SEBU7125-13 (en-us)
March 2016

Operation and Maintenance Manual

3412C Generator Set

4BZ 1-UP (Generator Set)
9EP 1-UP (Generator Set)
BCW 1-UP (Generator Set)
TGC 1-UP (Generator Set)
DJN 1-UP (Generator Set)
TFT 1-UP (Generator Set)
RTY 1-UP (Generator Set)
XJ5 1-UP (Generator)

Important Safety Information

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

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

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

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

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

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

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

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

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

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

⚠ WARNING

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

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

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

Table of Contents

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 Cat publications. The English used facilitates translation and consistency in electronic media delivery.

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

Safety

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

Operation

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

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

Maintenance

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

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

Recommended service should be performed at the appropriate intervals as indicated in the Maintenance Interval Schedule. The actual operating environment of the engine also governs the Maintenance Interval Schedule. Therefore, under 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 Cat dealer can assist you in adjusting your maintenance schedule to meet the needs of your operating environment.

Overhaul

Major engine overhaul details are not covered in the Operation and Maintenance Manual except for the interval and the maintenance items in that interval. Major repairs are best left to trained personnel or an authorized Cat dealer. Your Cat dealer offers 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 Cat 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 engine. The exact location and a description of the safety messages are reviewed in this section. Become familiar with all safety messages.

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

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

⚠ 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.

Servicing the Engine and Reading the Manual

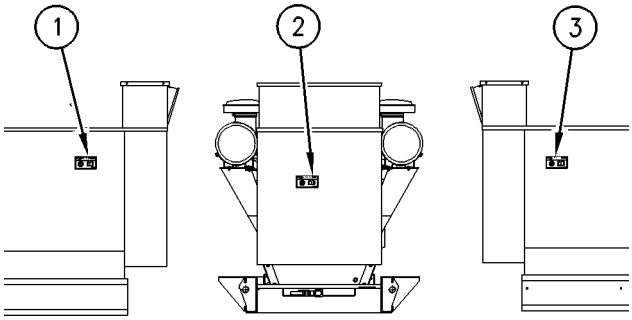

Illustration 1 g00329090

Locations of the safety message for servicing the engine and reading the manual

The safety message for servicing the engine and reading the manual is located on the following components: terminal box (1), customer connection box (2) and circuit breaker box (3).

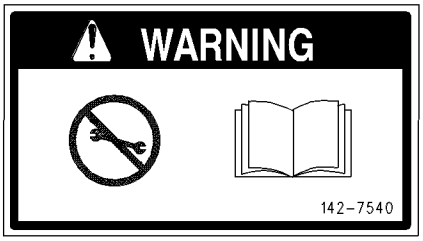

Illustration 2 g00308764

Do not operate or work on the engine unless the instruction and warnings in the Operation and Maintenance Manual are understood. Failure to follow the instructions or failure to heed the warnings could result in personal injury or death. Proper care is your responsibility.

Coolant Pressure and Hot Surface

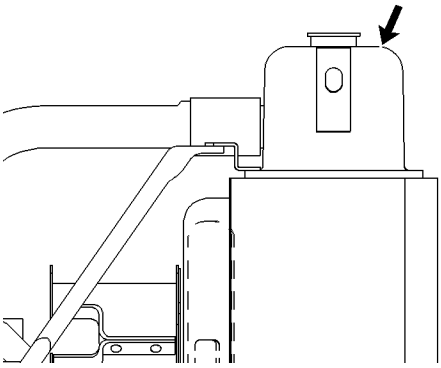

Illustration 3 g00309883

Location of the safety message for coolant pressure and hot surface

The safety message for coolant pressure is located near the top of the radiator.

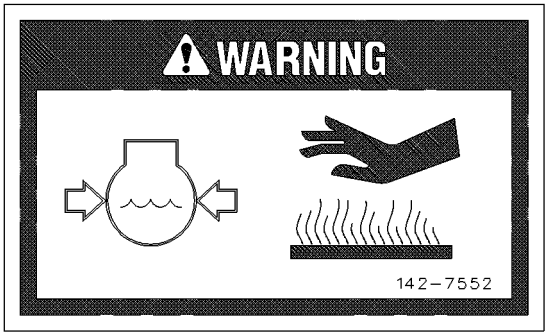

Illustration 4 g00107971

When the engine is at operating temperature, the engine coolant is hot. The engine coolant is also under pressure.

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

High Voltage

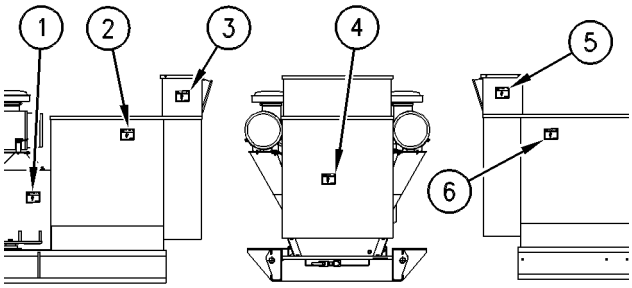

Illustration 5 g00329093

Locations of the safety message for high voltage

The safety message for high voltage is located on the following components: barrel of the generator (1), terminal box (2), side of the control panel (3), customer connection box (4), rear of the control panel (5) and circuit breaker box (6).

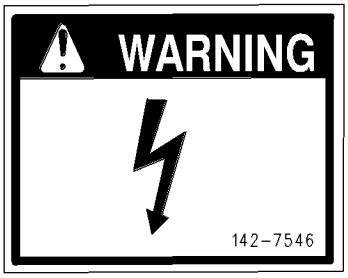

Illustration 6 g00308803

High voltage can cause electrical shocks. Electrical shocks can cause personal injury or death. Avoid contacting electrical components and wiring.

Lifting the Generator Set

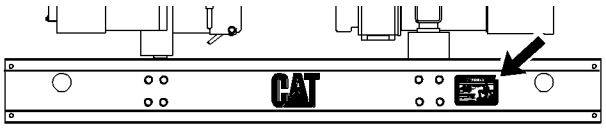

Illustration 7 g00309911

Location of the safety message for lifting the generator set

The safety message for lifting the generator set is located on the engine mounting rails.

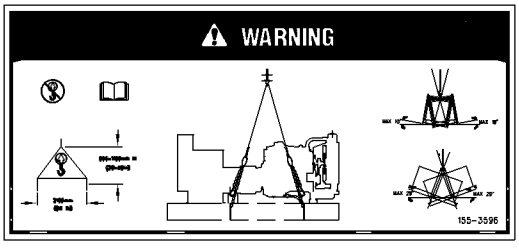

Illustration 8 g00309703

Read the Operation and Maintenance Manual and understand the Operation and Maintenance Manual before lifting the generator set.

If improper equipment is used to lift the generator set, injury and damage can occur. Use cables that are properly rated for the weight. Attach the cables according to the information on the safety message.

Diesel Fuel

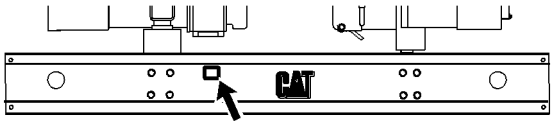

Illustration 9 g00309913

Location of the safety message for diesel fuel

The safety message for diesel fuel is located next to the fuel inlet on the engine mounting rail.

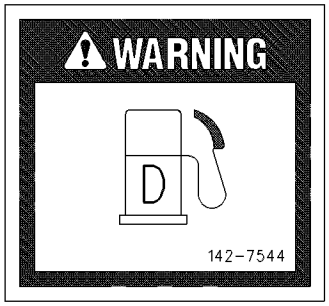

Illustration 10 g00309704

Use diesel fuel only in the engine. The use of gasoline can cause the following problems to occur: engine damage, personal injury, and possible death. Avoid spilling diesel fuel on hot engine components. Spilling diesel fuel on hot engine components can cause a fire. Personal injury or death can occur. Use extreme caution when you are filling the fuel tank with diesel fuel. Always wear protective clothing.

Hot Surface

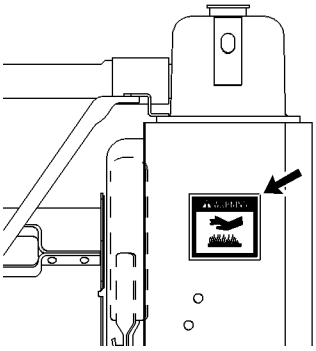

Illustration 11 g00309916

Location of the safety message for hot surface

The safety message for hot surfaces is located on both sides of the radiator.

Illustration 12 g00309705

When the engine is at operating temperature, the engine coolant is hot. Allow cooling system components to cool before the cooling system is drained. Any contact with hot coolant or with steam can cause severe burns.

Automatic Engine Starting

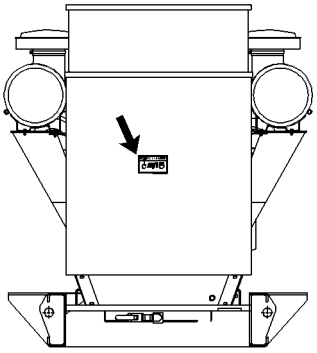

Illustration 13 g00329224

Location of automatic engine starting safety message

The automatic engine starting safety message is located on the front of the customer connection box.

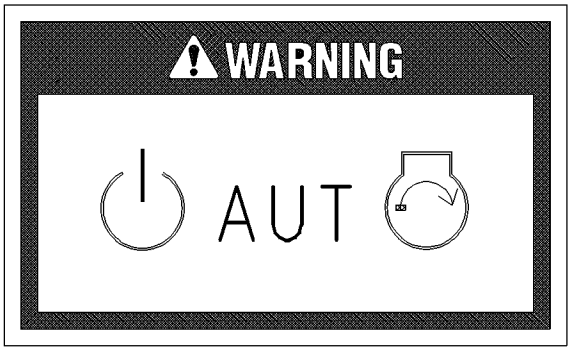

Illustration 14 g00327883

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

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General Hazard Information

SMCS Code: 1000; 7405

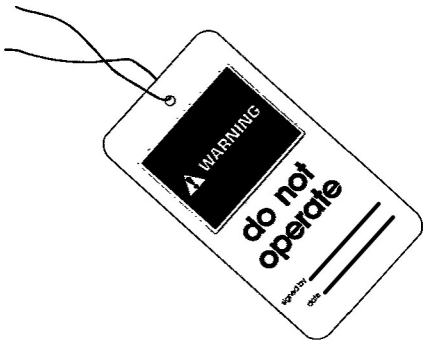

Illustration 15 g03838041

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

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

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

- Filler caps

- Grease fittings
- Pressure taps
- Breathers
- Drain plugs

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

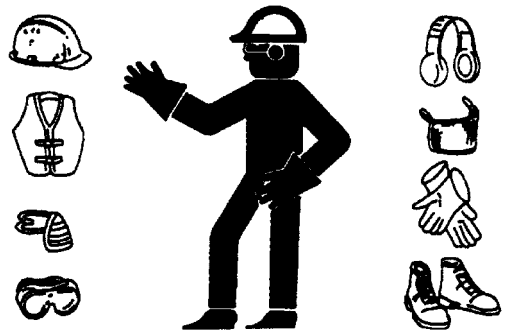

Illustration 16 g00702020

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

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

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

Pressurized Air and Water

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

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

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

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

Fluid Penetration

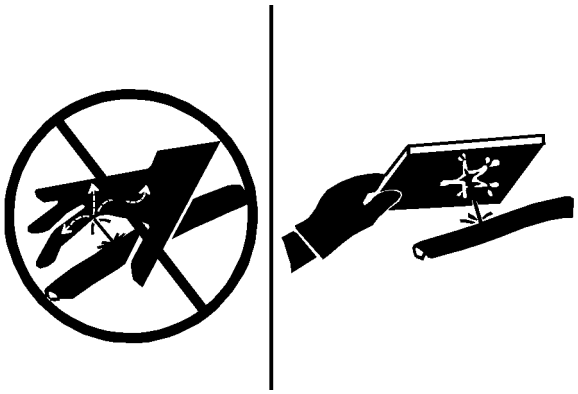

Illustration 17 g00687600

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

Containing Fluid Spillage

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

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

Dispose of all fluids according to local regulations and mandates.

