

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

i01987714

Cooling System Coolant Sample (Level 2) - Obtain

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

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

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

Submit the sample for Level 2 analysis.

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

i00912898

Cooling System Water Temperature Regulator - Replace

SMCS Code: 1355-510

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

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

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

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

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

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

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

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

Refer to the Service Manual for the replacement procedure of the water temperature regulator, or consult your Caterpillar dealer.

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

i02398768

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.

i02345750

Engine - Clean

SMCS Code: 1000-070

⚠ WARNING

Personal injury or death can result from high voltage.

Moisture can create paths of electrical conductivity.

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

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

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

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

Note: Caution must be used in order to prevent electrical components from being damaged by excessive water when 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 in order to wash the engine.

i02242500

Engine Air Cleaner Element (Single Element) - Replace

SMCS Code: 1051; 1054-510

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

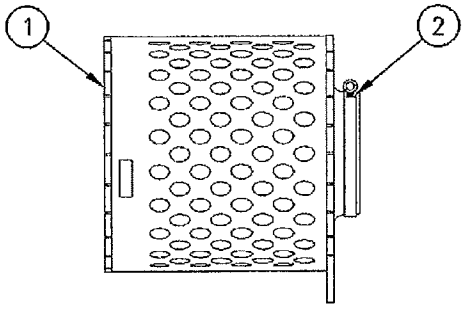


Illustration 76 g00109823

(1) Air cleaner element. (2) Clamp.

1. Loosen clamp (2) which fastens air cleaner element (1) to the air inlet. Remove the dirty air cleaner element and clamp.
2. Install clamp (2) on new air cleaner element (1).
3. Install new air cleaner element (1) to the air inlet and tighten clamp (2). Refer to Torque Specifications, SENR3130 for the correct torque.

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.

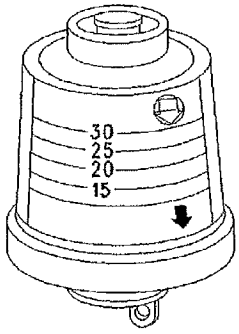


Illustration 77 g00103777

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.

i02326553

Engine Crankcase Breather Element - Replace

SMCS Code: 1317-510-FQ

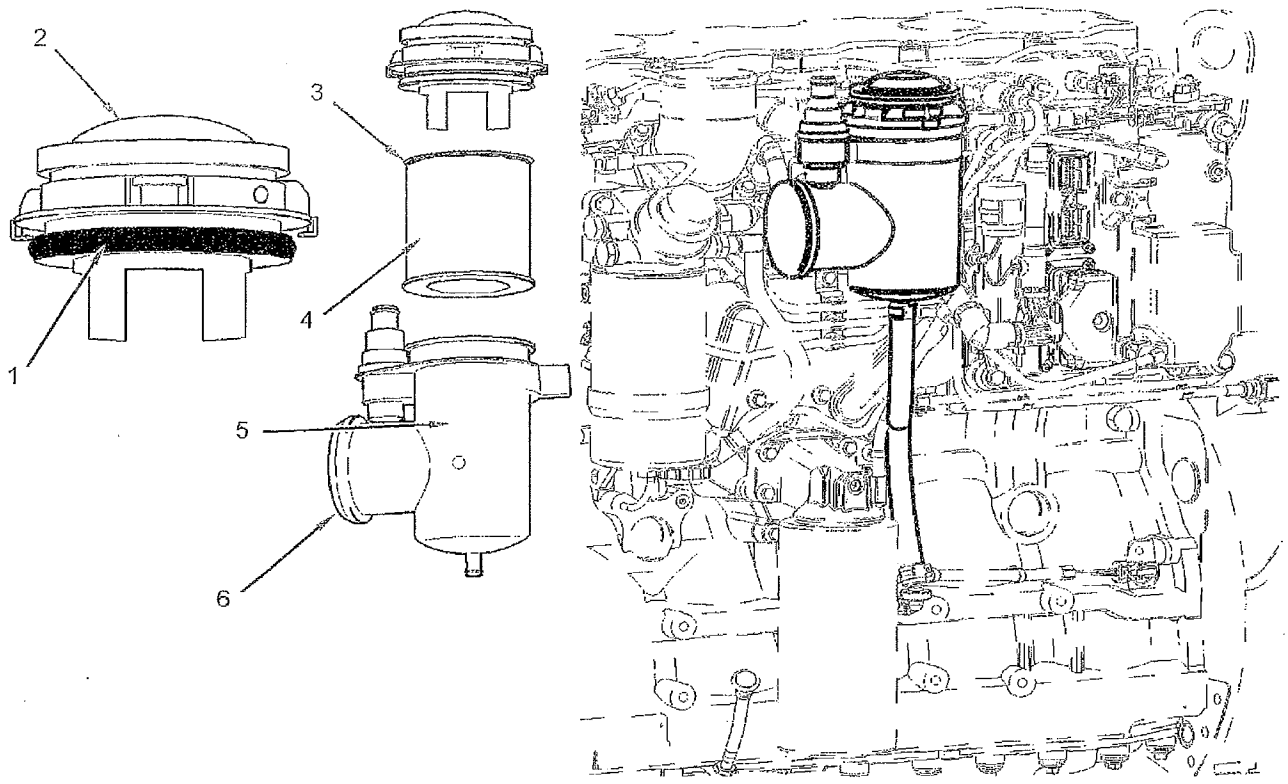


Illustration 78 g01156334

The breather assembly

(1) The O-ring for the top cover
(2) The top cover
(3) The O-ring for the filter element
(4) The filter element
(5) The breather body
(6) The side cover

NOTICE

Ensure that the components of the breather assembly are installed in the correct position. If installed incorrectly, engine damage can result.

Note: There are several vent holes under the top cover (2) and under the side cover (6). Keep the area around the vent holes clean. Do not restrict the vent holes.

1. Remove all dirt and oil from the outside of the breather assembly. Remove the top cover (2) by turning the top cover counterclockwise until the lugs disengage. The breather element includes an O ring (3). Remove the breather element (4) by turning and lifting the element. Discard the element. Clean the inner surfaces of the breather body (5). Clean the top cover and inspect the O ring (1) in the top cover. If the O ring in the top cover is worn or damaged, replace the O ring.

2. Lubricate the O ring (3) in the new filter element (4) with clean engine lubricating oil. Carefully insert the element into the breather body (5). Lubricate the O ring (1) in the top cover with clean engine lubricating oil. Carefully insert the top cover (2) into the breather body (5). Rotate the top cover clockwise until the lugs are fully engaged.

i02456872

Engine Mounts - Inspect

SMCS Code: 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.

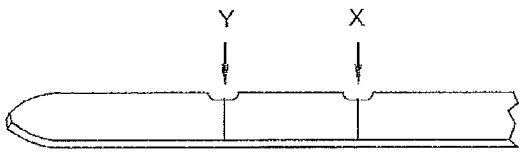
i02335785

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.



g01165836

Illustration 79

(Y) "Min" mark. (X) "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 ten minutes in order to allow the engine oil to drain to the oil pan before checking the oil level.

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

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.

i01935337

Engine Oil Sample - Obtain

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

In addition to a good preventive maintenance program, Caterpillar recommends using S·O·S oil analysis at regularly scheduled intervals in order to monitor the condition of the engine and the maintenance requirements of the engine. S·O·S oil analysis provides infrared analysis, which is required for determining nitration and oxidation levels.

Obtain the Sample and the Analysis

⚠ WARNING

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

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

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

- The amount of oil that has been added since the last oil change

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

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

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

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

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

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

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

i02325836

Engine Oil and Filter - Change

SMCS Code: 1318-510; 1348-044

⚠ WARNING

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

NOTICE
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.

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:

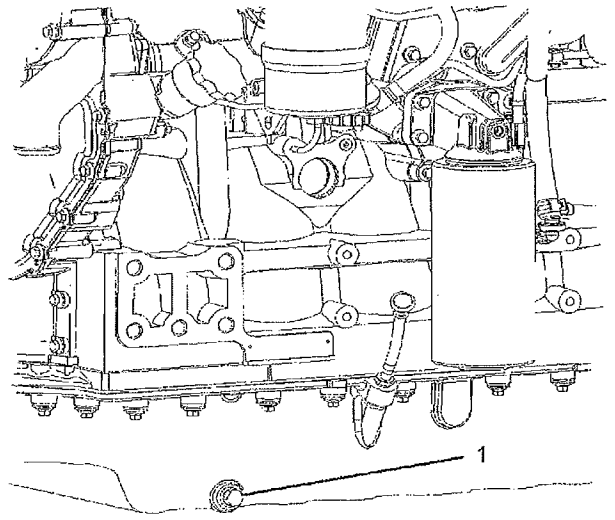


Illustration 80 g01157128

Typical example

- If the engine is equipped with a drain valve, turn the drain valve knob counterclockwise in order to drain the oil. After the oil has drained, turn the drain valve knob clockwise in order to close the drain valve.
- If the engine is not equipped with a drain valve, remove the oil drain plug (1) in order 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, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

1. Remove the oil filter with a 1U-8760 Chain Wrench.

Note: Some oil filters may be installed horizontally. This type of oil filter can be drained before the filter is removed. The torque for this drain plug is 12 N·m (8 lb ft).

Note: The following actions can be carried out as part of the preventive maintenance program.

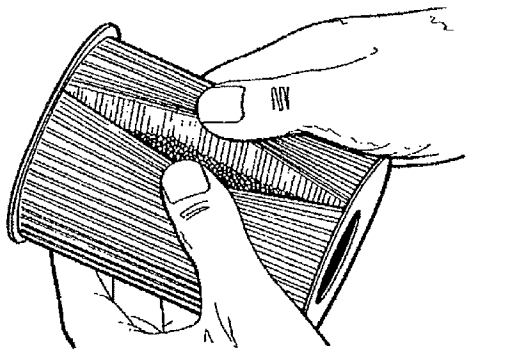


Illustration 81 g00588944

Element with debris

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

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

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

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

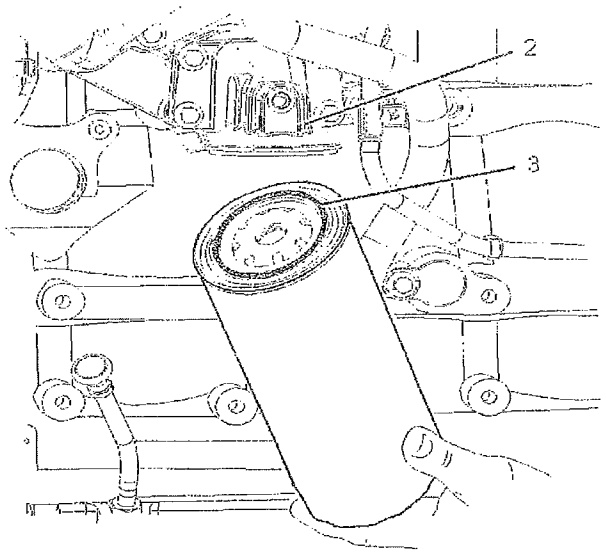


Illustration 82 g01157129
Typical example

3. Clean the sealing surface of the oil filter head (2). Ensure that the union is secure in the filter head.

4. Apply clean engine oil to the O ring seal (3) for the new oil filter.

Note: Some oil filters may be installed horizontally. Refer to the illustration . This type of oil filter assembly can be drained before the filter is removed. The torque for this drain plug (4) is 12 N·m (8 lb ft). If necessary, install a new O ring seal (5). Start at step 1 in order to remove the oil filter and install the oil filter.

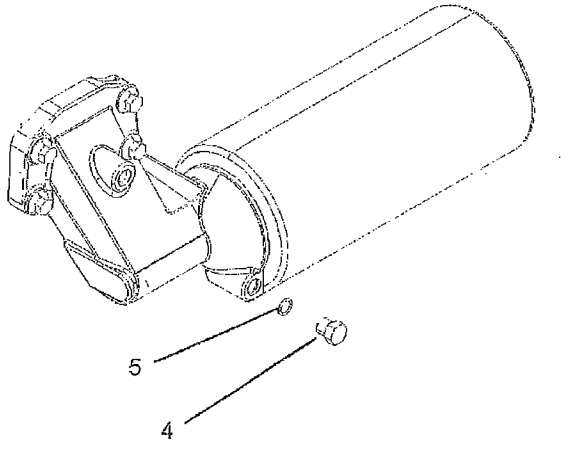


Illustration 83 g01169166
Typical example

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

5. Install the oil filter. Tighten the oil filter to 12 N·m (8.8 lb ft). Do not overtighten the oil filter.

Note: Some oil filters may be installed horizontally. Refer to illustration 83. This type of oil filter assembly can be drained before the oil is removed. The torque for the drain plug (4) is 12 N·m (8 lb ft). If necessary, install a new O ring seal (5). Start at 1 in order to remove the oil filter and install the oil filter.

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 auxilliary oil filter system or a remote filter system, follow the OEM or the filter manufacture's remonmendations. Under filling or over filling the crankcase with oil can cause engine damage.

2. Start the engine and run the engine at "LOW IDLE" for two minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.

3. Stop the engine and allow the oil to drain back to the oil pan for a minimum of ten minutes.

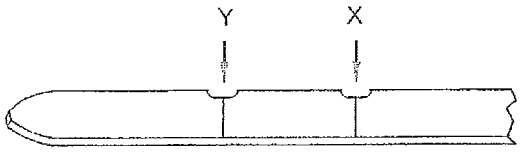


Illustration 84 g01165836
Typical example

4. Remove the engine oil level gauge in order to check the oil level. Maintain the oil level between the "MIN" and "MAX" marks on the engine oil level gauge.

i02519453

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

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

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

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

⚠ WARNING

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

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

Ensure that the engine is stopped before measuring the valve lash. To obtain an accurate measurement, allow the valves to cool before this maintenance is performed.

Refer to the Service Manual for more information.

i02326068

Fuel System - Prime

SMCS Code: 1258-548

⚠ 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.

Refer to the Operation and Maintenance Manual , "General Hazard Information and High Pressure Fuel Lines" before adjustments and repairs are performed.

Note: Refer to Testing and Adjusting Manual , "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.

Hand Fuel Priming Pump

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.

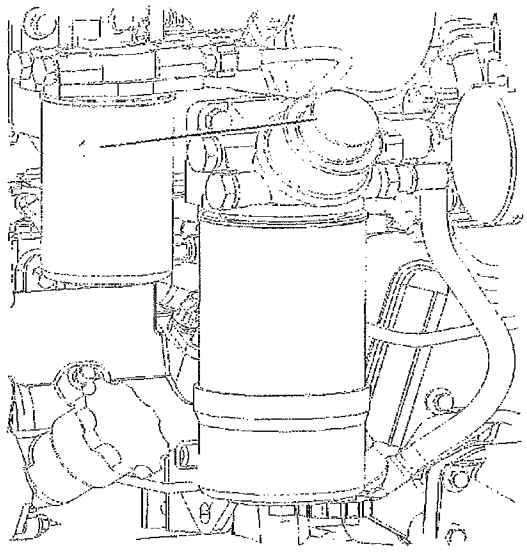


Illustration 85 g01154164
typical example

2. Operate the fuel priming pump (1). Count the number of operations of the fuel priming pump. After 100 depressions of the fuel priming pump stop.

3. The engine fuel system should now be primed and the engine should now be able to start.

4. Operate the engine starter and crank the engine. After the engine has started, operate the engine at low idle for a minimum of five minutes, immediately after air has been removed from the fuel system.

Note: Operating the engine for this period of time will help ensure that the fuel system is free of air.

Note: Do not loosen the high pressure fuel line in order to purge air from the fuel system. This procedure is not required.

After the engine has stopped, you must wait for 60 seconds 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. 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".

Electric Fuel Priming Pump

1. Ensure that the fuel system is in working order. Check that the fuel supply valve (if equipped) is in the "ON" position.

NOTICE
The electric fuel priming pump will operate for 90 seconds. If necessary the electric fuel priming pump can be stopped during the 90 seconds of operation, by operation of the switch.

2. Turn the keyswitch to the "RUN" position. Operate the switch for the electric priming pump. After 90 seconds of the electric fuel priming pump operation the fuel system will be primed and the electric fuel priming pump will turn off.

3. The engine should now be able to start.

4. Operate the engine starter and crank the engine. After the engine has started, operate the engine at low idle for a minimum of five minutes, immediately after air has been removed from the fuel system.

Note: Operating the engine for this period of time will help ensure that the fuel system is free of air.

Note: Do not loosen the high pressure fuel line in order to purge air from the fuel system. This procedure is not required.

After the engine has stopped, you must wait for 60 seconds 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. 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".

i02527046

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 Testing and Adjusting Manual , "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.

After the engine has stopped, you must wait for 60 seconds 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. 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".

1. Turn the fuel supply valve (if equipped) to the OFF position before performing this maintenance.
2. 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 of the water separator.

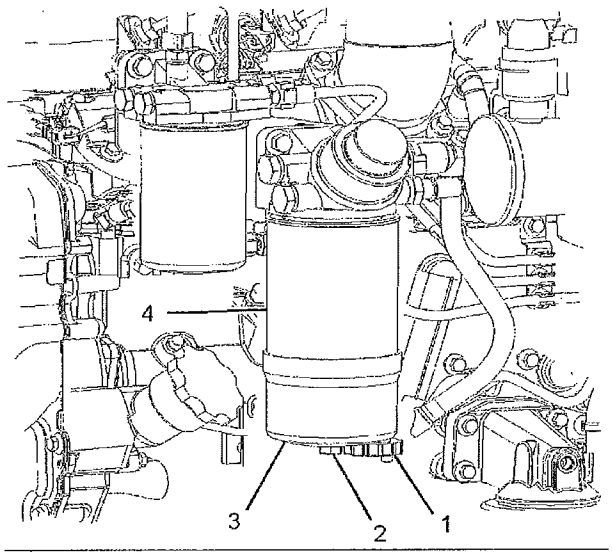


Illustration 86 g01153445
Typical example

3. Install a suitable tube onto the drain (1). Open the drain (1). Allow the fluid to drain into the container. Remove the tube.
4. Tighten the drain (1) by hand pressure only.
5. If equipped, remove the wiring harness from the sensor on the bottom of the glass bowl.
6. Hold the glass bowl (3) and remove the screw (2). Remove the glass bowl (3) from the canister (4).
7. Use a 1U-8760 Chain Wrench in order to remove the canister (4). Discard the old seals (5 and 6) and the canister in a safe place.
8. Clean the glass bowl (3).