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

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

⚠ WARNING

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

Lines, Tubes, and Hoses

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

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

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

Check for the following conditions:

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

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

Inhalation

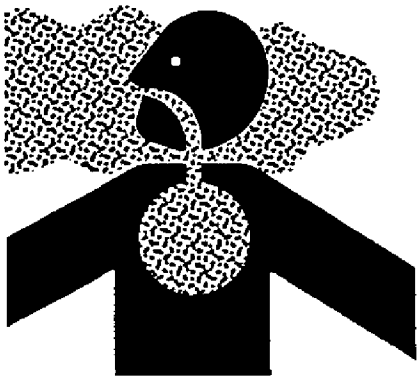

Illustration 18 g02159053

Exhaust

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

Asbestos Information

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

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

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

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

Softwrap

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

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

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

Dispose of Waste Properly

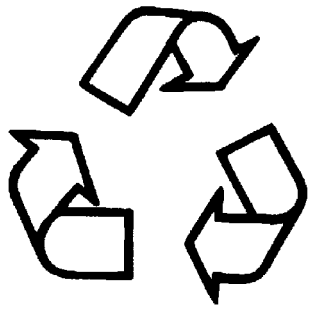

Illustration 19 g00706404

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

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

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Burn Prevention

SMCS Code: 1000; 7405

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

Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant. When pressure is relieved rapidly, the hot coolant can turn into steam.

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 only after the engine has been stopped.

Do not step on the engine in order to remove the filler cap. Use a ladder, if necessary. Ensure that the filler cap is cool before removing the filler cap. 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 components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Keep all of the exhaust manifold and turbocharger shields in place in order to protect components from oil spray if there is a failure of a line, a tube, or a seal.

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.

Batteries give off combustible gases which can explode. Ensure proper ventilation for batteries that are in an enclosure. 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 to ignite. Do not smoke when batteries are serviced.

Always thaw a frozen battery before jump starting the battery. Frozen batteries can explode.

i01028355

Fire Prevention and Explosion Prevention

SMCS Code: 1000; 7405

Fire may result from lubricating oil or from fuel that is sprayed on hot surfaces. Fire may cause personal injury and property damage. Inspect all lines and tubes for wear or for deterioration. The lines must be properly routed. The lines must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

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

If the application involves the presence of combustible gases, consult your Caterpillar dealer in order to obtain additional information concerning suitable protection devices.

Leaking fuel or fuel that is spilled onto hot surfaces or onto electrical components can cause a fire.

All fuels, most lubricants, and some coolant mixtures are flammable. Diesel fuel is flammable. Gasoline is flammable. The mixture of diesel fumes and gasoline fumes is extremely explosive.

Do not smoke while the engine is refueled. Do not smoke in the refueling area.

Store all fuels and all lubricants in properly marked containers. Store the protective containers in a safe place.

Do not smoke in battery charging areas. Batteries give off flammable fumes which can explode.

Do not smoke in areas that contain flammable material.

Store oily rags and other flammable material in protective containers.

Do not weld on pipes or tubes that contain flammable fluids. Do not flame cut pipes or tubes that contain flammable fluids. Before pipes or tubes are welded or flame cut, clean the inside and clean the outside of the pipes or tubes thoroughly with nonflammable solvent.

Do not allow flammable materials to accumulate on the engine.

Do not expose the engine to flames.

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.

Dispose of oil according to local regulations. Oil filters and fuel filters must be properly installed. The housing covers must be tightened to the proper torque when the housing covers are reinstalled.

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.

When the engine is started from an external source, always connect the positive “+” jump start cable to the positive “+” terminal of the battery of the engine that is being started. Make this connection before the negative “−” jump start cable is connected.

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

Check the electrical wires daily for wires that are loose or frayed. Before the engine is operated, tighten all loose electrical wires. Repair all frayed electrical wires.

Wiring must be kept in good condition. Wires must be properly routed and securely attached. Routinely inspect the wiring for wear or for deterioration. Loose wiring, unattached wiring, or unnecessary wiring must be eliminated. All wires and all cables must be of the recommended gauge. The wires and cables must be connected to a fuse or to a circuit breaker, as required. Do not bypass fuses and/or circuit breakers. Do not use a wire of a smaller gauge. Arcing or sparking could cause a fire. Secure connections, recommended wiring, and properly maintained battery cables will help to prevent arcing or sparking.

Fire Extinguisher

Ensure 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. Service the fire extinguisher according to the recommendations on the instruction plate.

i01359666

Crushing Prevention and Cutting Prevention

SMCS Code: 1000; 7405

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

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

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

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

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

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

i00605003

Mounting and Dismounting

SMCS Code: 1000; 7405

Do not climb on the engine, and do not jump off the engine. Do not stand on the components which can not support your weight. Mount the engine and dismount the engine only at locations that have steps and/or handholds.

When the engine is being worked on, clean the steps, the handholds, and the work areas.

Doors for Generator Enclosures

Strong winds may lift the doors for generator enclosures off the hinge pins.

If strong winds threaten to lift the doors for generator enclosures, the doors should be removed from the hinges in order to help prevent damage.

i03714833

Sound Information

SMCS Code: 1000

Note: Information of the sound level is for machines in European Union countries and in countries that adopt the directives of the European Union.

NOTICE
Hearing protection may be needed when working near an operating generator set.

Sound levels will vary depending on the configuration of the generator set and the final installation of the generator set.

Refer to the following for sound levels:

- The sound pressure level of a complete generator set (including the radiator) at 1 meter is 109 dB(A) for the noisiest configuration when “ISO 8528-10:1998(E) clause 14” is used at 75 percent of the rated power.
- The sound power level of a complete generator set (including the radiator) that is not covered by the “European Union Directive 2000/14/EC” is 125 dB(A) for the noisiest configuration when “ISO 8528-10:1998(E) clause 13” is used at 75 per cent of the rated power.

Note: The preceding sound levels are emission levels. The preceding sound levels are not necessarily safe sound levels. There is a correlation between the emission levels and the level of exposure. The correlation between emission levels and the level of exposure can not be used to determine if further precautions are required.

Refer to the following for factors that influence the level of exposure:

- The characteristics of the area around the generator set
- Other sources of noise
- The number of machines and other adjacent processes
- The length of time of exposure to the noise

This information will enable the user of the machine to evaluate the hazard and the risk.

i00061961

Before Starting Engine

SMCS Code: 1000

Inspect the engine for potential hazards.

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

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

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

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

See the Service Manual for repairs and for adjustments.

i01103904

Engine Starting

SMCS Code: 1000

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

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

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

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

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

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

Ether

Ether is poisonous and flammable.

Do not inhale ether, and do not allow ether to contact the skin. Personal injury could result.

Do not smoke while ether cylinders are changed.

Use ether in well ventilated areas.

Use ether with care in order to avoid fires.

Keep ether cylinders out of the reach of unauthorized persons.

Store ether cylinders in authorized storage areas only.

Do not store ether cylinders in direct sunlight or at temperatures above 49 °C (120 °F).

Discard the ether cylinders in a safe place. Do not puncture the ether cylinders. Do not burn the ether cylinders.

i01462046

Engine Stopping

SMCS Code: 1000

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

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

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

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

i01054945

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.

If the engine must be started by an external electrical source, then always connect the positive jump start cable “+” to the positive terminal “+” of the battery.

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

Grounding Practices

Proper grounding for the engine electrical system is necessary for proper engine performance and reliability. Improper grounding will result in uncontrolled electrical circuit paths and unreliable electrical circuit paths.

Uncontrolled engine electrical circuit paths can result in damage to the following components: main bearings, crankshaft bearing journal surfaces and aluminum components. All grounds should be tight and free of corrosion.

The alternator and the starting motor must be grounded to the negative “-” battery terminal.

For engines that have an alternator that is grounded to an engine component, a ground strap must be used. The ground strap must be connected to the component and to the negative “-” battery terminal. The component must be electrically isolated from the engine.

A ground plate with a direct path to the negative battery terminal “-” can be used as a common ground point for the components of one engine system.

The wire size that is used for the ground plate must be large enough to handle the full charging current of the alternator.

i02302349

Engine Electronics

SMCS Code: 1000; 1400; 1900

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

The ECM sends a high voltage signal to the unit injectors. To help prevent personal injury, do not disconnect the unit injector connector while the engine is operating. Do not come in contact with the harness connector for the unit injector while the engine is operating.

⚠ WARNING

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

Note: The control panel can only be programmed with electronic service tools and passwords. For information on programming, see the Service Manual, SENR6477, “Electronic Troubleshooting” module.

The engine has a monitoring system that can respond to abnormal engine operation with these modes: **WARNING, DERATE and SHUTDOWN**. These modes are available in order to help prevent damage to the engine. The customer can program these modes “ON” or “OFF” .

A warning indicates a serious condition that requires immediate attention. If a derating occurs, the engine power and/or the engine rpm is limited.

The following conditions will cause an engine shutdown:

- Engine overspeed
- High aftercooler coolant temperature
- High coolant temperature (jacket water)
- High crankcase pressure
- Low engine oil pressure

Except for an overspeed shutdown, the monitoring system can be overridden. An override switch is located in the control panel. Use of the switch will allow the engine to provide full power during an abnormal engine operating condition. The override switch is provided only for use in emergency situations.

For more information on the conditions that can initiate warnings, deratings, and shutdowns, see this Operation and Maintenance Manual, “Control Panel” topic (Operation Section).

i01226491

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.

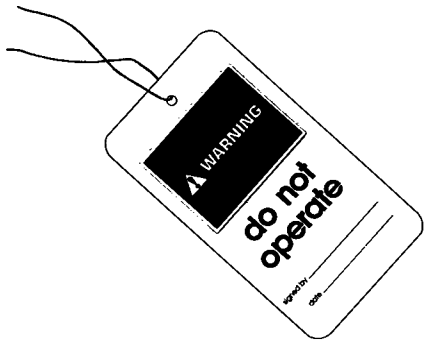

Illustration 20 g00104545

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. Remove the fuses for the transformers for the following circuitry:

- 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

Model Views

i06545965

Model View Illustrations

SMCS Code: 1000

The model view that follows shows a 3412C generator set engine. Due to individual applications, your engine may appear different from the illustration.

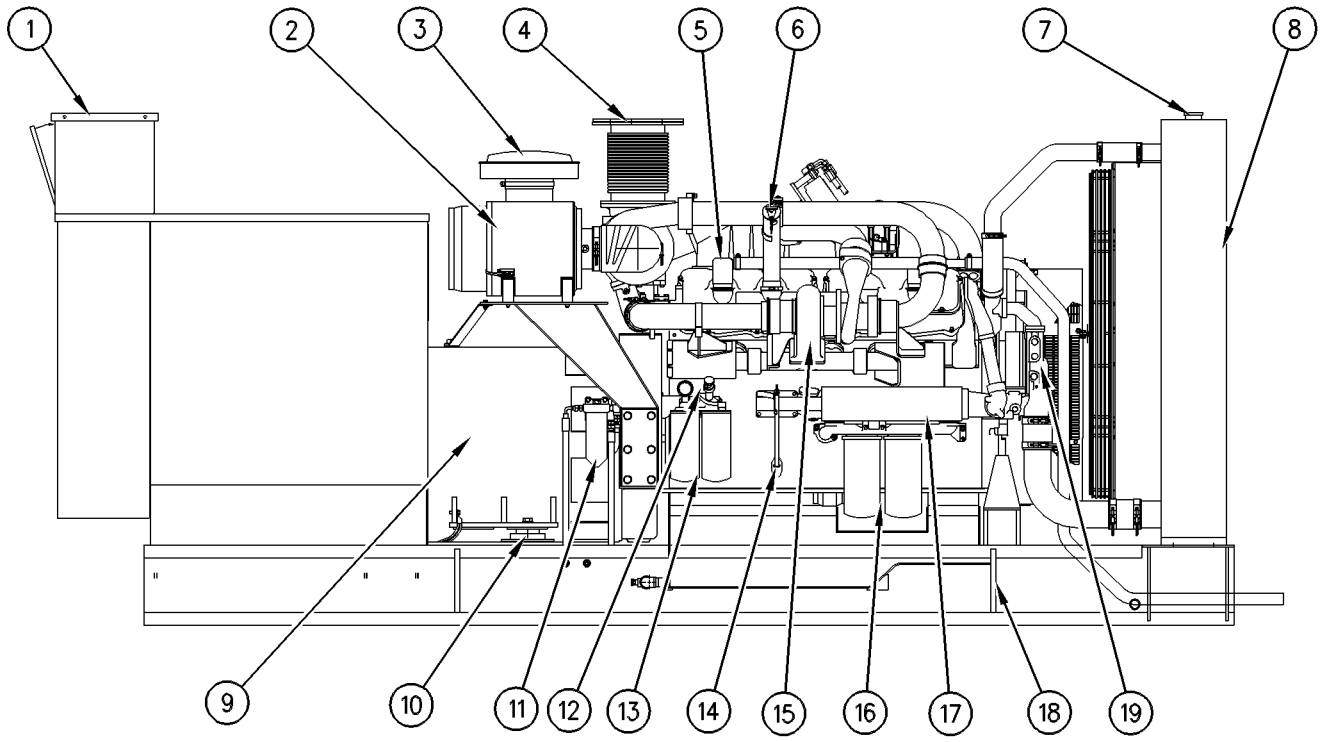

Illustration 21 g00303243

(1) Control panel
(2) Air cleaner
(3) Precleaner
(4) Exhaust piping
(5) Crankcase breather
(6) Oil filler cap
(7) Radiator cap
(8) Radiator
(9) Generator
(10) Generator mounts
(11) Primary fuel filter
(12) Fuel priming pump
(13) Fuel filters
(14) Oil level gauge
(15) Turbocharger
(16) Oil filters
(17) Oil cooler
(18) Lifting eye
(19) Water pump

i03734066

Product Description

SMCS Code: 1000; 4450; 4491; 7000

Intended Use

This Power Generator is intended to be used to generate electrical power.

Engine Description

The 3412C Generator Set engine is a 12 cylinder engine. The direct injection engine has a four stroke cycle. Each cylinder head has two inlet valves and two exhaust valves. The rocker arms and the valves are actuated by the camshaft. Mechanical lifters and pushrods perform the function.

A hydramechanical governor or an electronic control controls the output of the fuel injection pump. The operator maintains the engine rpm. The fuel injection pump meters the fuel and the fuel injection pump pumps the fuel. The high pressure gaseous fuel is pumped to the fuel injection nozzles. The mechanical timing advance provides the best fuel injection timing over the full range of engine speeds.

Inlet air is filtered by the air cleaner. The air is compressed by the turbocharger before the air enters the cylinders. The turbocharger is driven by the engine exhaust. The standard engine is turbocharged, available with aftercooling or no aftercooling.

The cooling system consists of the following components:

- A gear-driven centrifugal pump
- One water temperature regulator which regulates the engine coolant temperature
- An oil cooler
- A radiator which incorporates a shunt system

The engine lubricating oil is cooled and the engine lubricating oil is filtered. The engine lubricating oil is supplied by a gear-driven pump. If the oil viscosity is high or if the oil cooler and oil filter elements become plugged, bypass valves provide unrestricted flow of lubrication oil to the engine.

Engine efficiency and engine performance depend on adherence to proper operation and maintenance recommendations. Use the recommended fuel, lubrication oil, and coolant. Special attention should be given to the air cleaner, to the fuel system, to the lubrication system, and to the cooling system maintenance. Refer to the Operation and Maintenance Manual, “Maintenance Interval Schedule” for more information on maintenance items.

Engine Specifications

Note: The front end of the engine is opposite the flywheel end of the engine. The left and the right side of the engine are determined from the flywheel end.

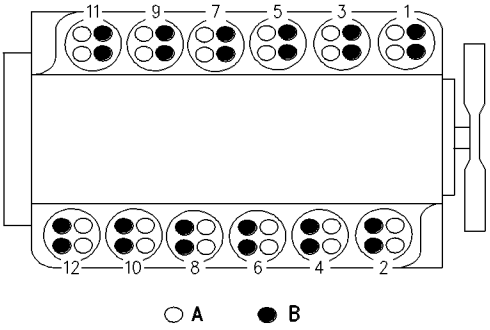

Illustration 22 g00291566

Cylinder and valve locations

(A) Inlet valves
(B) Exhaust valves

Table 1

3412C Engine Specifications	
Cylinders and Arrangement	12 cylinder vee block
Bore	137 mm (5.4 inch)
Stroke	152.4 mm (6.00 inch)
Aspiration	Turbocharged (T), Twin Turbocharged (TT), Twin Turbocharged Aftercooled (TTA), Series Turbocharged Aftercooled (STA)
Displacement	27 L (1648 cu in)
Firing Order	1-4-9-8-5-2-11-10-3-6-7-12
Rotation (flywheel end)	Counterclockwise

(continued)

(Table 1, contd)

Valve Lash (inlet)	0.38 mm (0.0150 inch)
Valve Lash (exhaust)	0.76 mm (0.030 inch)

Generator Description

The SR4B brushless generator is used with the following loads: mixed loads of motors and lights, SCR-controlled equipment, computer centers, installations of communications and petroleum drilling applications. The elimination of the brushes in the field circuit reduces maintenance. The elimination of the brushes in the field circuit increases reliability. The elimination of brushes provides a higher degree of protection in potentially hazardous atmospheres.

The generator set packages can be utilized for prime power generation or standby power generation. The generator set packages can be used in land based applications or marine applications.

SR4B generators are utilized in three-phase full-wave excitation and regulation. The generators are either four pole or six pole design with four, six, ten, or twelve lead configuration. The generators are capable of producing electrical power in either 50 Hz or 60 Hz applications.

Product Identification Information

i03663726

Plate Locations and Film Locations

SMCS Code: 1000

Engine Identification

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

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

Serial Number Plate

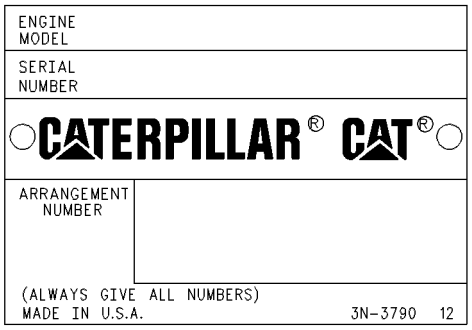

Illustration 23 g00123229

Typical serial number plate

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

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

Information Plate

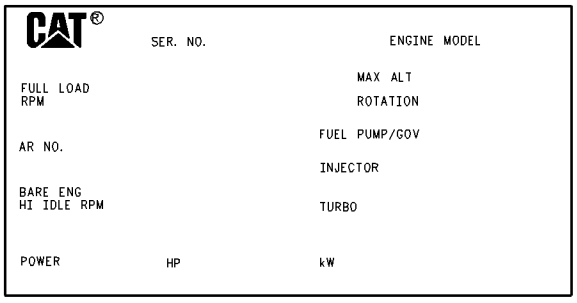

Illustration 24 g00755014

The Information Plate is on the valve cover. The following information is stamped on the Information Plate: engine's maximum altitude, horsepower, high idle, full load rpm, fuel settings and other information.

European Union

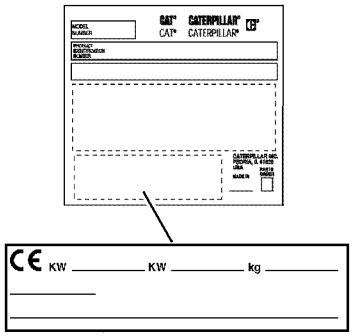

Illustration 25 g01880193

This plate is positioned on the bottom left side of the plate for the PIN.

Note: The CE plate is on machines that are certified to the European Union requirements that were effective at that time.

For machines compliant to 2006/42/EC, the following information is stamped onto the CE plate. For quick reference, record this information in the spaces that are provided below.

- Engine Power Primary Engine (kW)_____

- Engine Power for Additional Engine (If Equipped) _____
- Typical Machine Operating Weight for European Market (kg) _____
- Year of Construction _____
- Machine Type _____

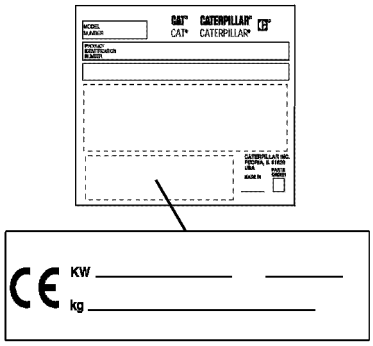

Illustration 26 g01120192

This plate is positioned on the bottom left side of the plate for the PIN.