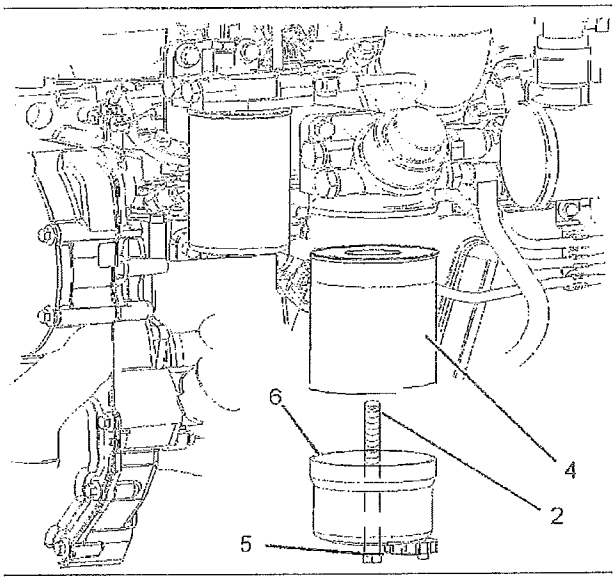


Illustration 87 g01153488

Typical example

9. Do not lubricate the O ring seal on the new canister. Install the new canister. Do not use a tool in order to install the canister. Tighten the canister by hand.

10. Install the new O ring seal (5) onto the setscrew (2). Install the new O ring seal (6) into the glass bowl.

11. Align the glass bowl to the canister. Ensure that the sensor (if equipped) is in the correct position. Install the setscrew (2). Tighten the setscrew to a torque of 5 N·m (44 lb in).

12. If equipped, install the wiring harness to the sensor.

13. Remove the container and dispose of the fuel in a safe place.

14. The secondary filter must be replaced at the same time as the primary filter. Refer to the Operation and Maintenance Manual , "Fuel System Filter - Replace".

i02334301

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.

1. Place a suitable container under the water separator in order to catch any fuel that might spill. Clean up any spilled fuel.

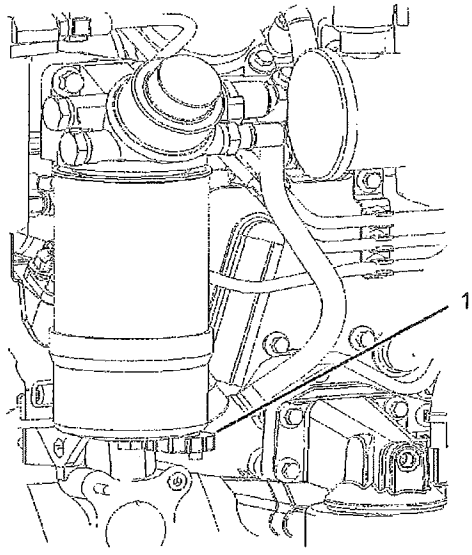


Illustration 88 g01153817

Typical example

2. Install a suitable tube onto the drain (1). Open the drain (1). Allow the fluid to drain into the container.

3. Tighten the drain (1) by hand pressure only. Remove the tube and dispose of the drained fluid in a safe place.

i02527047

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.

Note: Refer to Testing and Adjusting Manual , "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.

After the engine has stopped, you must wait for 60 seconds 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. 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".

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

1. Ensure that the fuel supply valve (if equipped) is in the OFF position. Place a suitable container under the fuel filter in order to catch any fuel that might spill. Clean up any spilled fuel.

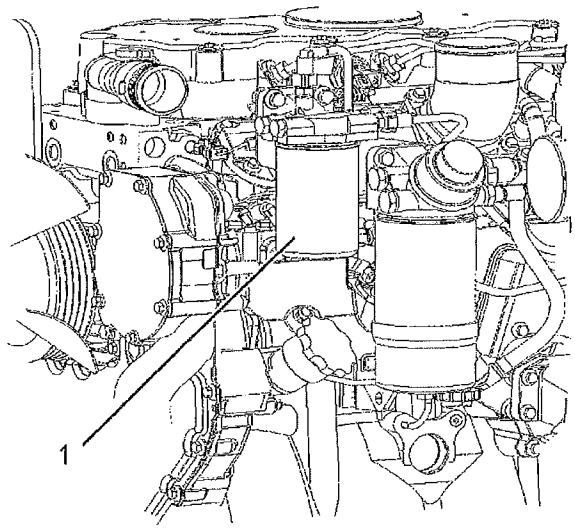


Illustration 89 g01153855
Typical example

2. Clean the outside of the fuel filter. Use 1U-8760 Chain Wrench in order to remove the canister (1) from the engine and dispose of the canister in a safe place.
3. Do not lubricate the O ring seal. Do not fill the new canister with fuel before the canister is installed.
4. Install the new canister. Do not use a tool in order to install the canister. Tighten the canister by hand.
5. Remove the container and dispose of the fluid in a safe place. If equipped, open the fuel supply valve.
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.

i02290310

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.

Self-Circulating Air Method

Run the engine and disconnect the generator load. This will help circulate air. Operate the generator space heaters.

Oven Method

Place the entire generator inside a forced air drying oven for four hours at 65 °C (149 °F).

NOTICE
Use a forced air type oven rather than a radiant type oven.

Radiant type ovens can cause localized overheating.

i02283395

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.

Refer to Safety Section, "Generator Isolating for Maintenance" for information regarding the procedure to safely isolate the generator.

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.

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.

If harmful dirt accumulations are present, a variety of 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)

NOTICE
Do not use water to clean the generator.

NOTICE
Do not use trichloroethane, perchlorethylene, trichloroethane or any alkaline products to clean the generator.

Cleaning may be required at the point of installation. At this point, 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. This will prevent the spreading of these contaminants.

A small nonconductive tube may need to be connected to the vacuum cleaner. This will allow the vacuum cleaner to clean the surfaces that are not exposed. After most of the dust has been removed, a small brush may be attached to the vacuum hose in order to loosen dirt that is more 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) in order to prevent mechanical damage to the insulation. If the above cleaning procedures are not effective, consult a Caterpillar dealer.

Cleaning (Disassembled Generators)

NOTICE
Do not use water to clean the generator.

NOTICE
Do not use trichloroethane, perchlorethylene, trichloroethane or any alkaline products to clean the generator.

An initial insulation resistance check should be made on the generator in order to confirm electrical integrity. A minimum reading of one 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:

- Unleaded Gasoline
- Toluene
- Benzene
- Ciclohexare

Avoid permitting the solvent to run into the slots. Apply the solvent with a brush. Use a sponge on the windings frequently in order 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".

i01878834

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.

During normal operation, monitor the power factor and monitor generator loading.

When a three-phase generator is installed 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. This 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 is not applicable to single-phase generators.

The power factor can be referred to as the efficiency of the load. This 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.

i01593517

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 17

Tools Needed		
Part Number	**Part**	**Quantity**
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's 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: 7554-040; 7554-510

⚠ WARNING

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

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.

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

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

3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
4. Remove the hose clamps.
5. Disconnect the old hose.
6. Replace the old hose with a new hose.
7. Install the hose clamps with a torque wrench.

Note: 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.

i02290325

Insulation - Test

SMCS Code: 4453-081; 4454-081; 4457-081; 4470-081

⚠ 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.

Table 18

TOOLS NEEDED		
Part Number	**Tool**	**Quantity**
142-5055	Insulation Tester Megohmmeter	1

⚠ WARNING

Personal injury or death can result from electrocution.

The megohmmeter is applying a high voltage to the circuit.

To avoid electrocution, do not touch the instrument leads without first discharging them. When finished testing also discharge the generator windings.

The following materials will cause the winding insulation to deteriorate:

- moisture (water)
- dust
- grease
- other foreign matter within the generator

This deterioration reduces the resistance of the insulation. This test will measure the resistance of the winding insulation.

The insulation tester (megohmmeter) produces a high potential voltage between the test leads. During the test, a small current flows. The tester converts this current to a resistance reading.

The insulation test is performed as part of periodic maintenance in order to detect the deterioration of the winding insulation. When there is a rapid decrease in the insulation resistance in a short amount of time, the generator needs to be cleaned.

Note: For information on generator cleaning, refer to Special Instruction, SEHS9124.

When generators have not been used for a period of time, moisture can accumulate. Therefore, the insulation test should be performed on generators that have been idle. If moisture is known to exist, the windings must be dried prior to testing. Refer to Testing And Adjusting, "Generator - Dry".

The winding needs to be reconditioned or the winding needs to be replaced in the following cases:

- The measured insulation resistance falls below the specified amount. The cleanup procedure does not correct the discrepancy.
- The measured insulation resistance falls below the specified amount. The drying procedure does not correct the discrepancy.

The specified insulation resistance is an approximate value. It can be possible to operate the generator with less than the specified value. However, a generator that has a low winding insulation resistance will be more likely to have a failure.

⚠ 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.

The insulation test gives accurate results only when the generator windings are free of moisture and the generator windings are at room temperature.

Each winding must have a minimum insulation resistance of one megohm.

Main Armature (Stator L4)

1. Remove the load from the generator by either of the following:

   - Open the line circuit breaker.
   - Open the following load connections: T1, T2, T3, and T0.

   Prevent these wires from coming into contact with each other and prevent these wires from contacting ground.

2. Isolate the main armature (L4) from the voltage regulator by disconnecting the wires for voltage sensing. If generator lead (T0) is connected to the generator frame or ground, open the connection.

3. Connect one test lead of the insulation tester (megohmmeter) to the generator enclosure (ground).

4. Connect the other test lead of the insulation tester (megohmmeter) to generator lead (T0).

5. The insulation resistance must be one megohm or more.

Exciter Field (Stator L1)

1. Isolate exciter field (L1) from the voltage regulator by disconnecting wires 5+ and 6-. Prevent these wires from coming into contact with each other and prevent these wires from contacting ground.
2. Connect one test lead of the insulation tester (megohmmeter) to the generator enclosure (ground).
3. Connect one test lead of the insulation tester (megohmmeter) to exciter field lead (5+ or 6-).
4. Measure the resistance of the exciter field winding insulation to ground. The insulation resistance must be a minimum of 0.25 megohm (250000 ohms).

Exciter Armature (Rotor L2)

1. Isolate exciter armature (L2) from the rectifier circuit. Disconnect the three wires of the exciter armature from the rectifier blocks.
2. Connect one test lead of the insulation tester (megohmmeter) to the rotor shaft.
3. Connect one test lead of the insulation tester (megohmmeter) to any one exciter field lead.
4. The insulation resistance must be a minimum of 0.25 megohm (250000 ohms).

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

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 19 lists the Hydrosolv Liquid Cleaners that are available from your Caterpillar dealer.

Table 19

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.

i01880286

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".

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Rotating Rectifier - Test

SMCS Code: 4465-081

⚠ 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.

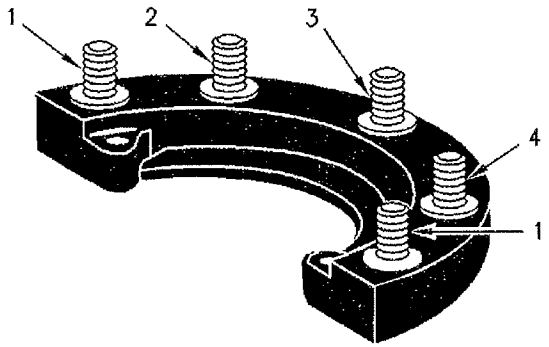

Illustration 90 g00992269

(1) Positive DC terminal or Negative DC terminal
(2) AC terminal
(3) AC terminal
(4) AC terminal

The following procedure tests all three diodes within a block. Check the positive rectifier block and the negative rectifier block. If any meter reading does not fall within the given ranges, replace the rectifier block.

1. Set the digital multimeter on the diode range. Remove all leads from the rectifier block.

2. To test the negative rectifier block, follow these steps:

   a. Place the red test lead on the negative "-" terminal (1). Place the black test lead on the following rectifier terminals: AC terminal (2), AC terminal (3), and AC terminal (4). All readings on the meter should be between 0.4 and 1.0.

   b. Place the black test lead on the negative "-" terminal (1). Place the red test lead on the following rectifier terminals: AC terminal (2), AC terminal (3), and AC terminal (4). In all cases, the meter should read "OL" (overload).

3. To test the positive rectifier block, follow these steps:

   a. Place the red test lead on the positive "+" rectifier terminal (1). Place the black test lead on the following rectifier terminals: AC terminal (2), AC terminal (3), and AC terminal (4). In all cases, the meter should read "OL" (overload).

   b. Place the black test lead on the positive "+" rectifier terminal (1). Place the red test lead on the following rectifier terminals: AC terminal (2), AC terminal (3), and AC terminal (4). All readings on the meter should be between 0.4 and 1.0.

Note: A shorted diode can cause damage to the exciter rotor. If a diode is shorted, check the exciter rotor. Refer to the Testing and Adjusting, "Winding - Test" and Testing and Adjusting, "Insulation - Test". Perform these tests.

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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.

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Turbocharger - Inspect

SMCS Code: 1052-040; 1052

A regular visual inspection of the turbocharger is recommended. Any fumes from the crankcase are filtered through the air inlet system. Therefore, by-products from oil and from combustion can collect in the turbocharger compressor housing. Over time, this buildup can contribute to loss of engine power, increased black smoke and overall loss of engine efficiency.

If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel 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 occured.

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

Note: The turbochargers that are supplied are nonserviceable.

For options regarding the removal, installation, and replacement, consult your Carerpillar dealer or your Carerpillar distributor. Refer to the Disassembly and Assembly Manual, "Turbocharger - Remove and Turbocharger - Install" for further information.

Inspecting

NOTICE
The compressor housing for the turbocharger must not be removed from the turbocharger for cleaning.

The actuator linkage is connected to the compressor housing. If the actuator linkage is moved or disturbed the engine may not comply with emmissions legislation.

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 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.
3. Inspect the bore of the housing of the turbine outlet for corrosion.
4. Fasten the air intake pipe and the exhaust outlet pipe to the turbocharger housing.

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Walk-Around Inspection

SMCS Code: 1000-040

Inspect the Engine for Leaks and for Loose Connections

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

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

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

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

NOTICE
Accumulated grease and/or oil on an engine is a fire hazard. Remove the accumulated grease and oil. Refer to this Operation and Maintenance Manual, "Engine - Clean" for more information.

- 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.

After the engine has stopped, you must wait for 60 seconds 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. 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".

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 on a daily basis in order to ensure that only clean fuel enters the fuel system.

- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires. 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 can not be calibrated.

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Water Pump - Inspect

SMCS Code: 1361-040; 1361

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

Visually inspect the water pump for leaks. If any leaking is observed, replace the water pump assembly. Refer to the Service Manual for the disassembly and assembly procedure.

Note: Refer to the Service Manual or consult your Caterpillar dealer if any repair is needed or any replacement is needed.

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^3 (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 will produce the net power that is available for the external load (flywheel).

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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 cursers, 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 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.

NOTICE

Operating engines above the rating definitions can result in shorter service life before overhaul.

Customer Service

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Customer Assistance

SMCS Code: 1000

USA and Canada

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

Your satisfaction is a primary concern to Caterpillar and to Caterpillar dealers. If you have a problem that has not been handled to your complete satisfaction, follow these steps:

1. Discuss your problem with a manager from the dealership.

2. If your problem cannot be resolved at the dealer level without additional assistance, use the phone number that is listed below to talk with a Field Service Coordinator:

   1-800-447-4986

   The normal hours are from 8:00 to 4:30 Monday through Friday Central Standard Time.

3. If your needs have not been met still, submit the matter in writing to the following address:

   Caterpillar Inc.
   Manager, Customer Service, Engine Division
   Mossville Bldg AC
   P.O. Box 610
   Mossville, Illinois 61552-0610

   Please keep in mind: probably, your problem will ultimately be solved at the dealership, using the dealership's facilities, equipment, and personnel. Therefore, follow the steps in sequence when a problem is experienced.

Outside of the USA and of Canada

If a problem arises outside the USA and outside Canada, and if the problem cannot be resolved at the dealer level, consult the appropriate Caterpillar office.

Latin America, Mexico, Carribean
Caterpillar Americas Co.
701 Waterford Way, Suite 200
Miami, FL 33126-4670
USA
Phone: 305-476-6800
Fax: 305-476-6801

Europe, Africa, and Middle East
Caterpillar Overseas S.A.
76 Route de Frontenex
P.O. Box 6000
CH-1211 Geneva 6
Switzerland
Phone: 22-849-4444
Fax: 22-849-4544

Far East
Caterpillar Asia Pte. Ltd.
7 Tractor Road
Jurong, Singapore 627968
Republic of Singapore
Phone: 65-662-8333
Fax: 65-662-8302

China
Caterpillar China Ltd.
37/F., The Lee Gardens
33 Hysan Avenue
Causeway Bay
G.P.O. Box 3069
Hong Kong
Phone: 852-2848-0333
Fax: 852-2848-0440

Japan
Shin Caterpillar Mitsubishi Ltd.
SBS Tower
10-1, Yoga 4-Chome
Setagaya-Ku, Tokyo 158-8530
Japan
Phone: 81-3-5717-1150
Fax: 81-3-5717-1177

Japan
Caterpillar Power Systems, Inc.
SBS Tower (14th floor)
4-10-1, Yoga
Setagaya-Ku, Tokyo 158-0097
Phone: 81-3-5797-4300
Fax: 81-3-5797-4359

Australia and New Zealand
Caterpillar of Australia Ltd.
1 Caterpillar Drive
Private Mail Bag 4
Tullamarine, Victoria 3043
Australia
Phone: 03-9953-9333
Fax: 03-9335-3366

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Ordering Replacement Parts

SMCS Code: 7567

⚠ WARNING

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

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

Quality Caterpillar replacement parts are available from Caterpillar dealers throughout the world. Caterpillar dealers' parts inventories are up-to-date. The parts stocks include all of the parts that are normally needed to protect your Caterpillar engine investment.