Note: The CE plate is on machines that are certified to the European Union requirements that were effective at that time.

For machines compliant to 1998/42/EC, the following information is stamped onto the CE plate. For quick reference, record this information in the spaces that are provided below.

- Engine Power Primary Engine (kW) _____
- Typical Machine Operating Weight for European Market (kg) _____
- Year _____

For the name and address of the manufacturer, and the country of origin of the machine, refer to the PIN plate.

For manufacturer name and address and the country of origin, see the PIN plate.

i00845105

Reference Numbers

SMCS Code: 1000

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

Record for Reference

Engine Model _____

Engine Serial Number _____

Engine Arrangement Number _____

Modification Number _____

Engine Low Idle rpm _____

Engine Full Load rpm _____

Performance Specification Number _____

Primary Fuel Filter Number _____

Water Separator Element Number _____

Secondary Fuel Filter Element Number _____

Lubrication Oil Filter Element Number _____

Auxiliary Oil Filter Element Number _____

Supplemental Coolant Additive Maintenance Element Number (Optional) _____

Total Lubrication System Capacity _____

Total Cooling System Capacity _____

Air Cleaner Element Number _____

Alternator Belt Number _____

i03714865

Declaration of Conformity

SMCS Code: 1000

Table 2

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

EC DECLARATION OF CONFORMITY OF MACHINERY

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

Person authorized to compile the Technical File and to communicate relevant part (s) of the Technical File to the Authorities of European Union Member States on request:

Standards & Regulations Manager,Caterpillar France S.A.S 40,
Avenue Leon-Blum, B.P. 55, 38041 Grenoble Cedex 9, France

I, the undersigned, _____, hereby certify that the construction equipment specified hereunder

Description:	Generic Denomination:	Power Generation Equipment
	Function:	Power Generator
	Model/Type:	3412C
	Serial Number:	
	Commercial Name:	Caterpillar

Fulfils all the relevant provisions of the following Directives

Directives	Notified Body	Document No.
2006/42/EC	N/A	
2006/95/EC	N/A	
2004/108/EC	N/A	
2000/14/EC amended by 2005/88/EC, Note (1)	Note (2)	

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

Note (2) Notified body name and address

Done at: **Signature**

Date: **Name/Position**

Note: The above information was correct as of October, 2009, but may be subject to change, please refer to the individual declaration of conformity issued with the machine for exact details.

i04605109

Emissions Certification Film

SMCS Code: 1000; 7405

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

Consult your Cat dealer for an Emission Control Warranty Statement.

This label is located on the engine.

i01297919

Generator Set Intended for Stationary Use Only

SMCS Code: 1000; 7002

THE FOLLOWING NOTICE IS INTENDED ONLY FOR UNITS SHIPPED INTO THE UNITED STATES OF AMERICA, CANADA OR UNITED STATES TERRITORIES

For units marked as being intended for stationary use only, which are used in the United States of America, United States Territories or Canada, the following restrictions apply:

This generating set may only be used in stationary applications, as defined by the Environmental Protection Agency (EPA) Regulation in Title 40 of the Code of Federal Regulations (40 CFR Part 89.2(2)).

The definition of stationary, per the regulations, is that a) the unit will remain at a single site at a building, structure, facility or installation for more than 12 consecutive months, or b) will remain at a seasonal source during it's full annual operation period, as defined in 40 CFR 89.2(2)(iii).

The following United States Territories must comply with United States EPA regulations: Puerto Rico, Virgin Islands, Guam, American Somoa and the Commonwealth of the Northern Mariana Islands.

i01172059

Generator Lead Connections

SMCS Code: 4450

Lead Numbering

The Wye configurations and the Delta configurations are the most common generator lead connections. The following three-phase connection diagrams illustrate the proper connection and lead identification.

The leads are numbered clockwise from the top and from the outside inward. The diagrams contained in the “Wye Configuration Diagrams” section show lead numbering for the four, six, ten and twelve lead generators. The diagrams contained in the “Delta Configuration Diagrams” section show lead numbering for the six and twelve lead generators.

Wye Configuration Diagrams

4 Lead

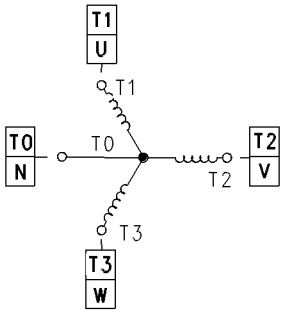

Illustration 27 g00611469

4 Lead Wye Configuration (for 3306B and 3406C generator sets only)

Terminal T0 is the neutral lead.

6 Lead

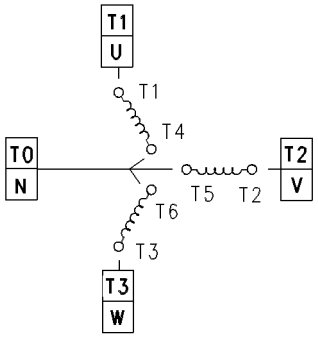

Illustration 28 g00611486

6 Lead Wye Configuration

Terminals T4, T5 and T6 become neutral connection when the terminals are tied together.

10 Lead

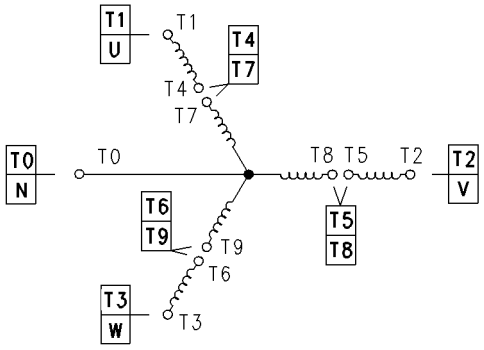

Illustration 29 g00669334

10 Lead Wye Configuration - High Voltage (for 3306B and 3406C generator sets only)

Terminal T0 is the neutral lead.

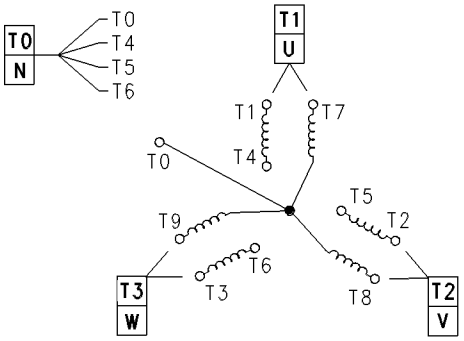

Illustration 30 g00611596

10 Lead Wye Configuration - Low Voltage (for 3306B and 3406C generator sets only)

Terminal T0 is the neutral lead.

12 Lead

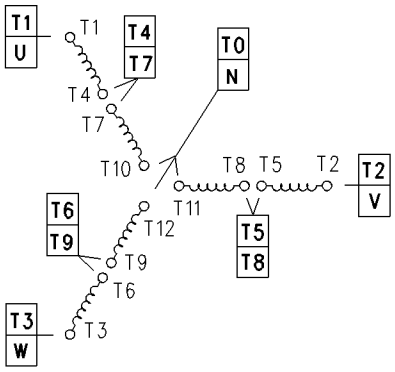

Illustration 31 g00661863

12 Lead Wye Configuration - High Voltage

Terminals T10, T11 and T12 become neutral connection when the terminals are tied together.

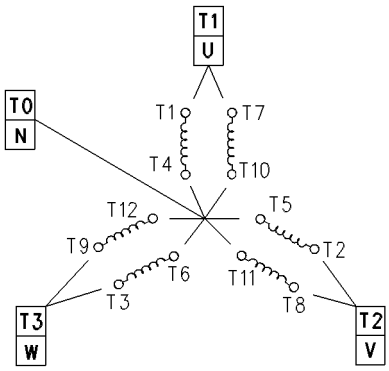

Illustration 32 g00611608

12 Lead Wye Configuration - Low Voltage

Terminals T10, T11 and T12 become neutral connection when the terminals are tied together.

Delta Configuration Diagrams

6 Lead

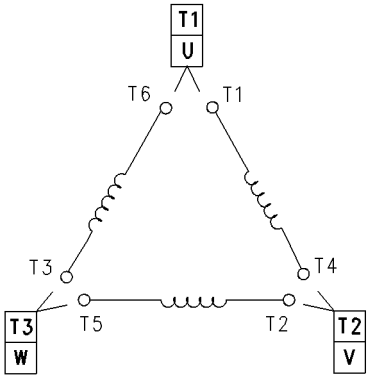

Illustration 33 g00669319

6 Lead Delta Configuration

12 Lead

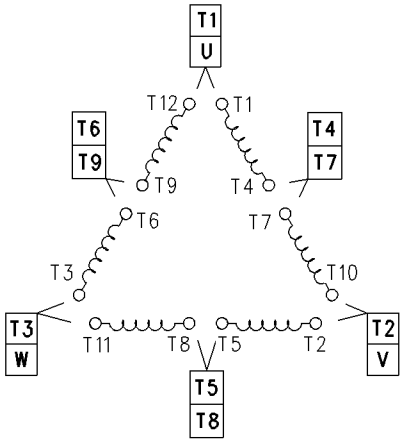

Illustration 34 g00669312

12 Lead Delta Configuration

Terminals T6 and T9 become the neutral connection when the terminals are tied together and grounded. This reflects the terminal T2 and T10 connection as the high phase.

Grounding the Frame

In any generator set installation, the frame of the generator must be positively connected to an earth ground or to the hull of a vessel. This connection is the first one that is made at the installation. This connection is the last one that should be removed. If the generator set is on flexible or resilient 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). Silver soldered and bolted joints are electrically and mechanically sound.

Neutral Connections

The generators with Wye Configuration usually have the neutral ground when the generator is installed. However, there are some cases when definite measures which can be taken in order to prevent grounds on the load side. The purpose of the grounding of the neutral is to prevent load side equipment damage.

If the neutral wire is grounded and one of the phase leads becomes grounded, the excessive current will open a load circuit breaker. The excessive current will also collapse the generator voltage. The result depends on the particular generator electrical characteristics, 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 instances in which it is undesirable to ground the neutral wire. An ungrounded generator neutral lead is acceptable in the applications in which definite measures have been taken in order to prevent grounds to the phase leads. An example of such measures are ground fault protective circuits. Ground fault protection requires that the entire group of distribution circuits should be studied and treated as a system. The owner should engage a certified and registered consultant if a new distribution system is being developed. The owner should also engage a certified and registered consultant if an existing system should be modified for the ground fault protection.

Single Units

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

In applications, in which definite measures are taken in order to prevent grounds to the load leads, an ungrounded neutral can be used. Be sure to check your local wiring codes.

Multiple Units

Operation of multiple generators in parallel, having all neutrals grounded, may result in the circulating current through the neutral connections. In order to eliminate the possibility of circulating currents, ground the neutral of only one generator. If multiple generators are alternated on line, a switch should be installed in the neutral ground circuit of each generator. In this case all neutral ground circuits except one can be opened. Be sure that one of the neutral ground circuits is closed.

Parallel to Utility

When a Wye connected generator is going to operate in parallel with a utility system (infinite bus) and when the secondary of the step-down transformer in the utility system is also a Wye connection, the following may happen. The grounding of both Wye neutrals may result in circulating currents through the neutrals. Also, the coordination of ground fault protection requires an entire system study. This study should be done by a certified and registered consultant who is familiar with generator systems. The study will determine which grounding method should be used.

i01172156

Voltage Connections

SMCS Code: 4450

Three-Phase Voltage Connections

The Wye Configuration for a 480 V generator and the Delta Configuration a 240 V generator are given in the following diagrams.

The terminals must be connected securely. The terminals must also be insulated with a good quality electrical tape.

If a Delta Configuration with grounded neutral is being used, a two-thirds winding pitch is recommended and is required with 590 frame size generators and above. If the generator winding pitch is not two-thirds, third harmonics will cause a high neutral current. This current can damage the wiring and cause a fire hazard. A floating neutral does not require a two-thirds pitch winding.

Wye Configuration Diagrams

6 Lead Generators

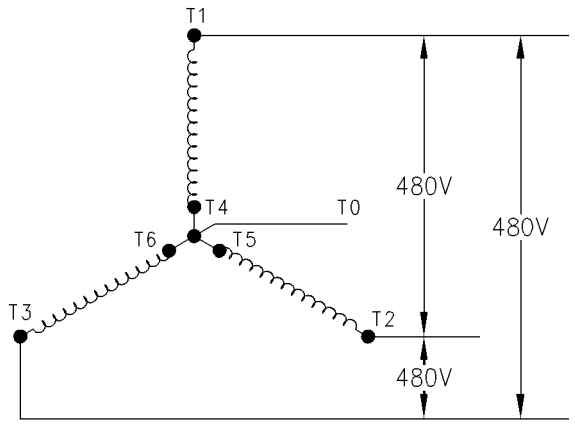

Illustration 35 g00626053

Typical Wye Configuration (60 Hz, 6 Lead)

10 Lead Generators

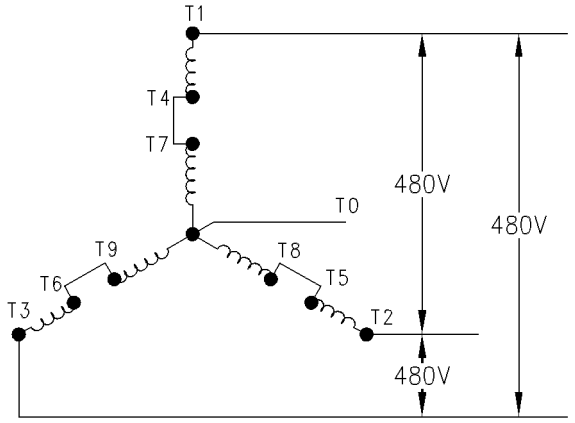

Illustration 36 g00626051

Typical Series Wye Configuration (60 Hz, 10 Lead) - for 3306B and 3406C generator sets only

This is a typical high voltage connection.

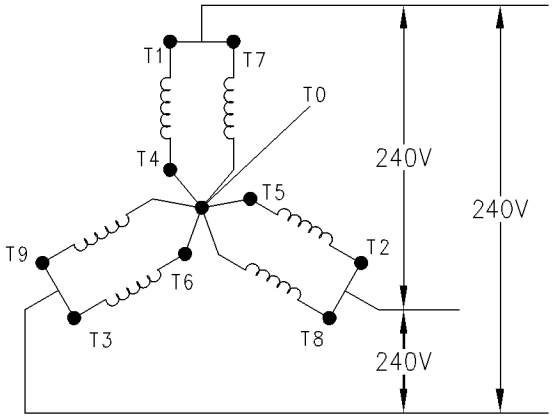

Illustration 37 g00626054

Typical Parallel Wye Configuration (60 Hz, 10 Lead) - for 3306B and 3406C generator sets only

This is a typical low voltage connection.

12 Lead Generators

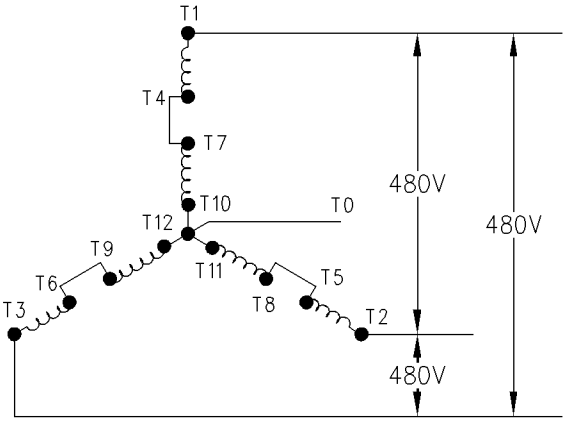

Illustration 38 g00637319

Typical Series Wye Configuration (60 Hz, 12 Lead) - for 3406E, 3412C and 3500 series generator sets only

This is a typical high voltage connection.

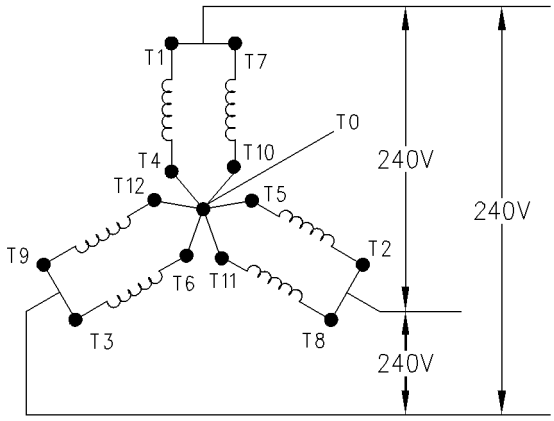

Illustration 39 g00637320

Typical Parallel Wye Configuration (60 Hz, 12 Lead) - for 3406E, 3412C and 3500 series generator sets only

This is a typical high voltage connection.

Delta Configuration Diagrams

6 Lead Generators

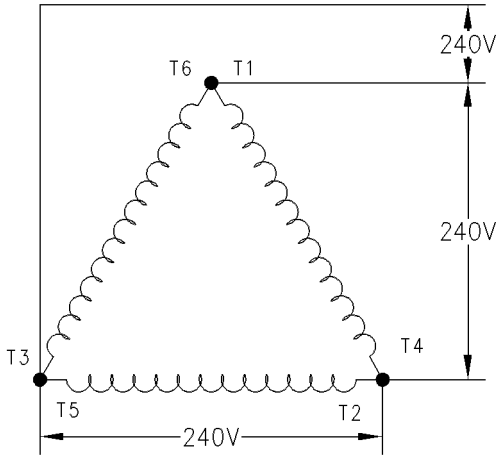

Illustration 40 g00626129

Typical Delta Configuration (60 Hz, 6 Lead)

12 Lead Generators

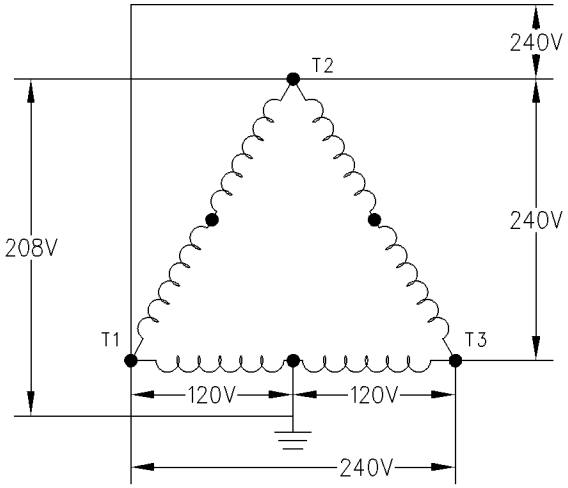

Illustration 41 g00626130

Typical Delta Configuration (60 Hz, 12 Lead)

Single-Phase Current From a Three-Phase Generator

Three-phase current and single-phase current can be taken simultaneously from a generator that is connected for three-phase service. In the Wye Configuration, connect the load to the three-phase leads (any two of the three leads). In the Delta Configuration, connect the load to the three-phase leads (any two of the three leads). In both configurations, this will provide single-phase voltage at the same voltage as three-phase voltage.

Connect the load to any phase lead and neutral lead of the Wye Configuration. This will produce voltage at 58% of three-phase voltage.

In the Delta Configuration that produces 240 Volts 60 Hz three-phase power, the voltages will be 208 Volts between the high phase and neutral and 240 Volts between either one of the low phases and neutral.

Refer to Operation Section, “Generator Operation” for allowable single-phase loading unbalance.

Single-phase power that is taken from a three-phase source can be a problem. Ensure that the single-phase loading is equally distributed.

Do not exceed the nameplate current rating for any one phase.

Wye Configuration Diagrams

6 Lead Generators

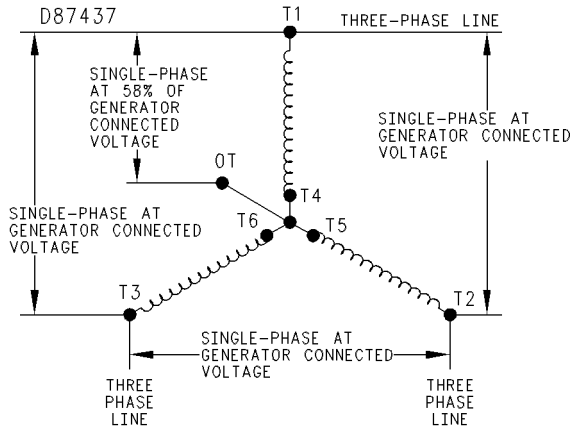

Illustration 42 g00626132

Single-Phase Voltage Diagram with 6 Lead Wye Configuration

10 Lead Generators

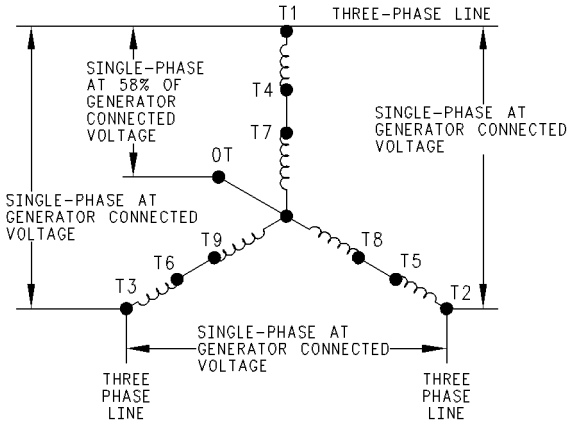

Illustration 43 g00626133

Single-Phase Voltage Diagram with 10 Lead Wye Configuration (for 3306B and 3406C generator sets only)