When you order parts, please specify the following information:

- Part number
- Part name
- Quantity

If there is a question concerning the part number, please provide your dealer with a complete description of the needed item.

When a Caterpillar engine requires maintenance and/or repair, provide the dealer with all the information that is stamped on the Information Plate. This information is described in this Operation and Maintenance Manual (Product Information Section).

Discuss the problem with the dealer. Inform the dealer about the conditions of the problem and the nature of the problem. Inform the dealer about when the problem occurs. This will help the dealer in troubleshooting the problem and solving the problem faster.

Reference Materials

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Reference Material

SMCS Code: 1000

The following literature can be obtained through any Caterpillar dealer.

Lubricants

- Special Publication, PEHP8038, "Data Sheet - Caterpillar Diesel Engine Oils (DEO) (CH-4) (North America)"
- Special Publication, PEHP9536, "Data Sheet - Caterpillar Diesel Engine Oil (DEO) (CF-4) (International only)"
- Special Publication, NEDG6022, "Cat Lubricating Grease"
- Special Publication, PEHP0002, "Data Sheet - Molybdenum (MPGM) Grease"
- Special Publication, NEHP6015, "Data Sheet - Caterpillar Special Purpose Grease (SPG)"
- Special Publication, SEBD0640, "Oil and Your Engine"
- Operation and Maintenance Manual, SEBU5898, "Cold Weather Recommendations"
- Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recomendations"
- Special Publication, PEHP6001, "How To Take A Good Oil Sample"

Fuels

- Special Publication, SEBD0717, "Diesel Fuels and Your Engine"
- Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recomendations"

Coolants

- Special Publication, PEHP4036, "Data Sheet - Extended Life Coolant"
- Special Publication, PEHP7057, "Data Sheet - S·O·S Coolant Analysis"
- Special Publication, SEBD0518, "Know Your Cooling System"
- Special Publication, SEBD0970, "Coolant and Your Engine"
- Label, PEEP5027, "Extended Life Coolant/Antifreeze"
- Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recomendations"

Miscellaneous

- Service Manual, KENR6207, "C6.6 Generator Set"
- Special Publication, PECP6026, "One Safe Source" English language for use in NACD
- Special Publication, PECP6027, "One Safe Source" English language for use in COSA
- Special Publication, PECP6028, "One Safe Source" English language for use in non NACD and non COSA
- Special Publication, LEDM5615, "Caterpillar Marine Parts and Service Locations Directory"
- Special Publication, SEBF8029, "Index to Guidelines for Reusable Parts and Salvage Operations"
- Special Publication, SEBF8062, "Procedure to Inspect and Clean Air Filters"
- Special Instruction, SEHS9031, "Storage Procedure for Caterpillar Products"
- Special Publication, NEHS0526, "Service Technician Application Guide"
- Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recomendations"
- Special Instruction, SEHS7633, "Battery Test Procedure"
- Label, SEHS7332, "Danger Do Not Operate"

Emissions Warranty

This engine may be Certified and this engine may be covered by an Emissions Warranty. A detailed explanation of the Emissions Warranty that is applicable to Certified engines is found in Supplement, SEBU6981, "Emissions Control Warranty Information". The engine is Certified if the engine has a special label that verifies the certification. A Caterpillar dealer can also inform you if the engine is certified.

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Maintenance Records

SMCS Code: 1000

Caterpillar Inc. recommends the retention of accurate maintenance records. Accurate maintenance records can be used for the following purposes:

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

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

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

Records should be kept for the following items:

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

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

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

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

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

i01176304

Maintenance Log

SMCS Code: 1000

Table 20

Engine Model			Customer Identifier	
Serial Number			Arrangement Number	
Service Hours	**Quantity Of Fuel**	**Service Item**	**Date**	**Authorization**

Index

A

Additional Messages 18
Alternator - Inspect 73
Alternator and Fan Belts - Inspect 73

B

Battery - Replace 73
Battery Electrolyte Level - Check 74
Battery or Battery Cable - Disconnect 74
Before Starting Engine 31
Burn Prevention 28
  Batteries 28
  Coolant 28
  Oils 28

C

Cold Weather Operation 62
  Hints for Cold Weather Operation 62
  Idling the Engine 63
  Recommendations for Coolant Warm Up 63
  Recommendations for the Coolant 63
  Viscosity of the Engine Lubrication Oil 62
Control Panel 48
  Alarm Indicators 49
  Basic Operation 49
  Navigation Keys 48
  Resetting Events 50
  Viewing Events 50
Cooling System Coolant (ELC) - Change 75
  Drain 75
  Fill 75
  Flush 75
Cooling System Coolant Extender (ELC) - Add 76
Cooling System Coolant Level - Check 77
Cooling System Coolant Sample (Level 1) - Obtain 77
Cooling System Coolant Sample (Level 2) - Obtain 78
Cooling System Water Temperature Regulator - Replace 78
Crushing Prevention and Cutting Prevention 31
Customer Assistance 106
  Outside of the USA and of Canada 106
  USA and Canada 106
Customer Service 106

E

Electrical Connections - Check 79
Electrical System 32
  Grounding Practices 32
Engine - Clean 79
Engine Air Cleaner Element (Single Element) - Replace 79
Engine Air Cleaner Service Indicator - Inspect 80
  Test the Service Indicator 80
Engine Crankcase Breather Element - Replace 81
Engine Identification 36
Engine Mounts - Inspect 82
Engine Oil and Filter - Change 83
  Drain the Engine Lubricating Oil 83
  Fill the Oil Pan 85
  Replace the Oil Filter 84
Engine Oil Level - Check 82
Engine Oil Sample - Obtain 82
  Obtain the Sample and the Analysis 82
Engine Operation 60
Engine Rating Conditions 104
Engine Rating Definitions 104
Engine Ratings 104
Engine Starting 31, 58
Engine Stopping 32, 61
Engine Valve Lash - Inspect/Adjust 86

F

Features and Controls 48
Fire Prevention and Explosion Prevention 28
  Ether 30
  Fire Extinguisher 30
  Lines, Tubes and Hoses 30
Foreword 5
  California Proposition 65 Warning 5
  Literature Information 4
  Maintenance 4
  Maintenance Intervals 4
  Operation 4
  Overhaul 4
  Safety 4
Fuel and the Effect from Cold Weather 64
Fuel Conservation Practices 60
Fuel System - Prime 86
  Electric Fuel Priming Pump 87
  Hand Fuel Priming Pump 86
Fuel System Primary Filter (Water Separator) Element - Replace 88
Fuel System Primary Filter/Water Separator - Drain 89
Fuel System Secondary Filter - Replace 90
Fuel Tank Water and Sediment - Drain 90
  Drain the Water and the Sediment 91
  Fuel Storage Tanks 91
  Fuel Tank 91

G

General Hazard Information 25
Asbestos Information 27
Containing Fluid Spillage 27
Dispose of Waste Properly 28
Fluid Penetration 26
Pressurized Air and Water 26
General Information 34
Generator - Dry 91
Drying Methods 91
Generator - Inspect 92
Cleaning (Assembled Generators) 92
Cleaning (Disassembled Generators) 93
Generator Isolating for Maintenance 33
Generator Lead Connections 38
Connection Diagrams 39
Grounding the Frame 39
Neutral Connections 39
Single Units 39
Generator Load - Check 93
Generator Set - Test 94
Generator Set Installation 47
Electrical Measurements 47
Location 47
Receiving Inspection 47
Remote Fuel Tanks and Auxiliary Fuel Tanks ... 47
Unpacking 47

H

Hoses and Clamps - Inspect/Replace 94
Replace the Hoses and the Clamps 95

I

Important Safety Information 2
Installation 47
Insulation - Test 95
Exciter Armature (Rotor L2) 97
Exciter Field (Stator L1) 97
Main Armature (Stator L4) 96

L

Lifting and Storage 45

M

Maintenance Interval Schedule (Prime Power Generator Sets) 70
Maintenance Interval Schedule (Standby Generator Sets) 72
Maintenance Log 110
Maintenance Records 109
Maintenance Section 65
Model View Illustrations 35
Model Views 35

O

Operation Section 45
Ordering Replacement Parts 107
Overhaul Considerations 97
Oil Consumption as an Overhaul Indicator 97
Overhaul Recommendation 98

P

Plate Locations and Film Locations 36
Emissions Certification Film 36
Serial Number Plate (1) 36
Product Identification Information 36
Product Information Section 34
Product Lifting 45
Engine Lifting with a Fuel Tank 45
Lifting of Generator Sets 45
Product Storage 46
Generator Storage 46

R

Reference Information Section 104
Reference Material 108
Coolants 108
Emissions Warranty 108
Fuels 108
Lubricants 108
Miscellaneous 108
Reference Materials 108
Refill Capacities 65
Refill Capacities and Recommendations 65
Coolant 68
Engine Oil 65
Fuel 67
Lubricating Grease 67
S·O·S Coolant Analysis 68
Rotating Rectifier - Check 99
Rotating Rectifier - Test 100

S

Safety Messages 6
Safety Section 6
Starting Motor - Inspect 100
Starting the Engine 58
Starting the Engine 58
Starting with Jump Start Cables 58
Stopping the Engine 61

T

Table of Contents 3

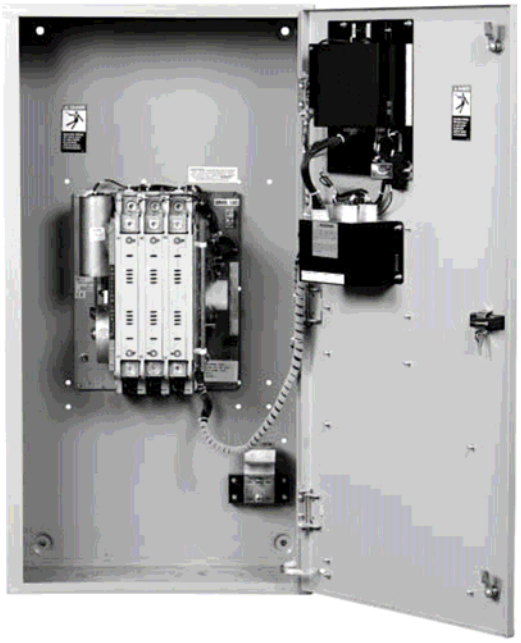
Turbocharger - Inspect 100
Inspecting 101
Removal and Installation 101

V

Voltage Regulators 51
R230 Adjustments 52
R438 and R448 Adjustment for Maximum Excitation 56
R438 and R448 Adjustments 54
Special Use 57

W

Walk-Around Inspection 101
High Pressure Fuel Lines 102
Inspect the Engine for Leaks and for Loose Connections 101
Water Pump - Inspect 102
Welding on Engines with Electronic Controls 34



CTG SERIES AUTOMATIC TRANSFER SWITCH

The Cat® CTG Series transfer switch is pre-configured for applications requiring the dependability and ease of operation found in a full feature power contactor type transfer switch.

CTG switches are equipped with the next generation MX150 microprocessor panel, which controls the operation and displays the status of the transfer switch's position, timers and available sources. As an embedded digital controller, the MX150 offers high reliability and ease of unattended operation across a range of applications.

FEATURES

- Ratings 40 to 3000 amps (2, 3 or 4 poles)
- UL 1008 listed at 480 VAC
- CSA certified at 600 VAC (200-225 amp – 480 V)
- IEC listed at 480 V
- Double throw, mechanically interlocked contactor mechanism
- Electrically operated, mechanically held
- Designed for emergency and standby applications
- Available in standard open transition (CTG) or delayed transition (CTGD) models
- Ringing wave immunity per IEEE 472 (ANSI C37.90A)
- Conducted and Radiated Emissions per EN55022 Class B (CISPR 11) (Exceeds EN55011 & MILSTD 461 Class 3)
- ESD immunity test per EN61000-4-2 (Level 4)
- Radiated RF, electromagnetic field immunity test per EN61000-4-3 (ENV50140) 10v/m
- Electrical fast transient/burst immunity test per EN61000-4-4
- Surge immunity test per EN61000-4-5 IEEE C62.41 (1.2 X 50 ms, 5 & 8 kV)
- Conducted immunity test per EN61000-4-6 (ENV50141)
- Voltage dips and interruption immunity EN61000-4-11
- Seismic Compliance to IEEE-693-2005 and IBC-2003

DESIGN AND CONSTRUCTION FEATURES

- Close differential 3 phase under-voltage sensing of the normal source – factory standard setting 90% pickup, 80% dropout (adjustable);under frequency sensing of the normal source factory setting 95% pickup (adjustable)
- Voltage and frequency sensing of the emergency source – factory standard setting 90% pickup voltage, 95% pickup frequency (adjustable)
- Test switch (fast test/load/no load) to simulate normal source failure – automatically bypassed should the emergency source fail
- Type 1 enclosure is standard – also available in open style or Types 3R, 4, 4X, or 12.

STANDARD FEATURES AND OPTIONS

STANDARD FEATURES

- Auxiliary Contact: Closed when the switch is in the emergency position(Additional contacts optional)
- Auxiliary Contact: Closed when the switch is in the normal position (Additional contacts optional)
- 7, 14, 28 day interval timed exerciser, pushbutton/timer operation
- Engine Start Contact
- Indicating LED Pilot Lights:
  - Switch in emergency position
  - Switch in normal position
  - Normal source available
  - Emergency source available
- Time Delay to Engine Start: Standard setting 3 seconds, adjustable 0-10 seconds
- In-Phase Monitor, self-adjusting (Not available on CTGD models)
- Time Delay on Retransfer to Normal: To delay retransfer to normal source (immediate retransfer on generator set failure); standard setting 30 minutes, adjustable 0-60 minutes
- Pushbutton Bypass of time delay and normal emergency
- Test Switch – Momentary
- Event Log OD 16 Event that track date, time, reason and action taken
- Voltage and Frequency Indication for S1 and S2
- Peak Shave/Remote Load Test: Input for peak shave or remote load test; includes automatic return to normal if emergency source fails and normal is present; 120 VAC

When specified for use with a CTGD Series delayed transition switch, the control panel also includes the following:

- Time Delay from Neutral Switch Position to Normal on Retransfer: Standard setting 5 seconds, adjustable 0-10 minutes
- Time Delay from Neutral Switch Position to Emergency: Standard setting 5 seconds, adjustable 0-10 minutes
- Center-Off position/Off Delay Timing Indicators

MX150 CONTROL PANEL

- Time Delay for Engine Cool Down: Allows engine to run unloaded after switch retransfer to normal; standard setting 5 minutes, adjustable 0-60 minutes
- Time Delay on Transfer to Emergency: To delay transfer to emergency after verifying emergency source available; standard setting 1 second, adjustable 0-5 minutes
- Timer and voltage/frequency settings adjustable without disconnection from power sources
- Built-in diagnostics with LCD display for immediate troubleshooting
- LED/LCD indicators for ease of viewing and long life
- Nonvolatile memory (exerciser battery backup not required for standard operation)
- Processor and digital circuitry isolated from line voltage
- Inputs optoisolated for high electrical immunity to transients and noise
- Communications header for network interface

OPTIONAL ATTACHMENTS

- Plant Exerciser, clock type (load/no load): Allows the generator to start and run unloaded or to simulate a power failure, start generator and run under load (7-14-28-365 days, user selectable)
- Space heater and thermostat
- Network communications interface card (LonWorks/ModBus)
- Maintained Test Switch
- Maintained Test Switch w/Keypad
- Service entrance configuration
- Auxiliary Contact, operates on Source 1 line failure
- Auxiliary Contact, operates on Source 2 availability
- Auxiliary Contacts: Closed when the transfer switch is in Source 2 position
- Auxiliary Contacts: Closed when the transfer switch is in Source 1 position
- Disconnect Switch: Permits transfer in “AUTO” position and inhibits transfer in “INHIBIT” position. (Standard 800A and above)
- Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer
- Universal Motor Load Disconnect Circuit: Auxiliary Contact opens 0-60 seconds prior to transfer in either direction, re-closes after transfer. Can be configured by end user for Pre-transfer, Post-transfer, or both.
- Voltage Imbalance Monitor (Three Phase)
- Lockable, see-through cover for ATS controller

OPTIONAL ATTACHMENTS (continued)

POWER MEASUREMENT METERS

- M90 – EPM 2000
  Digital Power Meter with Display:
  Amps, Volts, and Frequency
- M91 – EPM 6000
  Digital Meter with Display of Amps, Watts, Volts, Frequency, plus THD capability with Ethernet

NOTE:
For applications requiring additional options or other configurations, see the CTS Series fully configurable transfer switch.

DIMENSIONAL SPECIFICATIONS

CTG & CTGD TRANSFER SWITCHES

MODEL	AMP RATING	POLES	NEMA 1 ENCLOSED HEIGHT (A)	WIDTH (B)	DEPTH (C)	REFERENCE FIGURE	WEIGHT	APPLICATION NOTES
CTG	40, 80, 100, 150 & 200	2,3	24 (610)	18 (457)	11 (279)	A	69 (31)	1-6
		4	24 (610)	18 (457)	11 (279)	A	69 (31)	
	225	2,3	46 (1168)	24 (610)	14 (356)	A	69 (31)	1-5
		4	46 (1168)	24 (610)	14 (356)	A	75 (34)	
	260	2,3	46 (1168)	24 (610)	14 (356)	A	114 (52)	1-5
		4	46 (1168)	24 (610)	14 (356)	A	125 (57)	
	400	2,3	46 (1168)	24 (610)	14 (356)	A	168 (76)	1-5
		4	46 (1168)	24 (610)	14 (356)	A	180 (82)	
	600	2,3	66 (1686)	24 (610)	19.5 (495)	B	97 (44)	1-5 &7
		4	66 (1686)	24 (610)	19.5 (495)	B	224 (102)	
	800	2,3	74 (1880)	40 (1016)	19.5 (495)	B	460 (209)	1-5 &7
		4	74 (1880)	40 (1016)	19.5 (495)	B	490 (222)	
	1000	2,3	74 (1880)	40 (1016)	19.5 (495)	B	475 (215)	1-5 &7
		4	74 (1880)	40 (1016)	19.5 (495)	B	560 (254)	
	1200	2,3	74 (1880)	40 (1016)	19.5 (495)	B	475 (215)	1-5 &7
		4	74 (1880)	40 (1016)	19.5 (495)	B	560 (254)	
	1600	2,3	90 (2286)	35.5 (902)	48 (1219)	C	1030 (467)	1-5, 7&8
		4	90 (2286)	35.5 (902)	48 (1219)	C	1180 (535)	
	2000	2,3	90 (2286)	35.5 (902)	48 (1219)	C	1030 (467)	1-5, 7&8
		4	90 (2286)	35.5 (902)	48 (1219)	C	1180 (535)	
	2600	2,3	90 (2286)	35.5 (902)	48 (1219)	C	1150 (522)	1-5, 7&8
		4	90 (2286)	35.5 (902)	48 (1219)	C	1400 (635)	
	3000	2,3	90 (2286)	35.5 (902)	48 (1219)	C	1150 (522)	1-5, 7&8
		4	90 (2286)	35.5 (902)	48 (1219)	C	1400 (635)	
CTGD	40, 80, 100, 150, 200 & 225	2, 3	46 (1168)	24 (610)	14 (356)	A	127 (58)	1-5
		4	46 (1168)	24 (610)	14 (356)	A	133 (60)	
	260 & 400	2,3	46 (1168)	24 (610)	14 (356)	A	176 (80)	1-5
		4	46 (1168)	24 (610)	14 (356)	A	188 (85)	
	600	2,3	66 (1686)	24 (610)	19.5 (495)	B	221 (100)	1-5 & 7
		4	66 (1686)	24 (610)	19.5 (495)	B	230 (104)	
	800	2,3	74 (1880)	40 (1016)	19.5 (495)	B	475 (215)	1-5 & 7
		4	74 (1880)	40 (1016)	19.5 (495)	B	560 (254)	
	1000	2,3	74 (1880)	40 (1016)	19.5 (495)	B	475 (215)	1-5 & 7
		4	74 (1880)	40 (1016)	19.5 (495)	B	560 (254)	
	1200	2,3	74 (1880)	40 (1016)	19.5 (495)	B	475 (215)	1-5 & 7
		4	74 (1880)	40 (1016)	19.5 (495)	B	560 (254)	
	1600	2,3	90 (2286)	35.5 (902)	48 (1219)	C	1030 (467)	1-5 & 7-8
		4	90 (2286)	35.5 (902)	48 (1219)	C	1180 (535)	
	2000	2,3	90 (2286)	35.5 (902)	48 (1219)	C	1030 (467)	1-5 & 7-8
		4	90 (2286)	35.5 (902)	48 (1219)	C	1180 (535)	
	2600	2,3	90 (2286)	35.5 (902)	48 (1219)	C	1150 (522)	1-5 & 7-8
		4	90 (2286)	35.5 (902)	48 (1219)	C	1400 (635)	
	3000	2,3	90 (2286)	35.5 (902)	48 (1219)	C	1150 (522)	1-5 & 7-8
		4	90 (2286)	35.5 (902)	48 (1219)	C	1400 (635)	

Application Notes :

1. Dimensions are listed in inches (mm) and weights in pounds (kg).
2. Includes 1.25" door projection beyond base depth. Allow a minimum of 3" additional depth for projection of handle, light, switches, pushbuttons, etc.
3. **All dimensions and weights are approximate and subject to change without notice and are not for construction use.**
4. Packing materials must be added to weights shown. Allow 15% additional weight for cartons, skids, crates, etc.
5. Special enclosures (NEMA 3R, 4, 4X, 12, etc.) dimensions may differ. Consult Caterpillar for details.
6. CTG 40-200 require larger 36" H X 24" W X 14" D enclosure depending on options specified. Consult Caterpillar for details.
7. Add 3" in height for lifting eyes.
8. Ventilation louvers on side/rear of 2600 and 3000A units require one side or rear of enclosure to be clear in order to afford proper airflow.

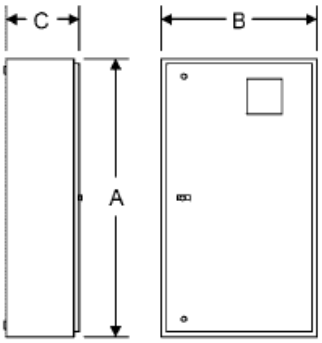


Figure A

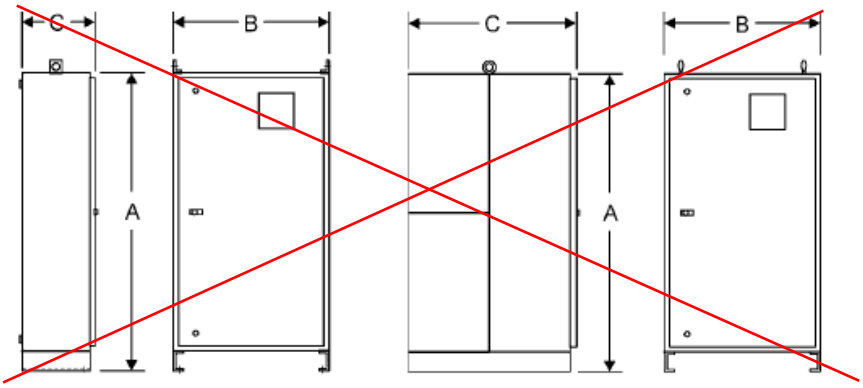


Figure B

Figure C

Figure A
CTG Series Transfer Switch
(40-400 amp)

Figure B
CTG Series Transfer Switch
(600-1200 amp)

Figure C
CTG Series Transfer Switch
(1600-3000 amp)

TESTING STANDARDS

UL, CSA and IEC listed	UL 1008, CSA 22.2 No. 178, IEC 947-6-1
Ringing wave immunity	IEEE 472 (ANSI C37.90A)
Conducted and Radiated Emissions	EN55022 Class B (CISPR 11) (Exceeds EN55011 & MILSTD 461 Class 3)
ESD immunity test Class B	EN61000-4-2 (Level 4)
Radiated RF, electromagnetic field immunity test	EN61000-4-3 (ENV50140) 10v/m
Electrical fast, transient / burst immunity test	EN61000-4-4
Surge immunity test	EN61000-4-5 IEEE C62.41
Conducted immunity test	EN61000-4-6 (ENV50141)
Voltage dips and interruption immunity	EN61000-4-11

AL/CU UL LISTED SOLDERLESS SCREW-TYPE TERMINALS FOR EXTERNAL POWER CONNECTIONS

Switch Size (Amps)	Normal, Emergency and Load Terminals	
	Cables per Pole	Range of Wire Sizes
40, 80	1	#8 to 3/0 AWG
100, 150, 200 & 225	1	#6 AWG to 250 MCM*
260 & 400	1	#4 AWG to 600 MCM*
600	2	#2 AWG to 600 MCM
800, 1000, 1200	4	#2 AWG to 600 MCM
1600, 2000, 2600, 3000	8	#2 AWG to 600 MCM

*or 2 1/0 - 250 MCM may be used

MX150 CONTROL SETTING RANGES

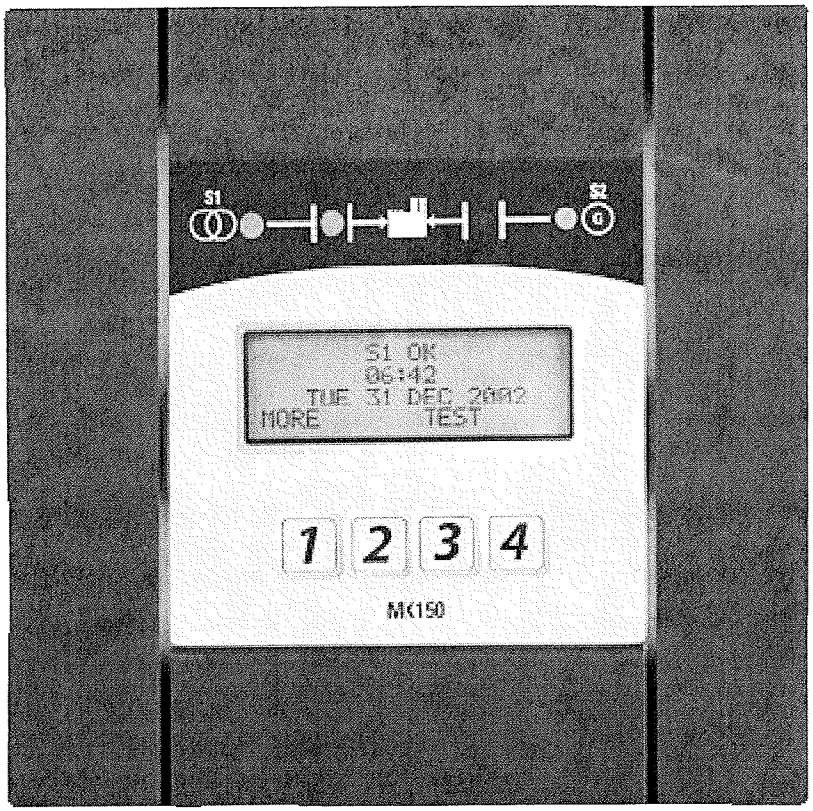
Control Function		Range	Factory Setting
Normal Line Sensing- Under-voltage	Dropout	75-98%	80%
	Pickup	85-100%	90%
Emergency Line Sensing - Under-voltage	Dropout	75-98%	80%
	Pickup	85-100%	90%
Emergency Line Sensing - Under-frequency	Dropout	2 Hz below pickup	Set
	Pickup	90-100%	95%
Time Delay - Engine Start		0-10 seconds	3 seconds
Time Delay - Engine Cool Down		0-60 seconds	5 minutes
Time Delay - Transfer to Emergency		0-5 minutes	1 second
Time Delay - Retransfer to Normal		0-60 minutes	30 minutes
Time Delay - Motor Disconnect or Transfer Presignal (When applicable)		0-60 seconds	20 seconds
Delayed Transition Time Delays (When applicable)		0-10 minutes	5 seconds

WITHSTAND CURRENT DATA

Withstand Current Ratings per UL 1008				
	Maximum Circuit Amps When Used With		Maximum Circuit Amps When Used With	
CTG Switch Ratings (Amps)	Specific Coordinated Breaker Rating	Current Limiting Fuse CTG/CTGD	CTGD Switch Ratings (Amps)	Specific Coordinated Breaker Rating
40, 80, 100, 150, 200, 225	30,000	200,000	40, 80, 100	50,000
260	35,000		150, 225, 260	50,000
400, 600	50,000		400, 600	50,000
800	65,000		800	65,000
1000, 1200	85,000		1000, 1200	85,000
1600, 2000, 2600, 3000	100,000		1600, 2000, 2600, 3000	100,000

CATERPILLAR®

MX150 Controller



CI-AZOM-00029-01-E (10/10)

70R-2000C

Operation and Maintenance Manual

Authorized Service

For Cat parts and service: in the U.S. call (866) 883-3879 for Int'l (678) 746-5000 of by email to the Helpdesk@cat-iso.com

Table of Contents

	Page
Introduction	2
Safety	3
Equipment Inspection and Storage	3
Final Equipment Inspection	3
Installation	4
Engine Start Control Connections	4
Initial Energization	4-5
Control Connections	6
MX150 Microprocessor Controller	7
Overview	7
LCD & Keypad	8
User Setting for Voltage & Frequency	9
Standard Features, MSTDG Option Pkg.	9-10
Standard Features, MEXEG Option Pkg.	11
Optional Accessories	12
How to Set the System Clock	13
CDT One Event Timer Exerciser	13-14
CDP Clock Exerciser	15
User Setup - CFG Menu	16
User Setup - SET Menu	17
User Setup - System Info	18
Testing	19
Standard Transition	19
Delayed Transition	19
Sequence of Operation	20
Standard Transition	20
Delayed Transition	20
Controls Power Supply (CPS)	21
Schematics, Standard and Delay	22
Troubleshooting & Diagnostics	23
Maintenance and Testing	24
Inspection and Cleaning	24
Servicing	24
Testing	24

Introduction

Cat Transfer Switches are used to provide a continuous source of power for lighting and other critical loads by automatically transferring from source 1 power to source 2 power in the event that source 1 voltage falls below preset limits.

Voltage sensing and system control is performed via a state-of-the-art microcontroller located on the cabinet door. It is designed to give highly accurate control of the transfer switch system.

Cat transfer switches are designed for use on emergency or standby systems, and are rated for total system or motor loads. Transfer switches are UL Listed under Standard 1008 and CSA Certified under Standard C22.2 No. 178 and IEC Listed under Standard 947.

NOTES: A protective device such as a molded case circuit breaker or fused disconnect switch MUST be installed on both sources of incoming power for circuit protection and as a disconnection device.

All references made within this manual about the term "S1" or "Source 1" relate to a Normal Power Source. All references made about the term "S2" or "Source 2" relate to an Emergency or Alternative Power Source.

Safety / Installation

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

The safe operation of your switch is IMPORTANT. The proper storage, installation, operation and maintenance will help increase the life of the switch.

⚠ CAUTION ⚠

Due to hazardous voltage and current, Caterpillar recommends that a Cat Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

Equipment Inspection and Storage

Once you have received the transfer switch, inspect it for any damage. This includes damage to the enclosure, power panel, control panel and wiring harness. If any damage is found or suspected, file a claim as soon as possible with the carrier and notify the freight carrier and your Cat dealer.

Before installation, if it is necessary, store the transfer switch in a clean dry place, protected from dirt and water. Provide ample air circulation and heat, if necessary, to prevent condensation.

Storage Temperature	Operating Temperature (Ambient):	Humidity
-30°C to +75°C (-22°F to +167°F)	**40-400 AMP** *(molded shell)* -20°C to +65°C (-4°F to +149°F) **40-4000 AMP** *(all other frame and panel types)* -20°C to +60°C (-4°F to +140°F)	5% to 95% (non-condensing)

Final Equipment Inspection

Prior to energizing the transfer switch:

1. Remove any debris incurred, with a vacuum, due to shipment or installation.
2. Verify that all cabled connections are correct and that phase rotation of both sources match.
3. Check engine start connections.
4. Verify the correct connection of all control wires.
5. Check settings of all timers and adjust as necessary.
6. Adjust any optional accessories as required.
7. Check the lug torque values of the power connections.

   NOTE: Lug torque values are specified in the power panel manual.

8. Make sure that all covers and barriers are installed and properly fastened.

   NOTE: Power panels ship from GE Zenith in Source 1 Position.

⚠ WARNING ⚠

Do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

Each Cat transfer switch is factory wired and tested. A complete information package is furnished with each switch which includes:

a. Sequence of operation.
b. Description and operation of all accessories supplied.
c. Power panel connection diagram and schematic.
d. Description and identification of all customer field connections.

Installation of Cat transfer switches includes:

a. Mounting the transfer switch cabinet.
b. Connection of Source 1, Source 2, and Load cables or bus bars.
c. Connection of external control circuits as required.

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

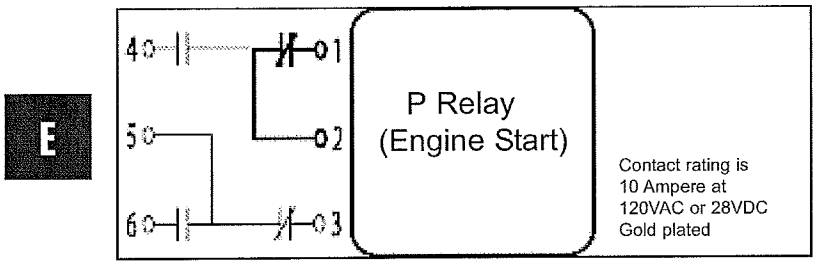


Figure 3

Engine Start Control Connections

The engine-start terminals are clearly identified by a label on the microcontroller backplate. In the case of manual transfer switches, or in other applications not requiring the microprocessor, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

Terminals for field connections to the A3 Emergency auxiliary contacts and the A4 Normal auxiliary contacts are also provided. These terminals are clearly marked and appear on the side of the power panel. On 400 amp metal frame units these terminals appear on the bracket above the operator handle.

Initial Energization

Before proceeding, refer to the information package supplied with the ATS and read and understand the information on all accessories provided.

1. Unlock the enclosure.
2. Open the enclosure.
3. Verify the correct system voltage.

   NOTE: The equipment rating nameplate on the transfer switch lists the voltage. See *Figure 3*.

4. Close Source 1 circuit. breaker.

   NOTE: The controller will illuminate Source 1 Available LED if proper voltage is sensed.

5. Verify the phase to phase voltages at the Normal line terminals.
6. Close the Emergency source circuit breaker.
7. Start the generator's engine.

   NOTE: The controller will illuminate Source 2 Available LED when preset voltage and frequency levels are reached.

8. Verify the phase to phase voltages at Source 1 line terminals.
9. Verify that the phase rotation of Source 1 is the same as the phase rotation of Source 2.

10. Shut down the generator's engine.
11. Place the starting control in the Automatic position.
12. Complete the visual inspection of the transfer switch.
13. Close the enclosure.
14. Lock the enclosure.

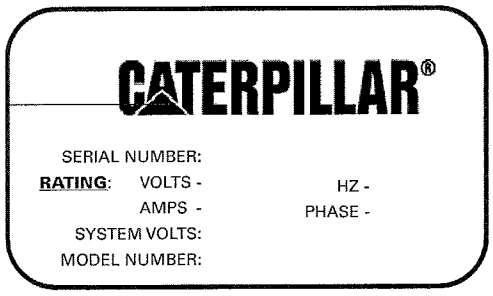


Figure 4

⚠ CAUTIONS ⚠

Certain accessories, per specific schematics, can inhibit automatic transfer. Engine Gen-Set could start when engine control wires are attached.

Initial Energization (cont'd)

After all options and accessories are checked and verified, follow these steps to set up the ATS. Refer to MX150 display *Figure 5*. The annunciation LEDs illuminate to indicate (1) source availability, (2) ATS position, and (3) MX150 control function (timing).