12 Lead Generators

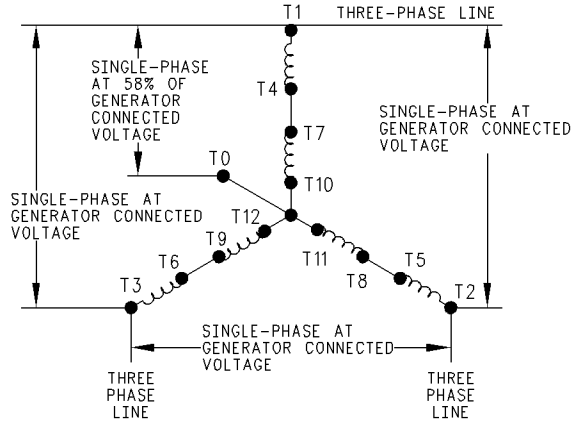

Illustration 44 g00637321

Single-Phase Voltage Diagram with 12 Lead Wye Configuration (for 3406E, 3412C and 3500 series generator sets only)

Delta Configuration Diagrams

6 Lead Generators

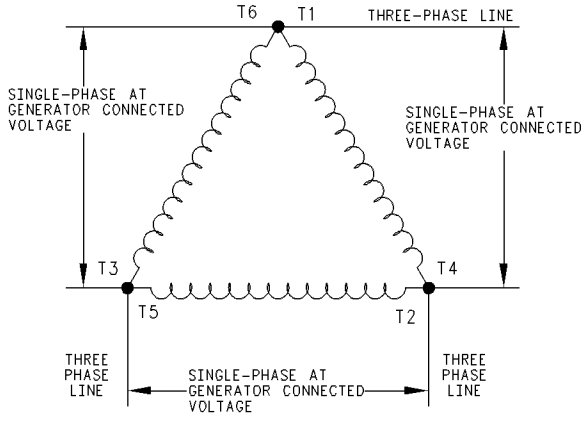

Illustration 45 g00626135

Single-Phase Voltage Diagram with 6 Lead Delta Configuration

12 Lead Generators

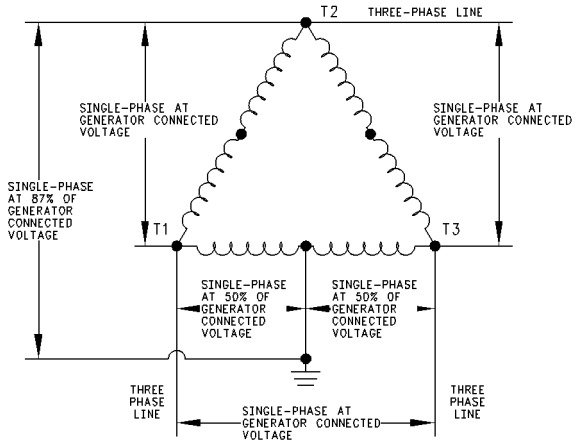

Illustration 46 g00626136

Single-Phase Voltage Diagram with 12 Lead Delta Configuration

Operation Section

Lifting and Storage

i02166058

Product Lifting

SMCS Code: 1000; 1404; 7002

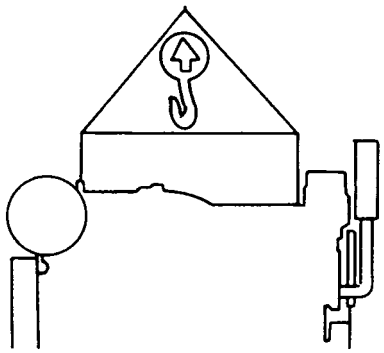

Illustration 47 g00103219

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

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

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

Some removals require lifting fixtures in order to obtain proper balance. Lifting fixtures also help to provide safety.

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

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

Engine Lifting with a Generator

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

Lifting the engine and the generator together requires special equipment and procedures. Consult your Caterpillar dealer for information regarding fixtures for proper lifting of your complete package.

A generator set package will not be level if you lift the unit with a single point lifting eye. A counterweight can be added between the package frame rails whenever the application requires frequent relocation of the unit. For complete information about adding the counterweight, consult your Caterpillar dealer.

The single point lifting eye is secured from the factory before the enclosure is shipped. The correct orientation of the single point lifting eye will allow you to look through the eye when you stand at the side of the enclosure. The lifting eye may stretch when the package is lifted. This may cause the locking nuts to loosen. This could cause the lifting eye to swivel. Ensure that the lifting eye is correctly oriented on the packaged generator set. Ensure that the lifting eye is tightened to the correct torque before you lift the packaged generator set.

Engine Lifting with a Fuel Tank

Lifting the engine with a fuel tank that is mounted to the engine requires special equipment and procedures. Do not lift the unit with fuel in the fuel tank. Consult your Caterpillar dealer for information regarding fixtures for proper lifting of your complete package.

i02046791

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

For information on generator storage, see the literature that is provided by the OEM of the generator. Consult your Caterpillar dealer for assistance.

Installation

i03663760

Generator Installation

SMCS Code: 1000; 4450

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. Follow the instructions under the “Product Lifting” topic. The hoist and the hoist cables should have a rating that is greater than the weight of 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. Air 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.

Note: For further information concerning the installation of this generator set, see the appropriate Application and Installation Guide.

Protective Devices

The output to the load of the generator should always be protected with an overload protection device such as a circuit breaker or fuses. Fuses should be sized by using the lowest possible current rating. However, this rating must be above the current rating for full load. A common recommendation is 115 percent of rated current. Determine the size of fuses or determine the size of circuit breakers in accordance with NEMA, IEC, and Local Electrical Codes.

Storage

If the generator is not installed immediately, refer to the “Product Storage” topic for the proper considerations for storing the unit.

Gauges and Indicators

i01233534

Gauges and Indicators

SMCS Code: 1900; 7450

Your engine may not have the same gauges or all of the gauges that are described. For more information about the gauge package, refer to the specifications for your engine.

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

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

NOTICE
If no oil pressure is indicated, STOP the engine. Engine damage can result.

Engine Oil Pressure – The oil pressure should be greatest after a cold engine is started. The typical oil pressure for turbocharged engines at rated rpm with SAE10W30 is 275 to 606 kPa (40 to 88 psi).

A lower oil pressure is normal at low idle. The minimum recommended oil pressure at 600 rpm is 103 kPa (15 psi). If the load is stable and the gauge reading changes, perform the following procedure:

1. Remove the load.

2. Reduce engine speed to low idle.

3. Check the oil level and maintain the oil level.

Jacket Water Coolant Temperature – Typical temperature range is 87 to 98°C (189 to 209°F). The maximum allowable temperature is 104°C (220°F). Higher temperatures may occur under certain conditions. The water temperature reading may vary according to load. The reading should never exceed the boiling point for the pressurized system that is being used.

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

1. Reduce the load and the engine rpm.

2. Inspect the cooling system for leaks.

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

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

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

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

Ammeter – This gauge indicates the amount of charge or discharge in the battery charging circuit. Operation of the indicator should be to the right side of “0” (zero).

Fuel Level – This gauge indicates the fuel level in the fuel tank. The fuel level gauge operates when the start switch is “ON” .

Fuel Pressure – This gauge indicates fuel pressure to the fuel injection pump. If the gauge moves to the “out” position the engine will not operate properly. If the gauge is below 160 kPa (23 psi) the engine will not operate properly. A decrease in fuel pressure usually indicates a plugged fuel filter.

Service Hour Meter – This gauge indicates the total number of clock hours that the engine has operated.

Features and Controls

i02916146

Electronic Modular Control Panel II (EMCP II)
(If Equipped)

SMCS Code: 4490

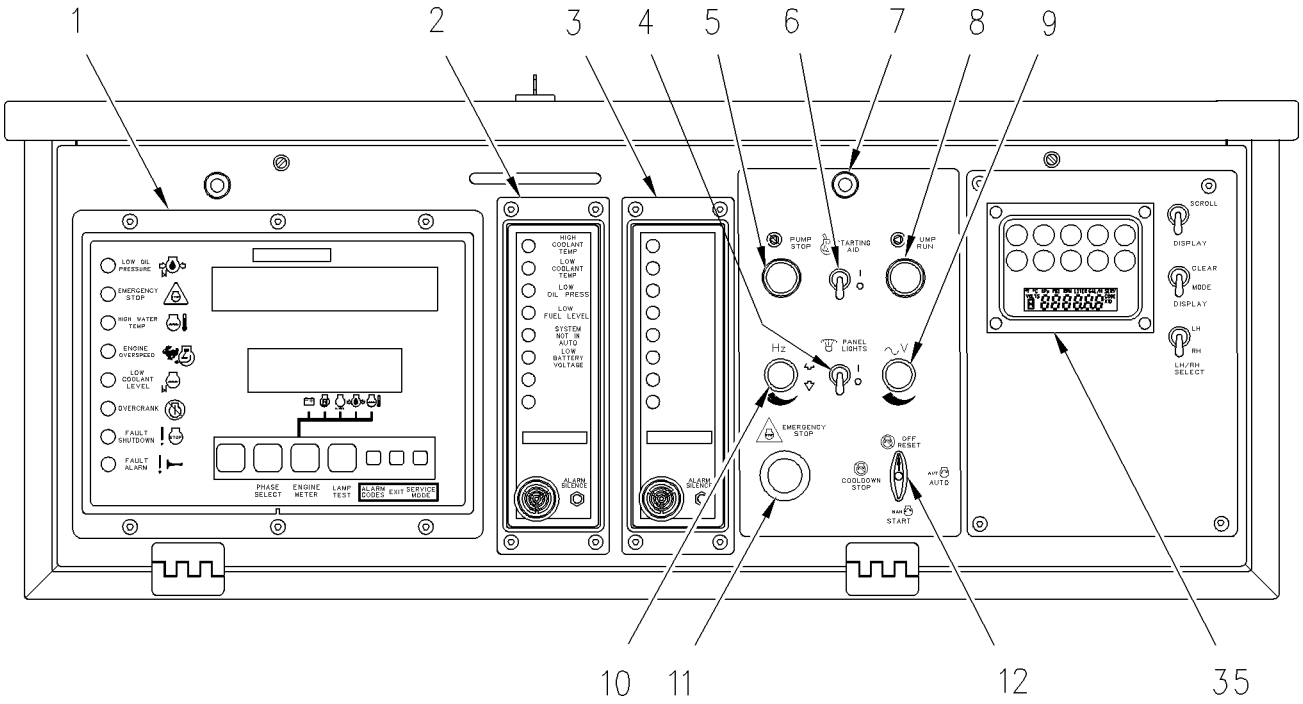

Illustration 48 g00638566

Electronic Modular Control Panel II (EMCP II)

(1) Generator set control (GSC)
(2) Alarm module (ALM)
(3) Custom alarm module (CAM) (if equipped)
(4) Panel light switch (PLS)
(5) Pump stop switch
(6) Starting aid switch (SAS) (if equipped)
(7) Panel lights (PL)
(8) Pump run switch (if equipped)
(9) Voltage adjust rheostat (VAR)
(10) Speed Potentiometer (SP) (if equipped) or Governor Switch (GS) (if equipped)
(11) Emergency stop push button (ESPB)
(12) Engine control switch (ECS)
(35) Caterpillar Monitoring System (if equipped)

The electronic modular control panel II (EMCP II) is located above the generator distribution housing. The control panel consists of a main panel with indicators, meters and control switches. This control panel may be equipped with optional modules in order to match the customers' needs and requirements.