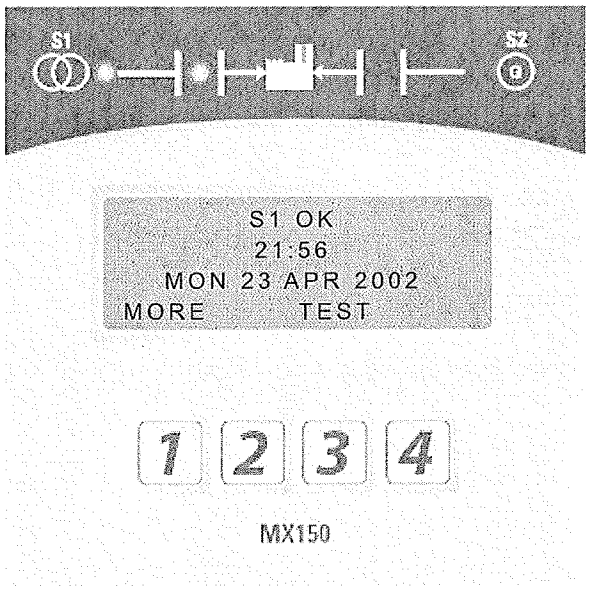


Figure 5 – LCD and keypad

1. Unlock the enclosure.
2. Open the enclosure.
3. Place the Disconnect Switch in the Inhibit.

   NOTE: This step is only performed if the "DS" Option was purchased.

4. Close the external (up-stream) Source 1 circuit breaker.

   NOTES: Source 1 Available and Source 1 Position LED's will illuminate.

   If Source 1 Available LED does not illuminate, verify that Source 1 Voltage is above the preset restore value.

   The Gen-Set will start and run while Source 2 stop Delay Timer is timing.

5. Close the External (up-stream) Source 2 line circuit breaker.
6. Start the engine generator in MANUAL mode.

   NOTE: When the voltage and frequency reach preset values, the Source 2 Available LED will illuminate.

7. Verify the phase to phase voltages at Source 2 line terminals.
8. Verify that the phase rotation of Source 2 is the same as the phase rotation of Source 1.

9. Shut down the generator's engine. (Place in Automatic Mode.)

   NOTE: Source 2 Available LED will turn off.

   NOTE: The engine generator will continue to run for the duration of Source 2 Stop Delay Timer.

10. Place the disconnect switch to ENABLE.
11. Complete the visual inspection of the transfer switch.
12. Close the enclosure.
13. Lock the enclosure.

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.

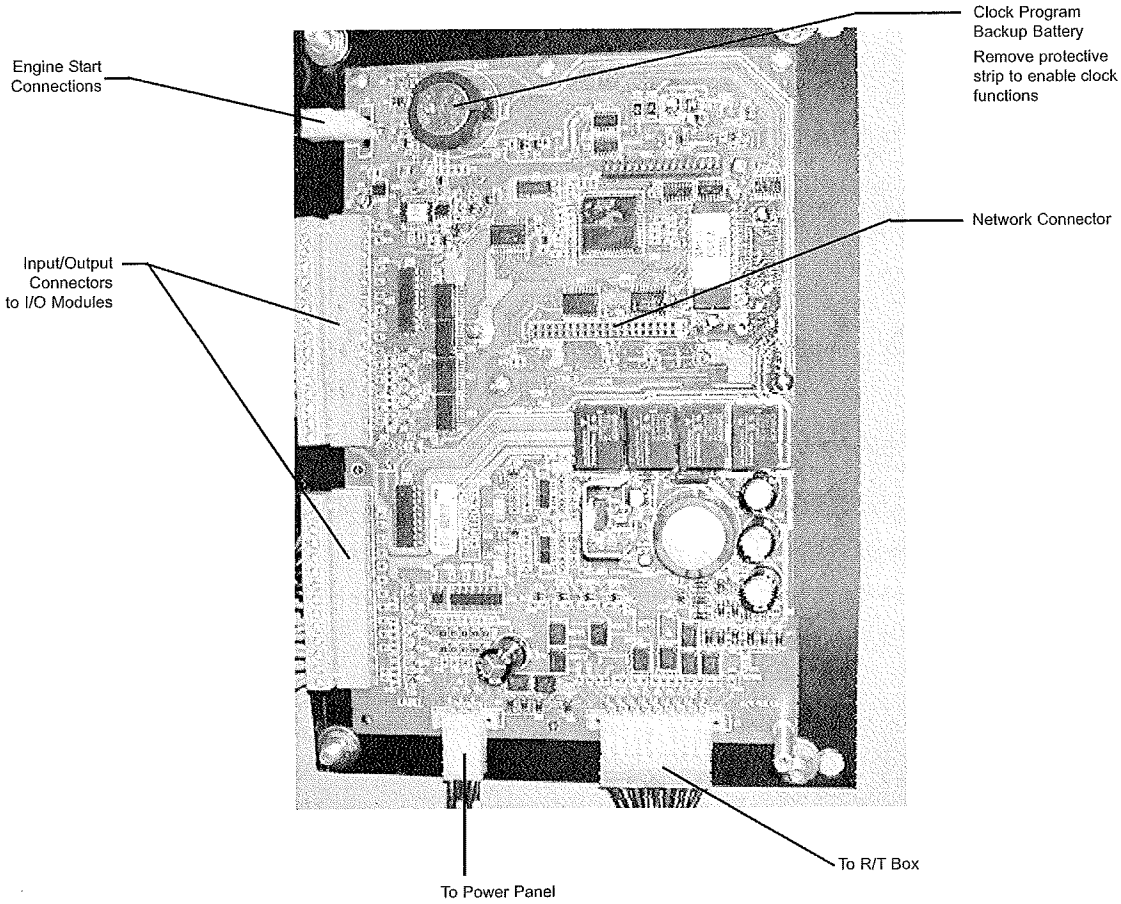
⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Control Connections

Figure 2



A complete information package is furnished with each transfer switch including a complete connection diagram and schematic which details all necessary control circuit field connections.

The engine start control wires connect to the engine start relay terminals located to the left of the microprocessor. Figure 2 shows the location of these terminals.

The terminals are clearly identified by a label on the microcontroller backplate. In the case of manual transfer switches, or in other applications not requiring the microprocessor, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

MX150 Controller

Consists of two major assemblies:

I. The **Microprocessor** contains the following:

A. MX150 Board - Customer Input and Output (I/O) for system interface. Located on the left hand side of the back of the unit (see figure 6)

1. I/O accessories that can be found here are:
   a. Engine start relay P output
   b. Pre-Signal to transfer T3, W3 and UMD output (optional)
   c. Transfer Inhibit Q3 and Q7 input (optional)
   d. Remote test Q2 input (optional)
   e. Network interface ZNET input/output (optional)

B. LCD and Keypad located on the exterior of the door (see figure 7)

1. User accessibility to the following:
   a. LED indication of source availability
   b. LED indication of transfer switch position
   c. LCD screen indicates:
      (1) timer count down (numeric)
      (2) event reporting (text)
   d. Keypad provides user interface to: *[in conjunction with LCD screen]*
      (1) Setting sensors and timers
      (2) Configuring logic accessories

II. The **Controls Power Supply (CPS)**

Contains transformers which drop line voltage to control level for controller input and SCR inputs (see figure 6).

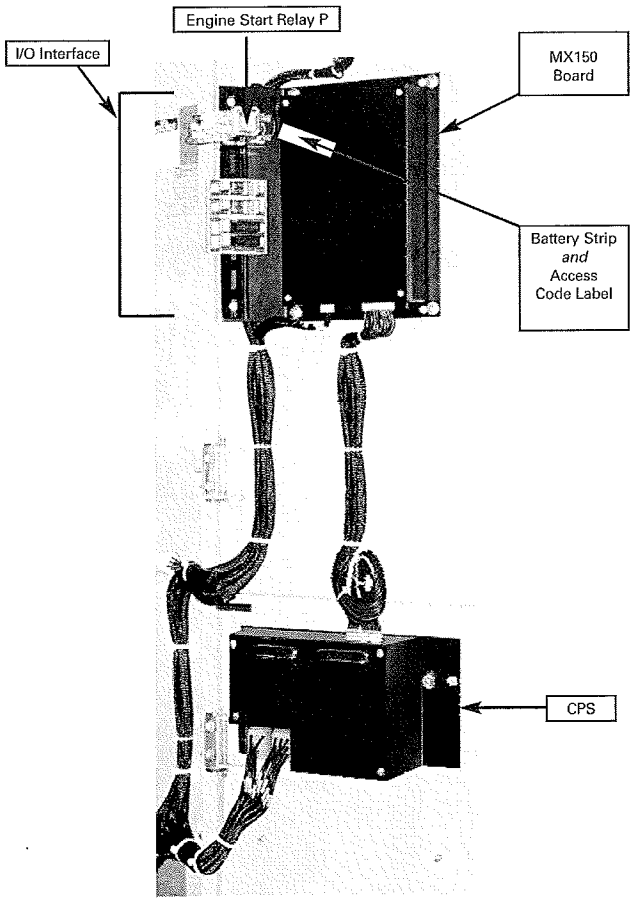


Figure 6

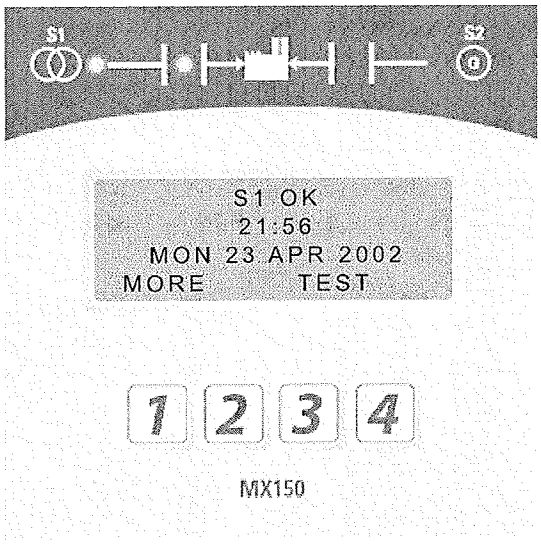


Figure 7

LCD & Keypad

These options are accessible through the LCD and keypad (see figure below). To become familiar with the options loaded into a particular unit, scrolling through the SET and CFG menu will show the descriptions of the options (see pages 16). These menus are the very same menus that are used to access the setting and/or configuration of these options. The SET (setting) menu is primarily used to show or change, time and voltage settings. The CFG menu is primarily used to turn an option on or off. When scrolling through these menus, no changes can be made without entry of the access code. The factory set six-digit access code is located on a white label on the back of the unit (see figure 9 pgs. 16-18).

The MX150 has many logic options. Each controller is downloaded with options at the time of manufacture. The collection of options that any one controller has is specified at the time of order placement. The following pages include all the options that can reside in the controller. Not all units include all options.

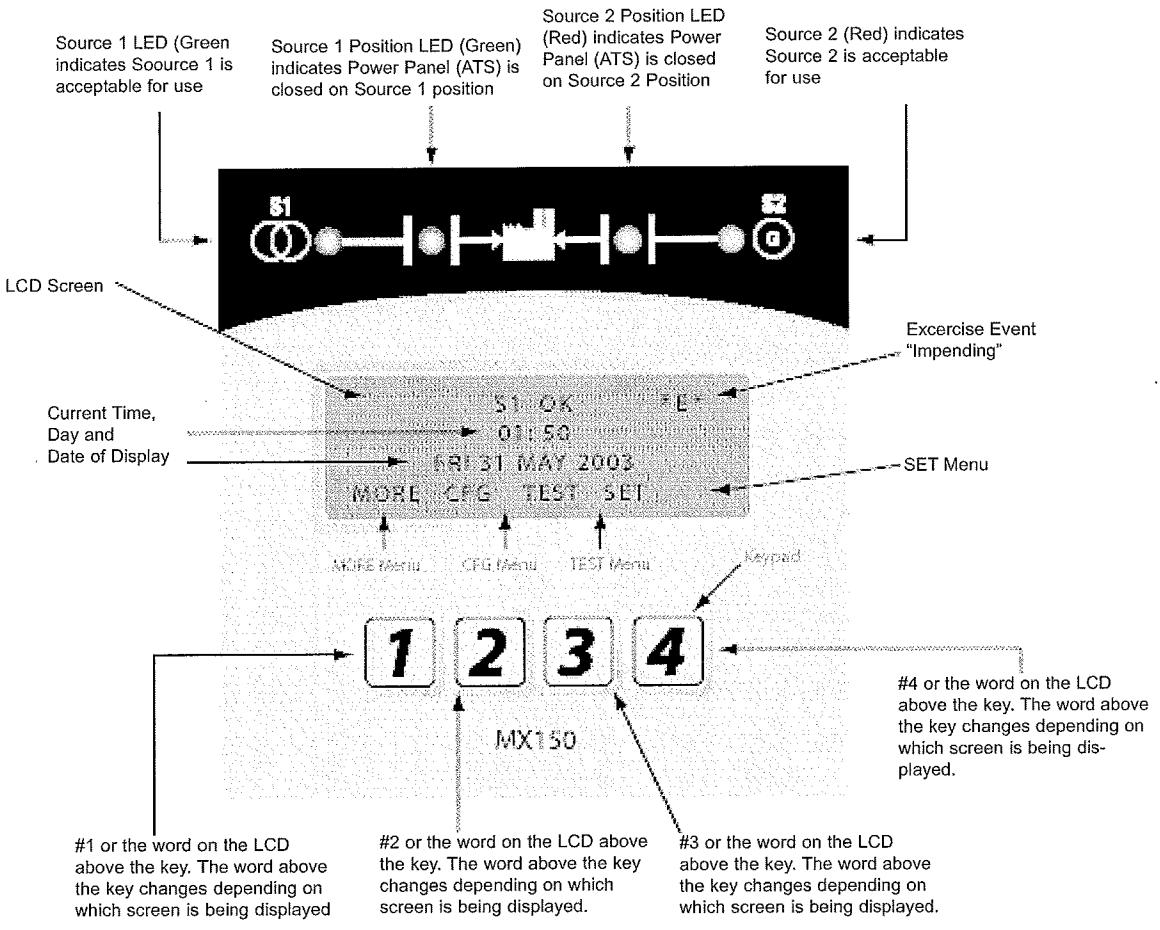


Figure 8

User Setting for Voltage & Frequency

Source 1

Voltage "Restore"
Factory Default: 90%
This adjustment determines the minimum acceptable voltage required to transfer to Source 1.
Adjust via the SET menu. Range is 85% to 100% in 1% increments (see page 17).
Once satisfied, the T timer will begin timing to transfer to Source 1.

Voltage "Fail"
Factory Default: 80%
This adjustment determines the low voltage threshold. Adjust via the SET menu. Range is 75% to 98% in 1% increments (see page 17).
"Fail" must be a minimum of 2 % below "Restore" setting. Once voltage falls below threshold, P timer begins timing to signal Source 2 Generator to start.

Source 2

Voltage "Restore"
Factory Default: 90%
This adjustment determines the minimum acceptable voltage required to transfer to Source 2.
Adjust via the SET menu. Range is 85% to 100% in 1% increments (see page 17).
Once satisfied, the W timer will begin timing to transfer to Source 2.

Voltage "Fail"
Factory Default: 80%
This adjustment determines the low voltage threshold. Adjust via the SET menu. Range is 75% to 98% in 1% increments (see page 17).
"Fail" must be a minimum of 2 % below "Restore" setting. Once voltage falls below threshold, T timer will be bypassed to expedite the transfer to Source 1.

Frequency "Restore"
Factory Default: 95%
This adjustment determines the minimum acceptable frequency required to transfer to Source 2.
Adjust via the SET menu. Range is 90% to 100% in 1% increments (see page 17).
Once satisfied, the W timer will begin timing to transfer to Source 2.

Frequency "Fail"
Factory Default: 90%
This adjustment determines the low frequency threshold. Adjust via the SET menu. Range is 88% to 98% in 1% increments (see page 17).
"Fail" must be a minimum of 2 % below "Restore" setting. Once satisfied, the W timer will begin timing to transfer to Source 2.

Standard Features, MSTDG Option Pkg.

6
Test Switch, Momentary

A3
Auxiliary Contact: Closed when the switch is in Source 2 position.

A4
Auxiliary Contact: Closed when the switch is in Source 1 position.

Calibrate
While monitoring the actual Phase to Phase voltage levels and Frequency with a calibrated test equipment, the Phase to Phase voltage sensing and Frequency can be adjusted accordingly. Calibration capabilities are available for Frequency and AB, BC, CA Phase to Phase voltage for both Sources. Adjust via SET menu (see page 18)

CDT
Load or NO-Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 minutes in 1 minute increments. Can be configured to run every 1, 7, 14, or 28 days. Factory Default is 20minutes. When exerciser is impending, (*E*) appears in the upper right hand corner of LCD screen. See page 13-14 for instructions. Configured via CFG (see page 16). Set via SET menu (see page 17).

DS
Disconnect Switch, Auto/Inhibit.
Inhibits transfer in either direction when in inhibit.
Allows automatic operation when in Auto.
(800-4000 Amp units)

DT *(Delayed Transition Only)*
Time Delay from Neutral Switch position to Source 1 position. Adjustable 0-10 minutes in 1 second increments. Standard setting is 5 seconds Adjust via SET menu (see page 17)

DW *(Delayed Transition Only)*
Time Delay from Neutral Switch position to Source 2 position. Adjustable 0-10 minutes in 1 second increments. Standard setting is 5 seconds.Adjust via SET menu (see page 17)

E
Engine Start Contact

Std. Features, MSTDG Option Pkg. (cont'd)

EL/P

Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken

System Data: Total Life Transfers (N2P)
Days Powered Up
Total Transfers to S2
Total S1 Failures
Time S1 available in Hrs
Time S2 available in Hrs. (N1P)

K/P

Frequency Indication for S1 and S2

L

LNP Center-off position LCD-Indicator
Indicating LED lights:

- **L1** Indicates Switch in Source 2 position.
- **L2** Indicates Switch in Source 1 position.
- **L3** Indicates Source 1 available.
- **L4** Indicates Source 2 available.

P1

Time Delay Source 2 Start. Adjustable 0-10 seconds. Standard setting is 3 seconds.
Adjust via SET menu (see page 17)

Q2

Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present.

R2E

Under voltage sensing of Source 2 for single-phase. (R17 replaces R2E for Utility to Utility switches)

R50

In Phase Monitor this feature restricts **Live to Live Source Transfers** to occur unless both Sources are within 7 electrical degrees or less of each other. (live Source to live Source transfers usually occur during transfer back to Source 1 or during Testing). R50 does not change the operation of the Automatic Transfer Switch in a power failure mode. After all timer functions have elapsed, **the CHECKING FOR SOURCE SYNCHRONISM** will be displayed as well as the direction of transfer (S1-S2 for example denotes transfer from Source 1 to Source2). When synchronism is accomplished, transfer will take place.