The left side of the control panel contains the generator set control (GSC). This is the main component of the system. The GSC displays generator output, fault conditions and key engine parameters. The center section of the control panel may be a blank or the center section of the control panel may contain one or two of the optional alarm modules. The right section may be a blank or the right section may contain the Caterpillar Monitoring System (35).

The main control panel may contain all of the components which are shown in Illustration 48 or the main control panel may not contain all of the components which are shown in Illustration 48 . Some components are optional. The optional components may not be required for your particular application.

Generator Set Control (1) – The generator set control (GSC) is the main component of the EMCP II. See the topic “Generator Set Control (GSC)” in this section.

Alarm Module (2) – The alarm module (ALM) is optional. The ALM provides a visual warning and an audible warning of the engine conditions before the engine conditions become severe enough to shut down the engine or before the engine conditions restrain the engine from starting.

Custom Alarm Module (3) – The custom alarm module (CAM) is optional. The CAM annunciates faults, alarms or other conditions from customer supplied inputs.

Panel Light Switch (4) – The panel lights switch (PLS) turns on the panel lights (7) or turns off the panel lights (7).

Pump Stop Switch (5) – The pump stop switch is optional on 3406E and 3412C generator sets only. This push button switch is used with the generator mounted automatic fuel transfer system, if equipped. The pump stop switch is used to manually stop the fuel transfer pump. The pump stop switch will be in the depressed position, when the switch is pushed. The red indicator will now be ON. The switch can be reset by pressing the switch again. The red indicator will now be OFF.

Start Aid Switch (6) – The start aid switch (SAS) is optional. The SAS is used to inject ether into the engine when you are starting the engine in cold weather conditions. When the SAS is in ON position, the switch energizes the starting aid solenoid valve (SASV) and the switch meters a specific amount of ether in a holding chamber. When the SAS is released, the solenoid releases the ether to the engine.

NOTICE
The engine must be cranking before using the start aid switch. Damage to the engine is possible if ether is released to the engine but not exhausted or burned by the engine when cranking.

Panel Lights (7) – The panel lights (PL) are controlled by panel lights switch (4). The panel lights switch (4) is an ON/OFF switch.

Pump Run Switch (8) – The pump run switch is optional. This momentary push button switch is used with the generator set mounted automatic fuel transfer system, if equipped. Pushing the pump run switch will cause the fuel transfer pump that is mounted on the generator set to fill the generator set dry tank. The green indicator will be ON when the pump is running. The pump will automatically shut OFF when the fuel reaches the high fuel level. The pump can be turned off manually by using the pump stop switch (5). The pump stop switch must be reset. Reset the pump stop switch by pressing the switch again.

Voltage Adjust Rheostat (9) – The voltage adjust rheostat (VAR) is used to adjust the generator output voltage to the desired level.

Speed Potentiometer (10) – The speed potentiometer (SP) is optional. The SP can be used with the generator set that has an electric governor. When the governor is equipped with a speed adjust motor, the governor switch (GS) can be mounted instead of the SP. The engine speed and frequency can be raised or the engine speed and frequency can be lowered by using the GS. The GS is also an option.

Emergency Stop Push Button (11) – The emergency stop push button (ESPB) is used to shut down the engine during an emergency situation. The ESPB shuts off the fuel and the ESPB activates the optional air shutoff, if equipped.

Engine Control Switch (12) – The engine control switch (ECS) determines the status of the control panel. In the AUTOMATIC position (3 o'clock), the engine starts automatically whenever a remote contact is closed. The engine will shut down after the contact opens and after a programmable cooldown period has elapsed. The cooldown period can be programmed to give a 0 to 30 minute cooldown period before the engine shuts down.

In the MANUAL START position (6 o'clock), the engine starts and the engine runs as long as the engine control switch (ECS) remains in this position.

In the STOP position (9 o'clock), the fuel solenoid shuts down the engine after a programmable cooldown period has elapsed.

In the OFF/RESET position (12 o'clock), the fault lights are reset and the engine shuts down immediately.

Caterpillar Monitoring System (35) – This system is the information center for the engine and related components. See the Operation Section, “Caterpillar Monitoring System”.

Below, you can find the descriptions of the following main modules of the EMCP II:

- Generator Set Control (GSC)
- Alarm Module (ALM)
- Custom Alarm Module (CAM)

Generator Set Control (GSC)

Functions and Features of the GSC

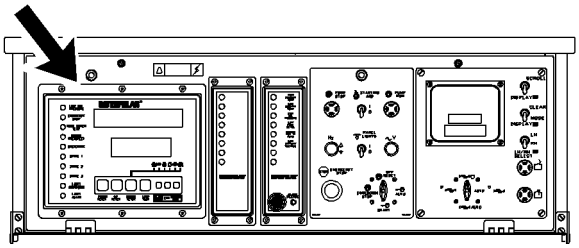

Illustration 49 g00643608

The Location of the GSC on the EMCP II Control Panel

The left side of the control panel contains the generator set control (GSC). The GSC is the main component of the system. The GSC displays generator output, generator set functions, fault conditions and key engine parameters. The GSC accepts information from the following sources: operator, magnetic pickup, oil pressure sensor, water temperature sensor and optional remote sources. This information is used to determine the “ON/OFF” state of the engine's air, fuel, and starter.

In the very basic operating conditions, the GSC receives a signal in order to run the generator set. The GSC turns on the engine's fuel and the engine starter. When the engine speed reaches the crank termination speed, the starter is disengaged. When the GSC receives a signal to stop the engine, the GSC shuts the fuel off.

The functions of the GSC are listed below.

- The GSC controls the normal starting and stopping of the engine.
- The GSC shows engine conditions and generator output information on two displays. The displays also show fault codes and GSC programming information.
- The GSC monitors the system for faults. If a fault occurs, the GSC performs a controlled fault shutdown or the GSC provides a fault alarm annunciation. The GSC uses indicators and displays in order to describe the fault.
- The GSC contains programmable features for certain applications or customer requirements.

The features of the GSC are listed below.

- **Cycle Crank** : The GSC can be programmed to crank for adjustable time periods. For programming instructions, refer to the Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) For MUI Engines” or to the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) For EUI Engines”.
- **Governor Control** : When the engine oil pressure increases past the low oil pressure set point, the GSC indicates that the governor should increase the engine speed from idle rpm to rated rpm.
- **Cooldown** : In order to perform a normal shutdown upon receiving a signal, the GSC waits for a preprogrammed time period before shutting down the engine via the fuel control.
- **Automatic Operation** : In the automatic mode, the GSC can be started by a remote signal (contact closure). Upon loss of the signal (contact opening), the GSC will perform a normal shutdown.
- **Alarm Module Communication** : The GSC can transmit the fault and alarm conditions to an alarm module (AM).
- **Power Down:** The EMCP II system is designed to remove power from the GSC when the engine control switch (ECS) is in the OFF/RESET mode and when the proper jumper wire is removed. The GSC will not allow the power down until the crank termination relay and the fuel control relay are turned off for about 70 seconds. The GSC remains powered, if the wire is not removed. For the wiring diagram and the location of the jumper wire, refer to the Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) For MUI Engines” or to the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) For EUI Engines”.
- **Fuel Solenoid Type** : The GSC can be programmed to work with an energized to run (ETR) fuel system or to work with an energized to shutdown(ETS) fuel system.

Fault indicators

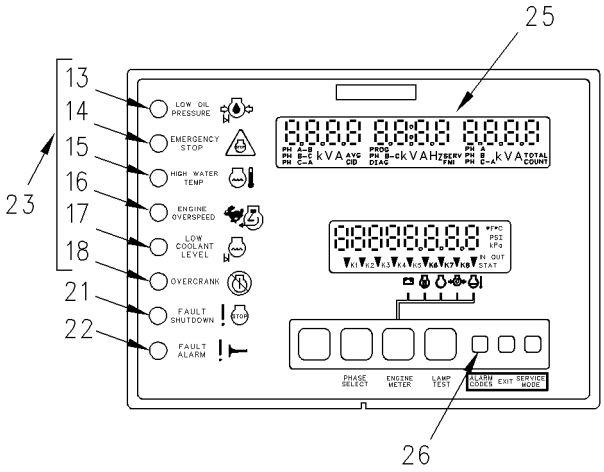

Illustration 50 g00636237

Display Area of the GSC

(13) Low oil pressure indicator
(14) Emergency stop indicator
(15) High water temperature indicator
(16) Engine overspeed indicator
(17) Low coolant level indicator
(18) Overcrank indicator
(21) Fault shutdown indicator
(22) Fault alarm indicator
(23) Dedicated shutdown indicators
(25) Upper display
(26) The alarm codes key

The eight fault indicators are used in order to show the fault in the engine. The eight fault indicators are also used to describe the fault in the engine. The fault indicators are divided into three groups. The three groups are listed below:

- fault alarm indicator (22)
- fault shutdown indicator (21)
- dedicated shutdown indicators (23)

The yellow fault alarm indicator (22) FLASHES when the GSC detects an alarm fault. The alarm fault does not cause the engine status to change. The engine can be started. The engine will continue operating, only if the engine is running at the time of the alarm fault. Fault alarm indicator (22) is accompanied by an alarm fault code that is shown on the upper display (25) when the alarm codes key (26) is pressed. For the descriptions of the fault codes, refer to the Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) For MUI Engines” or to the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) For EUI Engines”.

The red fault shutdown indicator (21) FLASHES when the GSC detects a shutdown fault. The engine will be shut down if the engine is running. The engine will not be allowed to start. Fault shutdown indicator (21) is accompanied by a fault code that is immediately shown on the upper display (25). For the descriptions of the fault codes, refer to the Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) For MUI Engines” or to the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) For EUI Engines”.

The red dedicated shutdown indicators (23) represent the following shutdown faults: low oil pressure, emergency stop, high water temperature, engine overspeed, low coolant level and engine overcrank. When the GSC detects a fault in one of these areas, the dedicated shutdown indicator (that corresponds to the fault) FLASHES. The engine is shutdown if the engine is running, and the engine is not allowed to start. No fault codes are associated with the dedicated shutdown indicators because each indicator has a descriptive label.

Many of the dedicated shutdown faults depend on certain setpoints in the GSC. For the descriptions of the fault codes, refer to the Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) For MUI Engines” or to the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) For EUI Engines”.

The conditions that are required to activate the dedicated fault shutdowns and the results of each dedicated fault are in the following list.

Low Oil Pressure – The engine oil pressure drops below the setpoints for low oil pressure shutdown that are programmed into the GSC. There are two low oil pressure setpoints. One setpoint is used when the engine is at idle speed. The other setpoint is used when the engine is at rated speed. When a low oil pressure fault occurs, the low oil pressure indicator FLASHES, and the engine is shut down. The engine is not allowed to start until the fault is corrected.