Notes:

- **If S2 Frequency is less than S1 Frequency, display will show a series of (- - - - -.....) symbols.**
- **If S2 Frequency is greater than S1 Frequency, display will show a series of (+++++.....) symbols.**
- **Each (-) or (+) symbol represents 10 electrical degrees out of phase. A maximum of 18 symbols (180 electrical degrees) can be monitored.**
- **The number of (-) or (+) symbols decrease as the two sources approach synchronism and increase as the two sources drift out of synchronism.**
- **If S1 and S2 Frequencies are identical, the display will show a series of alternating symbols (++++...) which also indicate the approximate out of phase degrees**

In the event that the Sources do not come within 7 electrical degrees of each other within 60 seconds, the unit will display the message: **SYNCH CHECKING** and will allow the user to **BYPASS**. If the **BYPASS** button is pressed, the unit will display the message: **WARNING MAY CAUSE DAMAGE TO THE LOAD**. Pressing **XFR** will actually bypass the R50. Since R50 is a passive device, the length of time it takes to reach Synchronism is dependent on the frequency difference between the two Sources. Source 1 is usually a Utility and the frequency is not within the control of the consumer. Source 2 needs to be adjusted to create an adequate difference in order for the transfer to happen a timely fashion.

Note: For optimum performance, Source 2 Generator should be adjusted a Maximum of 2 Hertz above or below the Utility frequency, minimum of 0.1 Hertz. (58 to 59.9) or (60.1 to 62) Hertz. Adjustment of Generator to 60Hertz could cause lengthy transfer delay.

R50 Feature can be turned ON or OFF via CFG Menu (see page 16). Factory Default if OFF.

S13

Transfer Commit. Configured via CFG menu. (see page 16) When this Feature is set to OFF: The transfer Switch is not committed to transfer unless the outage duration is longer than the timers that precede the transfer to Source 2 position. This assumes that the outage will be an isolated event. When this Feature is set to ON: The transfer Switch is committed to transfer to Source 2 position once the W timer has begun timing, even if Source 1 power returns before the transfer to Source 2. This is to ensure that the transfer takes place, because one outage may be followed by another.

T

Time Delay (S1) Source 1 Stable Timer. To delay transfer to Source 1 (immediate retransfer on Source 2 failure). Adjustable 0-60 minutes in 1 second increments. Standard setting is 30 minutes. Adjust via SET menu (see page 17)

U

(S2) Source 2 Stop Delay Timer. Allows Engine to run unloaded after switch retransfer to Source 1. Adjustable 0-60 minutes in 1 second increments. Standard setting is 5 minutes. Adjust via SET menu (see page 17)

W

Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2. Adjustable 0-5 minutes in 1 second increments. Standard setting is 1 second. Adjust via SET menu (see page 17)

YEN

Bypass Timers Key utilizing Keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.

Standard Features, MEXEG Option Pkg.

In addition to the features listed under the MSTDG Option Package, this enhanced package includes the following features:

A3
Additional Auxiliary contact: closed when switch is in Source 2 position.

A4
Additional Auxiliary contact: Closed when the transfer switch is in Source 1 position.

CDP (replaces CDT)
Clock Exerciser Load/ No Load: Allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load.
Can be configured by end user for 1, 7, 14, 28, 365 day cycle.

VI
Voltage Imbalance (Three Phase)
For a three phase source, this feature monitors phase voltage ratios based on a selected range within a selected time window. Should any phase fall below the selected lower window limit or exceed the selected higher window limit within the selected time frame, the controller initiates transfer to the other source.

Range: 5% to 20% of Nominal voltage,
10 to 30 seconds window, user adjustable.
Resolution: 1% Increments
Minimum Differential: 2% between "Fail" and "Restore" settings.
Factory default: 10% "Fail", 8% "Restore, 30 Seconds.
See CFG Menu page 16 to configure ON or OFF.
See SET Menu page 17 to set Percentage and time windows

Optional Accessories

6A
Test Switch, Maintained / Momentary

6AP
Test Switch, Maintained / Momentary, utilizing Keypad

A1
Auxiliary Contact, operates on Source 1 line failure.

A1E
Auxiliary Contact, operates on Source 2 line failure.

A3
Auxiliary Contacts: Closed when the transfer switch is in Source 2 position.

A4
Auxiliary Contacts: Closed when the transfer switch is in Source 1 position.

A62
Sequential Universal Motor Load Disconnect Circuit. Normally closed Auxiliary contacts for Motor Loads. Open 0-60 seconds prior to transfer, after transfer, or both in either direction then re-close in timed sequence after transfer.

CTAP
Alarm Panel on transfer to Source 2 with Silence button.

DS
Disconnect Switch, Auto/Inhibit.
Inhibits transfer in either direction when in inhibit.
Allows automatic operation when in Auto.
(40-600 Amp units)

HT
Heater and Thermostat.

Manual
Manual Transfer Switch transfers in either direction by depressing designated pushbuttons.

M80
Digital Power Meter with Display: Amps, Volts, and Frequency.

M82
Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.

M83A
Digital Meter w/Diplay of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/Modbus.

T3/W3
Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer.

UMD
Universal Motor Load Disconnect Circuit: Auxiliary Contact opens 0-60 seconds prior to transfer in either direction, re-closes after transfer. Can be configured by end user for Pre-transfer, Post-transfer, or both.

VI
Voltage Imbalance (Three Phase)
For a three phase source, this feature monitors phase voltage ratios based on a selected range within a selected time window. Should any phase fall below the selected lower window limit or exceed the selected higher window limit within the selected time frame, the controller initiates transfer to the other source.

Range: 5% to 20% of Nominal voltage,
10 to 30 seconds window, user adjustable.
Resolution: 1% Increments
Minimum Differential: 2% between "Fail" and "Restore" settings.
Factory default: 10% "Fail", 8% "Restore, 30 Seconds.
See CFG Menu page 16 to configure ON or OFF.
See SET Menu page 17 to set Percentage and time windows

ZNET
Network Communications Interface Card

How to Set the System Clock

How to Set the System Clock

Set System Clock, time and date

- If the clock is not set, the display will show SET SYSTEM CLOCK on the second line of the S1 OK screen.
- The S1 OK screen will show time (hours and minutes) on the second line if the system clock has been set. (Date on third line)

Setting the System Clock

(Start from **S1 OK** screen)

1. Remove battery protective white plastic strip near **P** relay. *
2. Press **MORE** then press **SET**.
3. Press **MORE** and scroll to **SET SYSTEM CLOCK** using the **MORE** key.
4. Press **SEL**.
5. **ENTER ACCESS CODE** located on the white label on the back of the controller.
6. Press **SEL**.
7. Use the up and down keys to change the hour value.
8. Press **SAVE** (this will enter this value and move cursor to minutes).
9. Use the up and down keys to change the minutes.
10. Press **SAVE** (this will enter this value and move cursor to month).
11. Use the up and down key up to change the month.
12. Press **SAVE** (This will enter this value and complete the clock setting).
13. Use the up and down keys to change the date.
14. Press **SAVE** (this will enter this value and move cursor to year).
15. Use the up and down keys to change year.
16. Press **SAVE** (this will enter this value and compete the clock setting).
17. To edit settings, press **SEL** and repeat steps 6-16.
18. If the setting is satisfactory, press **MORE** (unit then returns to the **SET** menu then press **BACK**, then **ESC**.)

* Replacement battery part #K-4100
Battery will last 5 years and provides power to retain clock function only (Controller functions without battery).

CDT One Event Timer Exerciser

Load / No-Load

One event Exerciser with adjustable Timer. Exercise duration can be set between 5 and 60 minutes in 1 minute increments. Can be configured to run every 1,7,14, or 28 days. Factory default is 20 minutes.

How to CONFIGURE (CFG) and Set (SET) the Timer Exerciser

1. Beginning from the **S1 OK** screen, press **MORE** then **CFG**.
2. Press **MORE** to scroll to **CONFIG TIMER EXERCISER** screen.
3. The third line of the **CONFG TIMER EXERCISER** will show either **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, or **OFF**.
4. If the third line of the **CONFG TIMER EXERCISER** shows **DAILY**, **WEEKLY**, **14 DAY**, or **28 DAY** as desired, then proceed to step 10.
5. If the third line of the **CONFG TIMER EXERCISER** shows **OFF** or if another timer selection is desired, continue.
6. Press **SEL**.
7. Enter **ACCESS** code located on white label on the back of the controller.
8. Press **UP** or **DOWN** to select **DAILY**, **WEEKLY**, **14 DAY**, or **28 DAY** as desired.
9. Press **SAVE**.
10. Press **MORE** to scroll to **CONFG TIMER EXERCISER (XFR)** or **(NO XFR)**.
11. Press Up or Down to select **XFR** (Load Transfer) or **NO XFR** (No Load Transfer).
12. Press **SAVE**.
13. Press **MORE** repeatedly to **BACK** then **S1 OK** screen.

Set (SET) the Exerciser:

14. Beginning from the **S1 OK** screen, press **MORE** then **SET**.
15. Press **MORE** repeatedly until **EXER S2 RUN TIME** screen.
16. Press **SEL**
17. Enter **ACCESS** code located on white label on the back of the controller.
18. Press **SEL**
19. Cursor is indicated as a line under character to be changed. Change values with up and down keys.
20. Press **SAVE** when complete.
21. Press **MORE** repeatedly until **SET USER SETUP** then press **BACK** then **ESC** to the **S1 OK** screen.

CDT One Event Timer Exerciser (cont'd)

How to Initiate CDT Exerciser and to start an exercise cycle every 1, 7, 14, or 28 days

From S1 screen

1) Press **TEST**
2) Press **MORE**
3) Press **START TEST TIMER** (to initiate Test).

- If the CDT Exerciser is Factory configured for a Load Exerciser, the Controller will immediately start a load exercise. The controller will start the generator, transfer the load to Source 2 and remain in Source 2 for the duration set for **EXER S2 RUN TIME** in the **SET** menu. The controller will retransfer the load back to Source 1 after the S1 stable timer has timed out and run the generator unloaded for the duration of the S2 stop delay timer (Engine Cool Down Timer).
- If the CDT Exerciser is Factory configured for a No-Load Exerciser, the Controller will immediately start a No-load exercise. The controller will start the generator and run it unloaded for the duration of the S2 stop delay timer (Engine Cool Down Timer).

Exercise will be repeated at the same time as initiated on every 1, 7, 14, or 28 days according to the selection made in the Configure **CFG** menu.

How to Bypass (Cancel) an exercise during an exercise cycle

1) Press **BPASS**
2) Allow the controller to complete the Engine cool down cycle

If the CDT Exerciser is Factory configured for a No-Load Exerciser Or allow the controller to complete retransfer to Source 1 If the CDT Exerciser is Factory configured for a Load Exerciser

How to Bypass the next exercise event and Keep the rest of scheduled events unchanged

1) Press Test
2) Press **MORE**
3) Press **BYPASS EXER**

To re-institute the next exercise event back, press **CANCL BPASS**

How to initiate a new exercise start time

1) Press **TEST**
2) Press **MORE**
3) Press **EXER CANCL**
4) Press **START TIMER TEST**

How to check the next exercise event

1) From **S1 OK** screen, press **MORE** three times.
2) The unit will display the **PLANT EXERCISER NEXT** event in **DAYS**, **HOURS**, and **MINUTES**
3) Press **ESC** to **S1 OK** Screen.

Notes:

- ***E*** appears in the upper right hand corner of LCD screen when exercise is impending.
- For Load Exerciser, actual exercise period (ATS in S2 position)= CDT (Exerciser) timing period +T (S1 stable Timer) timing period.

CDP Clock Exerciser

Load / No-Load Clock Exerciser

Allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by the end user for 1, 7, 14, 28, or 365 day cycles.

- A total of 7 independent No Load exercise periods (up to 10 hours each) can be programmed for each of the daily, weekly, 14-day, and 28-day exercisers.
- A total of 12 independent No Load exercise periods (up to 10 hours) can be programmed for the 365-day Exerciser.

How to Configure (CFG) the Exerciser

1. Beginning from the **S1 OK** screen, press **MORE** then **CFG**.
2. Press **MORE** to scroll to **CONFIG CLOCK EXERCISER** screen.
3. The third line of the **CONFG CLOCK EXERCISER** will show either **DAILY, WEEKLY, 14 DAY, 28 DAY, 365 DAY** or **OFF**.
4. If the third line of the **CONFG CLOCK EXERCISER** shows **DAILY, WEEKLY, 14 DAY, 28 DAY,** or **365 DAY** as desired, press **MORE** repeatedly to **BACK**. Press **ESC** then proceed to the **SET** menu to set the **EXERCISER**.
5. If the third line of the **CONFG CLOCK EXERCISER** shows **OFF**, continue.
6. Press **SEL**.
7. Enter **ACCESS** code located on white label on the back of the controller.
8. Press **UP** or **DOWN** to select **DAILY, WEEKLY, 14 DAY, 28 DAY,** or **365 DAY** as desired.
9. Press **SAVE**.
10. Press **MORE** repeatedly to **BACK** then **ESC** to **S1 OK** screen.

How to set (SET) the DAILY Exerciser

1. Beginning from the **S1 OK** screen, press **MORE** then **SET**.
2. Press **MORE** repeatedly until **SET EXERCISER** screen.
3. Press **SEL**.
4. Enter **ACCESS** code located on white label on the back of the controller.
5. Press **SEL**
6. Cursor is indicated as a line under character to be changed. Change values with up and down keys. Press **SAVE** after each entry to save value and to move to the next value to be changed.
7. Press **BACK** when complete.
8. Press **MORE** repeatedly until **SET USER SETUP**. Press **BACK** then **ESC** to the **S1 OK** screen.

How to Bypass (Cancel) an exercise during an exercise cycle

1) Press **BPASS**
2) Allow the controller to complete the Engine cool down cycle.

If the CD Exerciser is configured or Set for a No-Load Exercise. Or allow the controller to complete retransfer to Source 1. If the CD Exerciser is configured for a Load Exerciser

How to Bypass the next exercise event and Keep the rest of scheduled events unchanged

1) Press **TEST**
2) Press **MORE**
3) Press **BYPASS EXER**

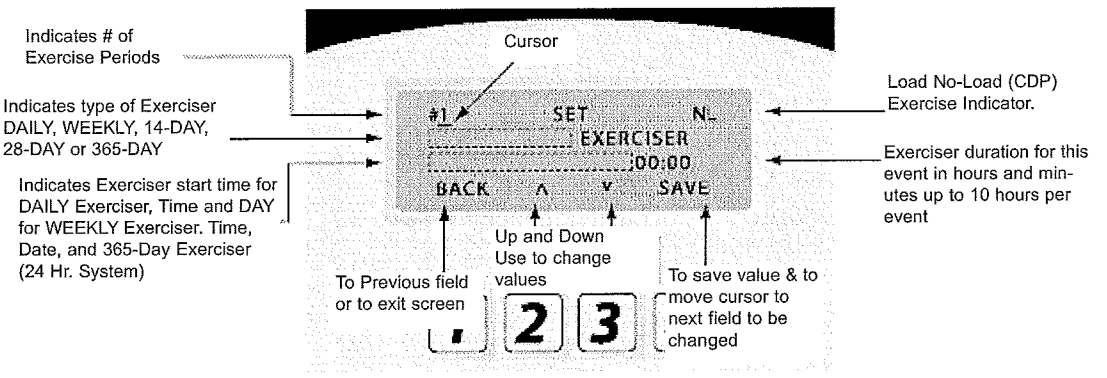
To re-institute the next exercise event back, press **CANCL BPASS**

How to check the next exercise event

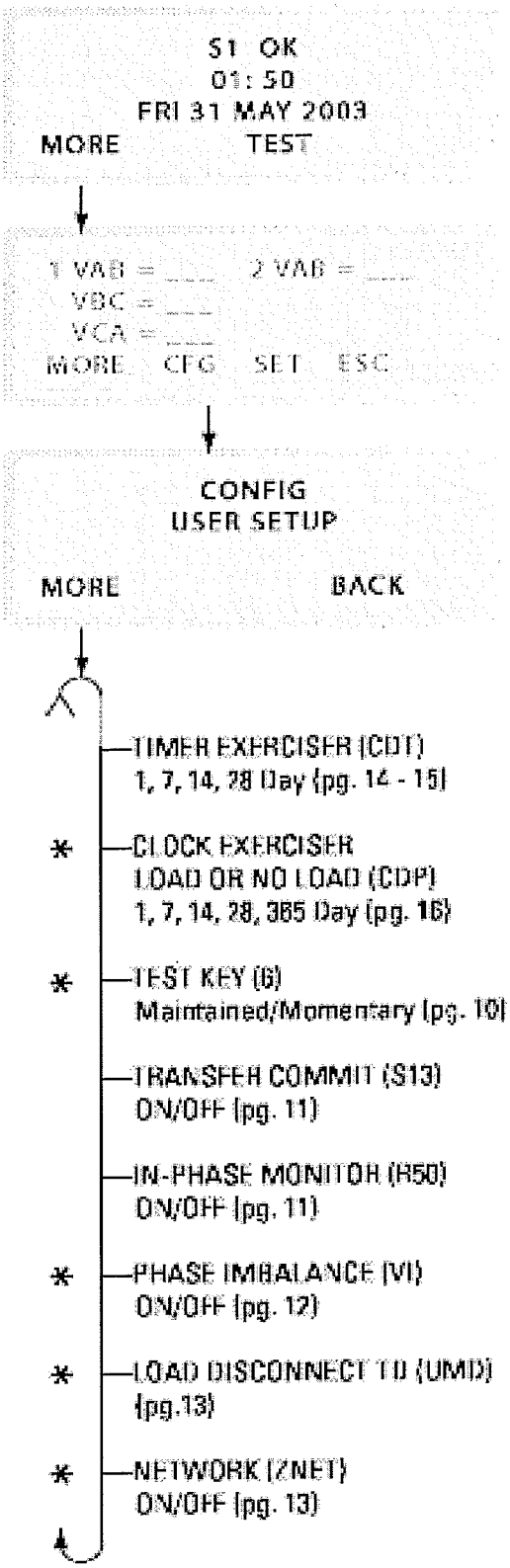
1) From **S1 OK** screen, press **MORE** three times.
2) The unit will display the **PLANT EXERCISER NEXT** event in **DAYS, HOURS,** and **MINUTES**
3) Press **ESC** to **S1 OK** Screen.

Notes:

- In the **S1 OK** screen, an (***E***) appears in the upper right hand corner of LCD screen when exercise is impending.
- For Load Exerciser, actual exercise period (ATS in S2 position)= **CDT** (Exerciser) timing period +T (S1 Stable Timer) timing period.
- A value greater than zero must be entered in the Exerciser duration field to be accepted as a valid exercise period.
- The Exercise cycle will be repeated on a regular basis as programmed and initiated in the **SET** menu depending on what Exerciser was configured (selected) in the **CFG** menu.



MX150 User Setup - CFG Menu



* Optional Accessories

Turn options ON or OFF via keypad through the CFG menu

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

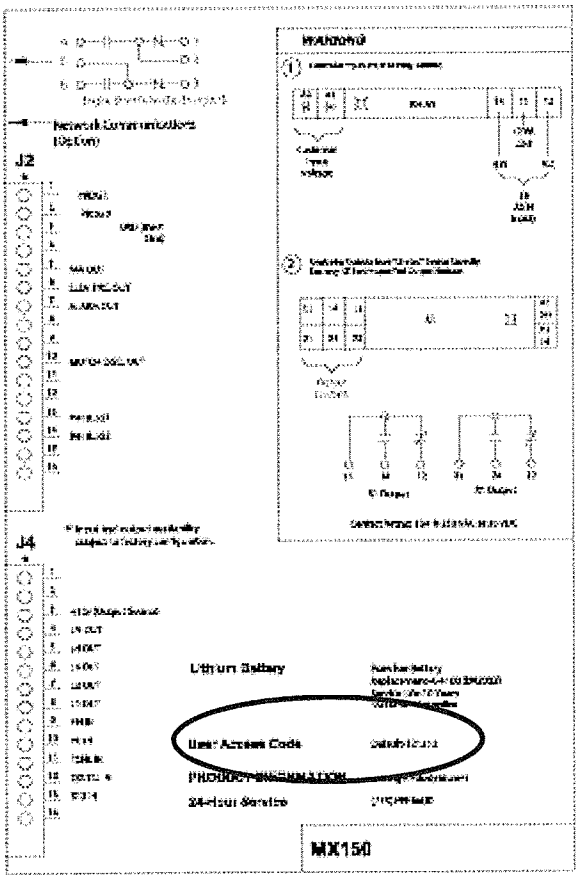
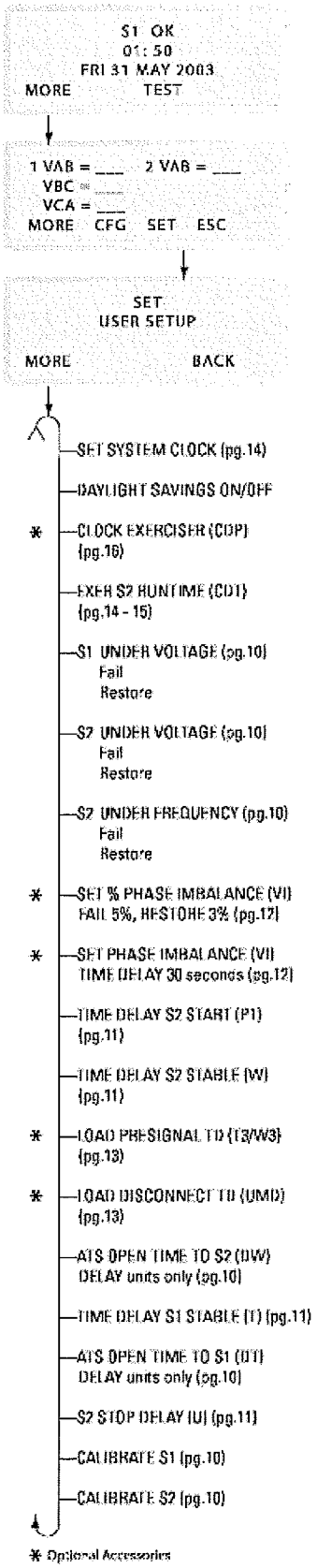


Figure 9

MX150 User Setup - SET Menu



Change adjustable values through the SET menu.

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

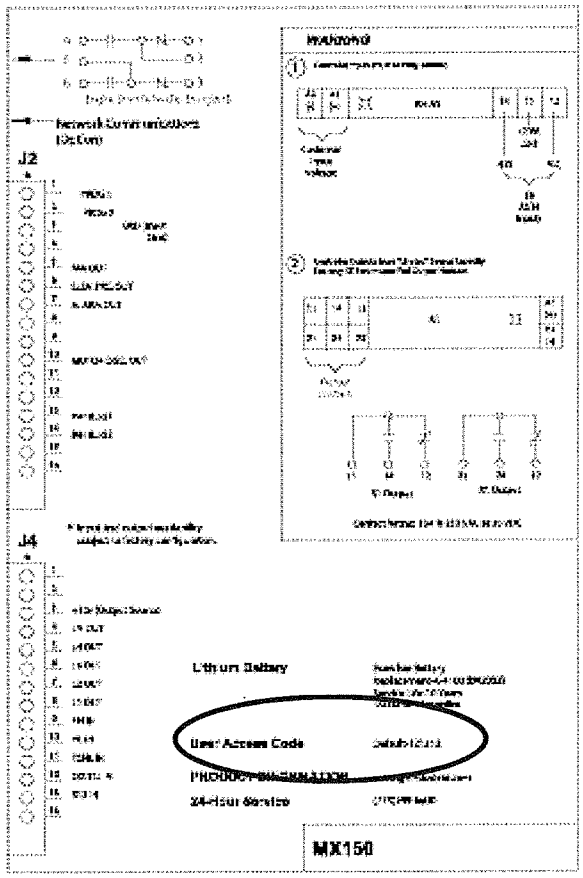
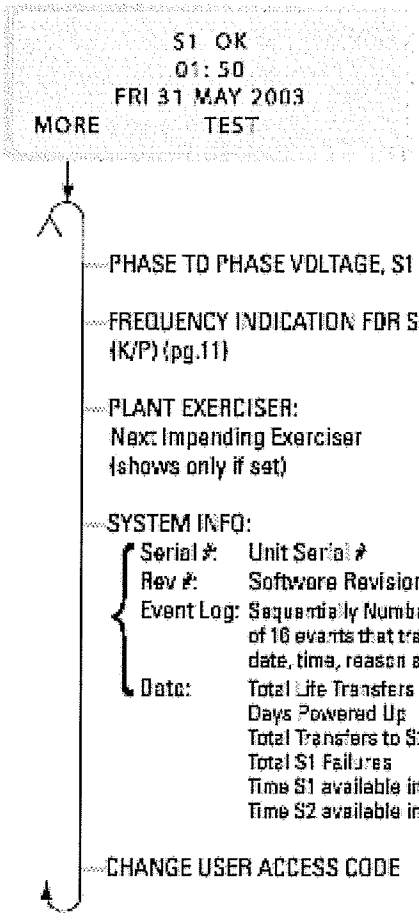


Figure 9

MX150 User Setup - System Info



View System Data

Enter six digit access code
(The factory assigned six-digit access code
is located on the back of the controller)

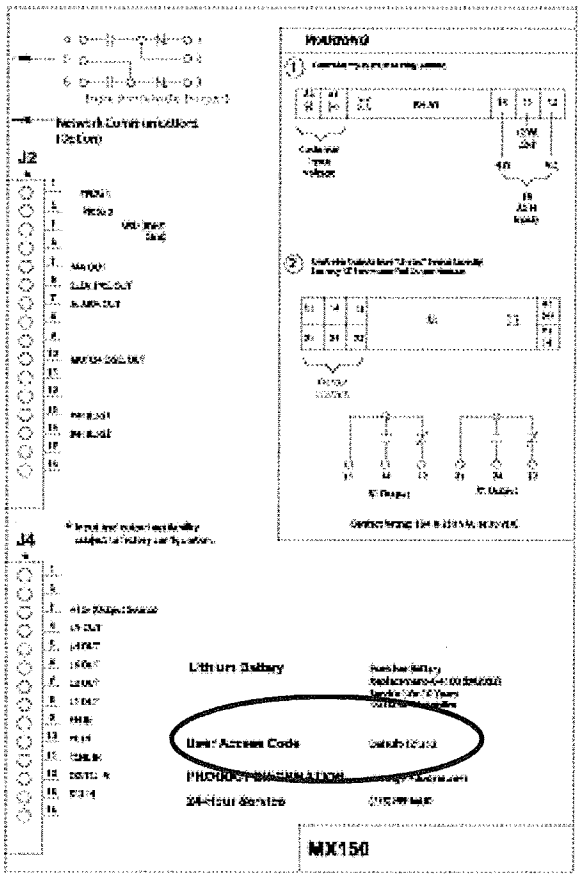


Figure 9

Testing

⚠ NOTICE ⚠

A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701)

ATS Testing

Start generator and verify proper voltage, frequency and phase sequence (match to Source 1). Shut down gen set and place in Auto. Complete the visual inspection of the transfer switch, and close the cabinet door.

Initiate the test by pressing the TEST button on the LCD keypad. The controller will then prompt for your access code. After entering the code, three test options will appear—XFR LOAD, FAST TEST and NO XFR (See Figure 10).

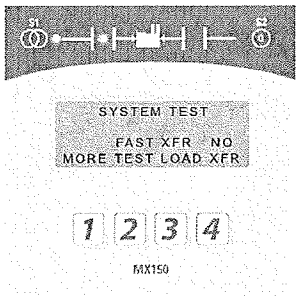


Figure 10

- **XFR LOAD** test starts the generator and using the current timer settings, transfers the load to Source 2.
- **FAST TEST** test presets timer values to a maximum 30 seconds during the test. After completion of the test, all timers are reset to their original values. (T3, W3, DT and DW remain)
- **NO XFR** test starts the generator but does not transfer the load to the Source 2.

Press and hold the desired test option button until the switch transfers to Source 2 (load test) or until the generator has been run for the desired amount of time (no load test). Releasing the test button before W timer timeout will abort the test (Exception: when the transfer commit option, is configured "ON").

To test lamps, press TEST then scroll through MORE, then press LAMP TEST. To cancel LAMP TEST press MORE.

Standard Transition

When the test is initiated, the controller initiates the Time Delay Source 2 Start Timer (Engine Start Timer "P") cycle. A manual CANCEL button is provided to cancel the test if desired. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" Values, the time delay to Source 2 Timer (W) begins its timing cycle to ensure voltage and frequency stabilization before transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the MX controller initiates a transfer signal through the SCR-E to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

Restoration of Source 1 Power:

Deactivating the test switch initiates re-transfer to Source 1 sequence. The delay to Source 1 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the MX controller initiates a transfer signal through the SCR-N to operate the main transfer operator. The load is now transferred to Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Delayed Transition

Source 1 Power Failure:

When the test is initiated, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. A manual CANCEL button is provided to cancel the test if desired Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins its timing cycle to ensure voltage and frequency stabilization before re-transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the MX controller initiates a transfer signal through the SCR-NO to operate the main transfer operator. The load is now transferred to the Open position. The time delay to Source 2 timer (DW) begins its timing cycle. After the (DW) time delay, the MX controller initiates a transfer signal through the SCR-E to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

Restoration of Source 1 Power:

Deactivating the test switch initiates re-transfer to Source 1sequence. The delay to open Source 2 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the MX controller initiates a transfer signal through the SCR-EO to operate the main transfer operator. The load is now transferred to the Open position. The time delay to Source 1 timer (DT) begins its timing cycle. After the (DT) time delay, the MX controller initiates a transfer signal through the SCR-N to operate the main transfer operator. The load is now transferred to Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Sequence of Operation

Standard Transition

Source 1 Power Failure:
When Source 1 voltage or frequency has fallen below the preset "Fail" values, the controller initiates the Time Delay Source 2 Start Timer (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" Values, the time delay to Source 2 Timer (W) begins its timing cycle to ensure voltage and frequency stabilization before transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the MX controller initiates a transfer signal through the SCR-E to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

Restoration of Source 1 Power:
When Source 1 power reach the preset "Restore" values, the controller initiates re-transfer to Source 1sequence. The delay to Source 1 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the MX controller initiates a transfer signal through the SCR-N to operate the main transfer operator. The load is now transferred to Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Delayed Transition

Source 1 Power Failure:
When Source 1 voltage or frequency has fallen below the preset "Fail" values, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins its timing cycle to ensure voltage and frequency stabilization before re-transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the MX controller initiates a transfer signal through the SCR-NO to operate the main transfer operator. The load is now transferred to the Open position. The time delay to Source 2 timer (DW) begins its timing cycle. After the (DW) time delay, the MX controller initiates a transfer signal through the SCR-E to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

Restoration of Source 1 Power:
When Source 1 power reach the preset "Restore" values, the controller initiates re-transfer to Source 1 sequence. The delay to open Source 2 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the MX controller initiates a transfer signal through the SCR-EO to operate the main transfer operator. The load is now transferred to the Open position. The time delay to Source 1 timer (DT) begins its timing cycle. After the (DT) time delay, the MX controller initiates a transfer signal through the SCR-N to operate the main transfer operator. The load is now transferred to Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Table 3

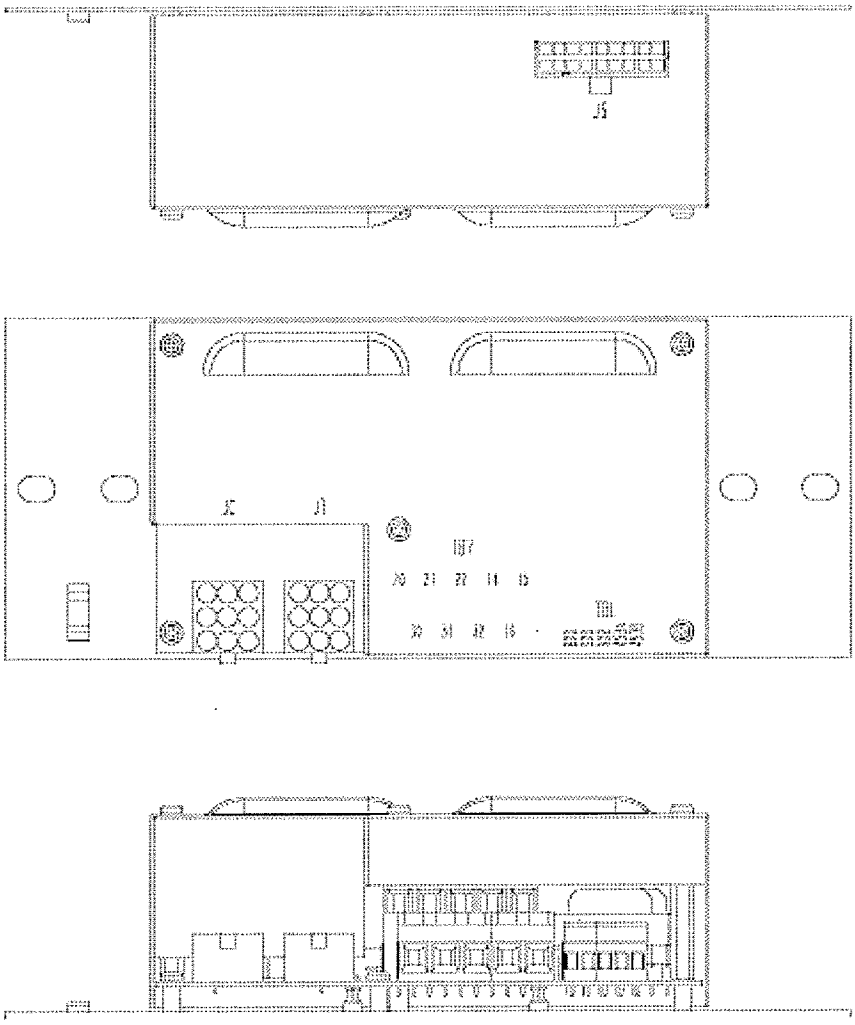
Timer Designations as they appear in the SET menu

ATS Type	P	W	DW	T	DT	U
Standard	Time Delay S2 Start	Time Delay S2 Stable	→	Time Delay S1 Stable	→	S2 Stop Delay
Delay	Time Delay S2 Start	Time Delay S2 Stable	ATS Open Time to S2	Time Delay S1 Stable	ATS Open Time to S1	S2 Stop Delay
Source 1 Fails	Transfer to Source 2 →			Source 1 Returns ↓	Transfer to Source 1 →	Engine Cooldown

Controls Power Supply (CPS)

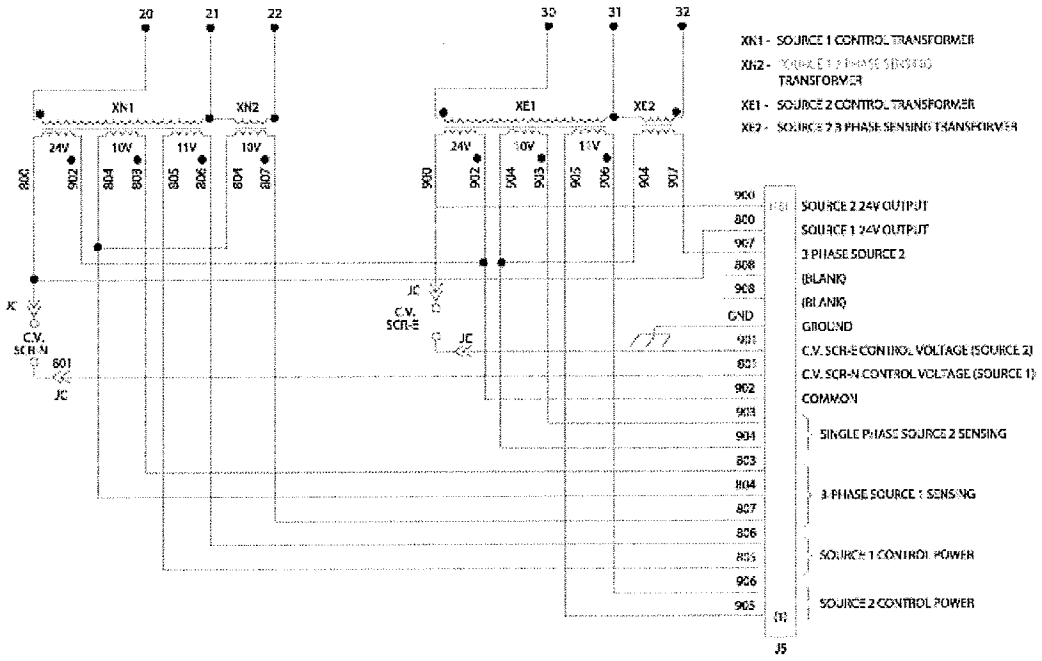
Standard and Delay Transition

Each MX150 microprocessor based ATS controller requires a Controls Power Supply (CPS) to apply line voltage to the ATS operator via SCRs. Also required is power for the MX150 printed circuit board and an application of sensing voltage proportional to line voltage. This is accomplished by the Controls Power Supply (CPS). This method of switching operator voltage and applying power and sensing voltage to the printed circuit board isolates the MX150 from the line voltage, further protecting the controller from harmful line transients.

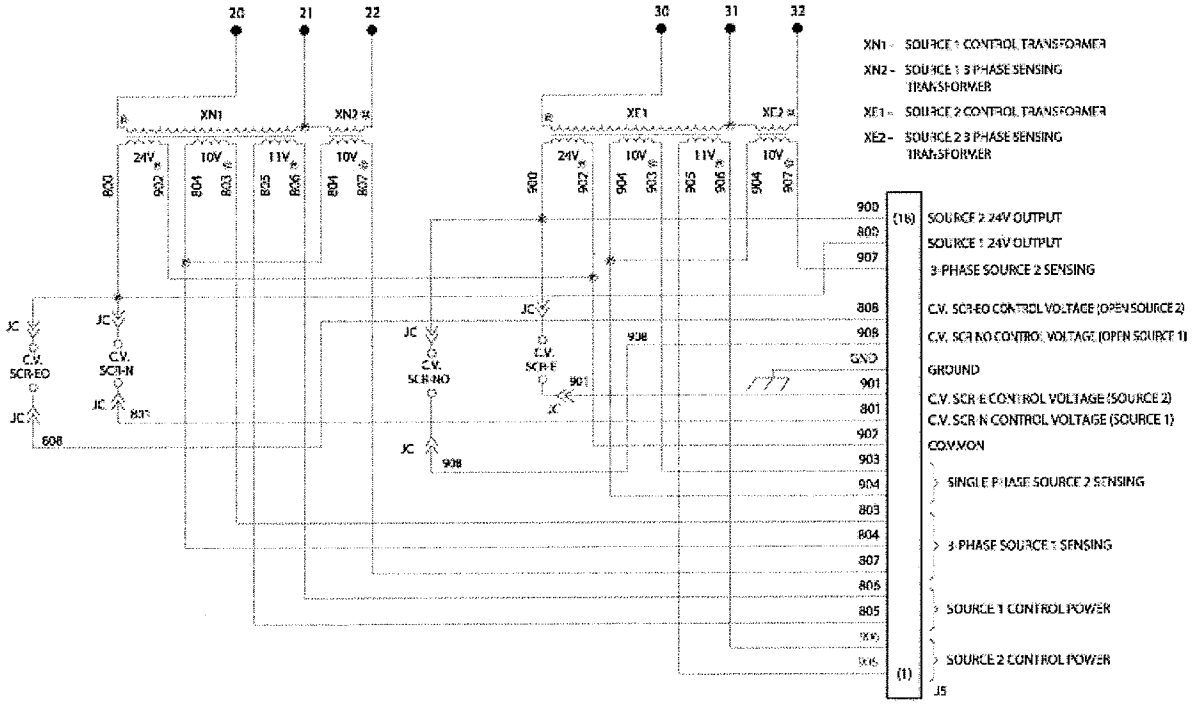


Primary Voltage at 50/60 Hz	CPS Assembly Part No.	CPS Board No.
120V	50P-1224	50P-1200
208-220V	50P-1225	50P-1201
230-240V	50P-1226	50P-1202
277V	50P-1227	50P-1203
380-400V	50P-1228	50P-1204
416-440V	50P-1229	50P-1205
460-480V	50P-1230	50P-1206
575-600V	50P-1231	50P-1207

Standard Transition CPS Schematic



Delayed Transition CPS Schematic



Troubleshooting and Diagnostics

⚠ DANGER ⚠

HAZARDOUS VOLTAGES CAN CAUSE SEVERE INJURY OR DEATH.
These charts may indicate problems that require authorized Caterpillar service personnel.
Hazardous voltages may exist on termination plugs other than those that go into the MX150.

General Troubleshooting

The following troubleshooting guide is used to recognize, and determine basic faults. When using this guide, it will ask several questions about the condition of the switch. This guide will then list an order of the possible faults. You will then look at the first suspected fault to determine if it is the problem. If it is not a fault, you go to the second suspected fault. If you go through all of the suspected faults, or the chart instructs you to, call your Cat dealer for further assistance.

NOTE: When you use the troubleshooting charts, the Annunciation column refers to the LED's on the control panel.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
Engine does not START	SOURCE 2 AVAILABLE LED off	Engine start wires not terminated properly	Check engine start connections
		Generator is in OFF position	Investigate why Engine Control Switch was turned off
Engine does not stop	LCD Display - "TD Engine Cool Down"	U timing cycle not complete	Check U timer setting
	SOURCE 1 POSITION, and SOURCE 1 and SOURCE 2 AVAILABLE LEDs on, but U timer has timed out	Engine start wires not terminated correctly	Check Engine Start Connections
		Generator in MANUAL	Place generator in AUTO
ATS will not transfer to SOURCE 2 ZTG Series	SOURCE 2•AVAILABLE LED•off	SOURCE 2 voltage or frequency not within acceptable parameters	Check: Engine Start Connections, Generator Breaker, Generator Output, and Engine Control Switch
	None	Power supply connector unplugged	Plug in connector
	LCD Display - "S1 _ _ _ _ TD XFR S1>S2 Time Remaining _ _ _ _"	**W** timing cycle not complete	Check **W** Timer setting
ATS will not transfer to SOURCE 1 ZTGD Series	LCD Display - "ATS Open Time Remaining _ _ _ _"	**DW** timing cycle not complete	Check **DW** Timer setting
	SOURCE 1•AVAILABLE LED•off	SOURCE 1 voltage or frequency not within acceptable parameters	Check utility and utility breakers
	None	Power supply connector unplugged	Plug in connector
	LCD Display - "Diagnostic Code 001"	Limit switch or RT box connector unplugged	Call Technical Services
	LCD Display - "S1 OK Time Remaining _ _ _ _ Bypass"	**T** timing cycle not complete	Check **T** Timer setting
	LCD Display - "ATS Open Time Remaining _ _ _ _"	**TD** timing cycle not complete	Check **DT** Timer setting

Maintenance and Testing

⚠ CAUTION ⚠

Due to hazardous voltage and current, Caterpillar recommends that a Caterpillar Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

⚠ WARNING ⚠

Both power sources must be disconnected before manual operation of the switch.

A preventive maintenance program will insure high reliability and long life for the transfer switch. The preventive maintenance program for the transfer switch should include the following items:

Inspection and Cleaning

The switch should be inspected for any accumulation of dust, dirt, or moisture, and should be cleaned by vacuuming or wiping with a dry cloth or soft brush. do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

Remove the transfer switch barriers and check the condition of the contacts. Any surface deposits must be removed with a clean cloth (do not use emery cloth or a file). If the contacts are pitted or worn excessively, they should be replaced. A general inspection of mechanical integrity should be made to include loose, broken or badly worn parts.

Servicing

All worn or inoperative parts must be replaced using Caterpillar recommended replacement parts. Please contact your Cat dealer for specific part information and ordering procedures.

The operating mechanism of the transfer switch is lubricated with Lubriplate 105. The lubricant applied at the factory provides adequate lubrication for the lifetime of the switch. Should debris contaminate the mechanism, clean and apply additional Lubriplate.

Caterpillar can provide complete preventative maintenance services. Please contact the Technical Services Department for additional information.

CDT battery replacement - lithium batteries may last up to 10 years, however it is recommended that battery replacement be included in a 3-5 year service cycle. The battery maintains the exerceser memory only and does not otherwise affect the operation.

Testing

A manual operator handle is provided with the transfer switch for maintenance purposes only. Manual operation of the switch must be checked before it is operated electrically. **Both power sources must be disconnected before manual operation of the switch.** Insert the handle and operate the transfer switch between the Source 1 and Source 2 positions. The transfer switch should operate smoothly without binding. Return the switch to Source 1 position, remove the handle, and return it to the holder provided.

After completing the inspection, cleaning and servicing of the transfer switch, reinstall the switch cover, and close and lock the cabinet door. Reclose the circuit breakers feeding the utility and generator sources to the switch.

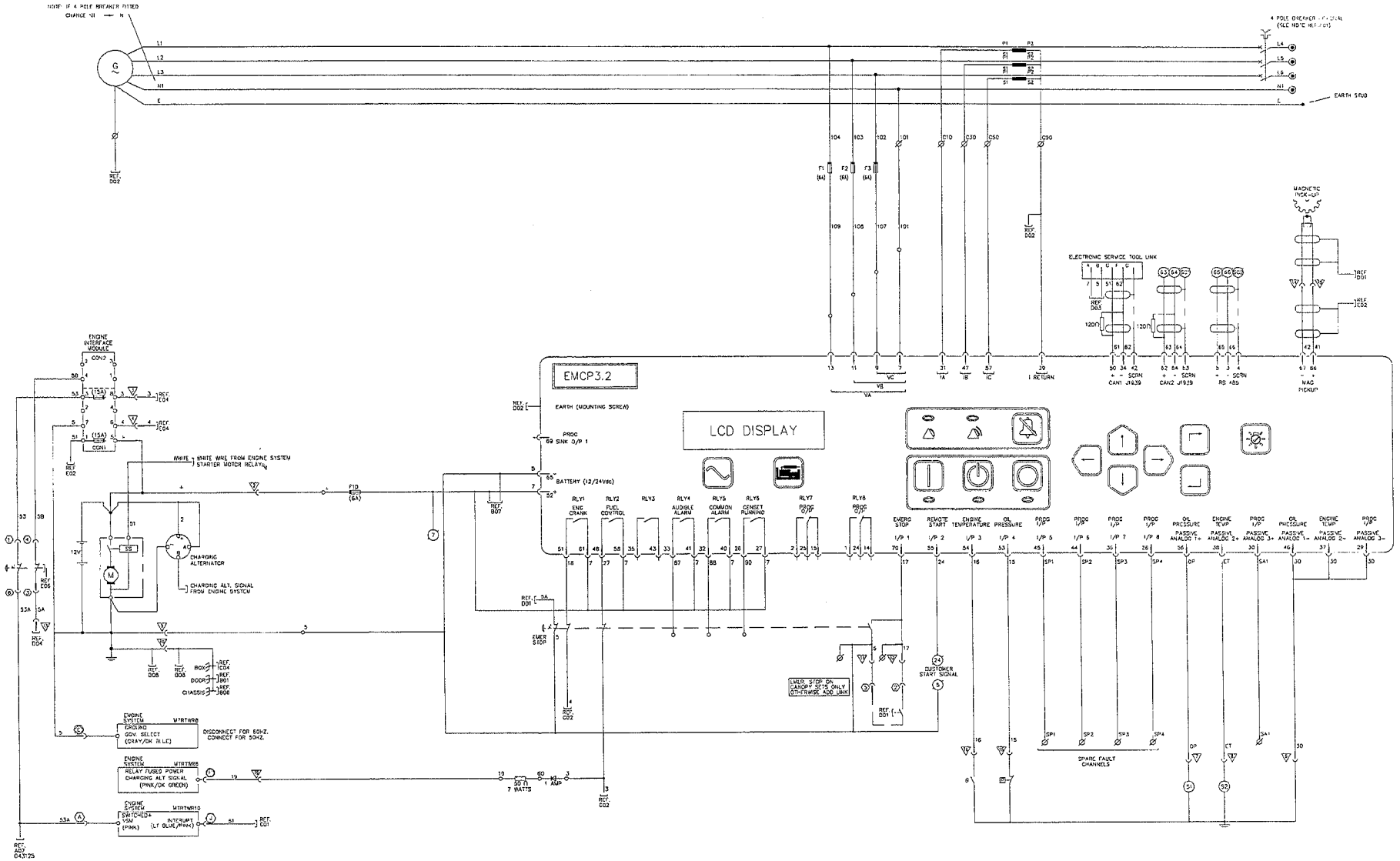
Initiate the electrical transfer test by activating the TS test switch. P timer will time out and the microcontroller will send an engine start signal. When the W time has elapsed, the switch will complete its transfer by closing into Source 2.

Deactivating the test switch will start retransfer to Source 1. The switch will complete its retransfer to Source 1 after the time delay of the T timer. The U engine overrun timer allows the engine generator to run unloaded for a preset cool down period.

NOTE: A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.



REMARKS	
⊘ OUTGOING/INCOMING PANEL TERMINAL	V D.C. CONNECTOR FROM ENGINE
◉ CUSTOMER POWER CONNECTION	S 6 WAY CONNECTOR ON EMER. STOP LOOM
○ INTERNAL PANEL TERMINAL	(50) CUSTOMER TERMINALS
(53) A.C CONNECTOR FROM ENGINE	A 10 WAY CONNECTOR FOR IGNITION MODULE
A 3 WAY CONNECTOR FOR CHARGING ALTERNATOR	B 12 WAY ELECT. GOV. CONNECTION

ISSUE	DESCRIPTION	ECR/ECR	BY	DATE
A	FIRST ISSUE	-	-	-

DO NOT SCALE

DRN BY P. MCBRIDE
DATE 26/07/05
APPD BY A Cavanagh
DATE 27/07/2005

TITLE WIRING DIAGRAM OF EMCP3.2 CSA PANEL FOR 12V 8.1L GM GAS ENGINE (ONA 3P 4W)

SHEET SIZE	ORIGINAL SCALE	DRAWING NO.	ISSUE
A3	N.T.S.	D43136	A

(Refer to LERE5255 for a printable .pdf file.)

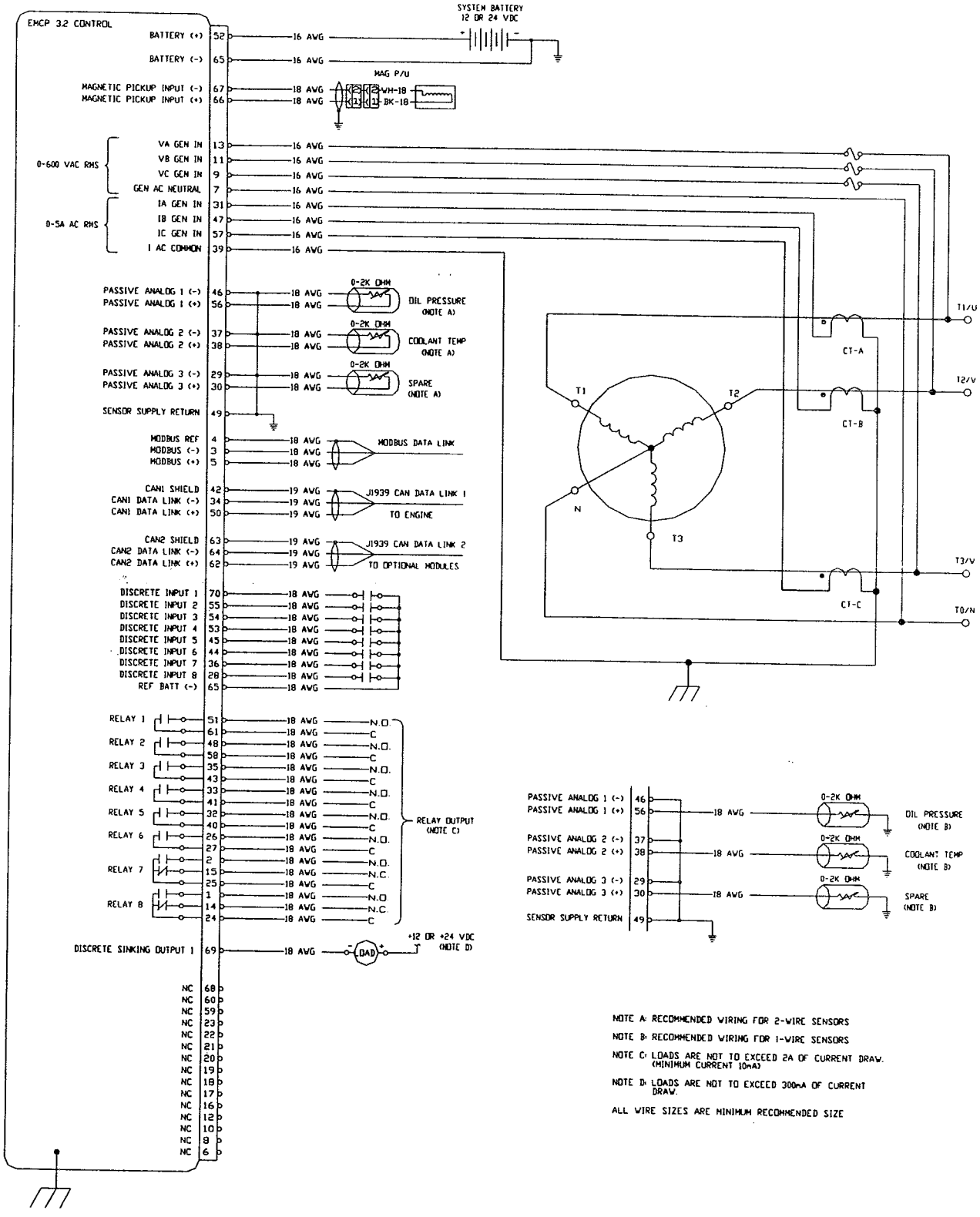


Figure 4: EMCP 3.2 Control Electrical Connections
(Refer to LERE5255 for a printable .pdf file.)