Emergency Stop – The operator presses the emergency stop push button (ESPB) on the front panel. When an emergency stop condition occurs, the emergency stop indicator FLASHES and the engine is shut down. The engine is not allowed to start until the condition is corrected.

High Water Temperature – The engine coolant temperature rises above the setpoint for high water temperature shutdown that is programmed into the GSC. When the high water temperature fault occurs, the high water temperature indicator FLASHES. The engine is shutdown and the engine is not allowed to start until the fault is corrected.

Engine Overspeed – The engine speed exceeds the setpoint for engine overspeed that is programmed

into the GSC. When the engine overspeeds, the engine overspeed indicator FLASHES. The engine is shutdown and the engine is not allowed to start until the fault is corrected.

Low Coolant Level – The engine coolant level drops below the probe of the coolant loss sensor. When the low coolant level fault occurs, the engine coolant level indicator FLASHES. The engine is shut down. The engine is not allowed to start until the fault is corrected.

Overcrank – The engine does not start within the setpoint for total cycle crank time that is programmed into the GSC. When the overcrank fault occurs, the overcrank indicator FLASHES. The engine is not allowed to start until the fault is corrected.

Note: The GSC can be programmed to override the shutdown for low oil pressure and high water temperature faults. When the operator overrides the shutdown faults, the GSC responds to the faults as though the faults are alarm faults. The corresponding dedicated shutdown indicator is ON CONTINUOUSLY and the shut down indicator will not be flashing. The engine continues to run and the engine can be restarted if required. When the dedicated shutdown indicator is ON CONTINUOUSLY, the setpoint for shutdown has been exceeded, but the GSC is programmed to override the shutdown fault. The GSC does not treat the shutdown fault as a shutdown fault. The GSC treats the shutdown fault as an alarm fault. At the factory, the GSC is programmed to treat a low oil pressure fault and a high water temperature fault as shutdown faults. The operator or the service technician must decide to override these shutdown faults. The operator or the service technician must program the GSC to treat the shutdown faults as alarm faults. For programming procedures, refer to the Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) for MUI Engines” or to the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) for EUI Engines”.

Display

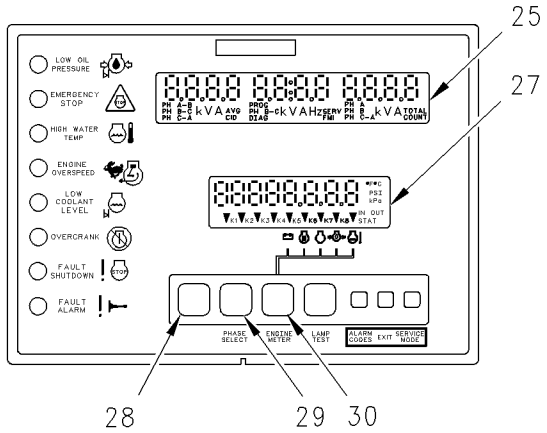

Illustration 51 g00636342

Display Area of the GSC

(25) Upper display
(27) Lower display
(28) The leftmost key
(29) The phase select key
(30) The engine meter key

The display consists of the upper display and the lower display. Both displays are used for programming functions when the GSC is in the service mode. For more information, see Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) for MUI Engines” or see the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) for EUI Engines”.

Upper display

The upper display (25) shows: AC voltage, current and frequency of one phase of the generator output. Each phase can be viewed one at a time by pushing phase select key (29). The upper display (25) is also used to show the various fault codes for system faults. For more information on fault codes, refer to Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) for MUI Engines” or to the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) for EUI Engines”.

Lower display

The lower display (27) shows the following parameters: system battery voltage, engine hours, engine speed, engine oil pressure, engine coolant temperature and relay status.

The value for one of these conditions is shown for two seconds. Then, the display scrolls to the value for the next condition. A small pointer identifies the engine condition that corresponds to the value which is showing. When the engine meter key (30) is pressed, the lower display (27) stops scrolling. The lower display (27) continuously shows one particular value. The pointer flashes when the indicated value is above a predetermined value. When engine meter key (30) is pressed for a second time, the display (27) will return to scrolling.

The relay status indicators are on the bottom of the lower display (27). When a GSC relay is activated, the corresponding indicator (K1, K2, etc) is shown on lower display (27). When a relay is not activated, the corresponding indicator (K1, K2, etc) is not shown. For a description of the relay functions, see the Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) for MUI Engines” or the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) for EUI Engines”.

Keypad

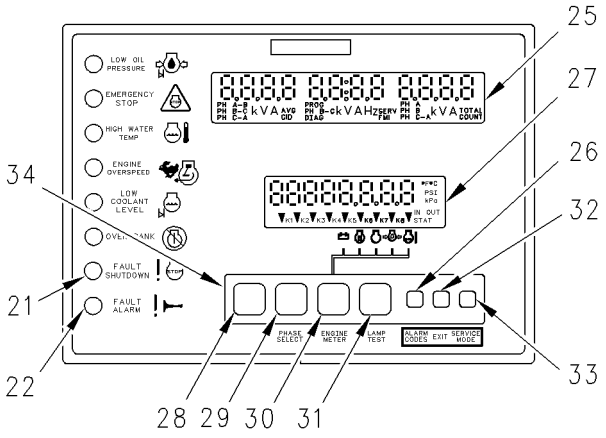

Illustration 52 g00636347

Keypad Area of the GSC

(21) Fault shutdown indicator
(22) Fault alarm indicator
(25) Upper display
(26) The alarm codes key
(27) Lower display
(28) Leftmost key
(29) Phase select key
(30) Engine meter key
(31) Lamp test key
(32) Exit key
(33) Service mode key
(34) Keypad

Keypad (34) is used to control the information that is shown on upper display (25) and lower display (27). The seven keys have two sets of functions: normal functions and service functions. For a description of the service functions of the keys, see the Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) for MUI Engines” or see the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) for EUI Engines”. The normal functions of the keys are described in the following paragraphs.

Leftmost Key (28) – This key only functions when the GSC is in service mode. This key is used to scroll right.

Phase Select Key (29) – This key selects the phase of the generator output that is displayed on the GSC. When you press this key, the display shows the voltage, current, and frequency of each phase one at a time.

Engine Meter Key (30) – This key controls the viewing of engine parameters on the lower display. Pressing the key stops the scrolling of engine conditions. The value for one particular engine condition will show continuously. The pointer flashes indicating that the scrolling is stopped. The scrolling of the engine conditions will resume when the engine meter key is pressed again.

Lamp Test Key (31) – Pressing this key performs a lamp test on the GSC and the optional alarm module. On the GSC, the eight fault indicators are ON CONTINUOUSLY. Every segment of upper display (5) and lower display (6) is ON. On the optional alarm module, all of the indicators are ON and the horn sounds. The lamp test function automatically turns off when an operator presses the key and the operator holds the key for more than ten seconds.

The Alarm Codes Key (26) – If fault alarm indicator (22) is FLASHING, pressing this key causes upper display (25) to show the corresponding alarm fault code. If this key is pressed again, the generator AC output information will be shown on the upper display (25). If fault alarm indicator (22) is OFF, this key has no function.

Exit Key (32) – This key only functions when the GSC is in Service Mode. For more information, see the Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) for MUI Engines” or see the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) for EUI Engines”.

Service Mode Key (33) – Pressing this key causes the GSC to enter service mode. For more information, see the Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) for MUI Engines” or see the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) for EUI Engines”.

Alarm Module

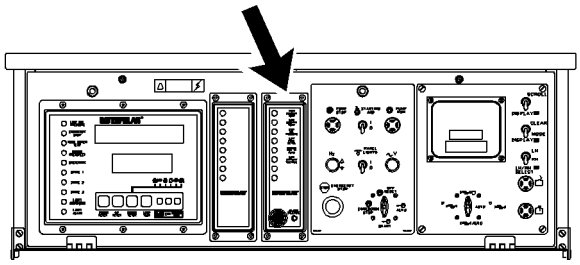

Illustration 53 g00643609

The Location of the Alarm Module (ALM) on the EMCP II Control Panel

The alarm module (ALM) is optional. The ALM is located in the center of the control panel. The alarm module provides a visual warning and an audible warning of the engine conditions before these conditions become severe enough that the engine shut down or the engine is unable to start.

One basic alarm module is used to satisfy the requirements for a standby NFPA 99 alarm module, standby NFPA 110 alarm module, NFPA 99 remote annunciator panel, and the prime power alarm. This is accomplished by using different inputs to the module and different decals on the front of the module in order to indicate alarms or shutdown conditions. Refer to the Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) for MUI Engines” or to the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) for EUI Engines” for all wiring and installation information. Refer to the above manuals for a list of indicators and alarm functions.

The front of the alarm module consists of the following indicators.

- Four amber indicators indicate the following parameters (depending on the module configuration): High Coolant Temperature, Low Coolant Temperature or Low Coolant Level, Low Oil Pressure, Generator On Load, Charger Malfunction, Low Oil Level and Low Fuel Level.
- Four red indicators indicate the following parameters (depending on the module configuration) :Not in AUTO condition, Low DC Voltage, Air Damper Closed, Low Oil Pressure Shutdown, Overcrank Shutdown, High Coolant Temperature Shutdown and Overspeed Shutdown
- An audible alarm and Acknowledge/Silence switch

For more detailed information, refer to the Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) for MUI Engines” or to the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) for EUI Engines”.

Custom Alarm Module

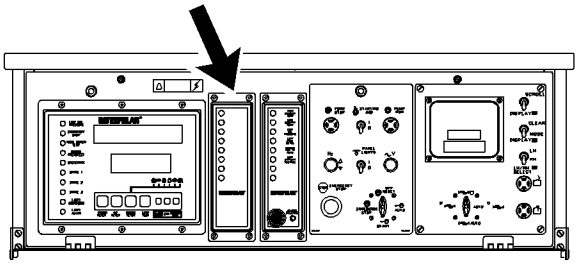

Illustration 54 g00643610

The Location of the Custom Alarm Module (CAM) on the EMCP II Control Panel

The custom alarm module (CAM) is optional. The CAM is located in the center of the control panel. The custom alarm module provides a visual warning and an audible warning of the conditions of the customer supplied inputs before these conditions become severe enough that the engine shuts down or the engine is unable to start. The CAM is equipped with a horn, an alarm silence switch, a lamp test switch and 8 switched inputs for customer use. Refer to the Systems Operation, Testing and Adjusting, SENR5809, “Electronic Modular Control Panel II (EMCP II) for MUI Engines” or to the Systems Operation, Testing and Adjusting, SENR5398, “Electronic Modular Control Panel II (EMCP II) for EUI Engines” for all wiring and installation information. Refer to the above manuals for the names of input signals.

The front of the alarm module consists of the following indicators.

- Four amber indicators, which are used to display alarm conditions

- Four red indicators, which are used to display shutdown conditions

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Electronic Modular Control Panel II+ (EMCP II+)
(If Equipped)

SMCS Code: 4490

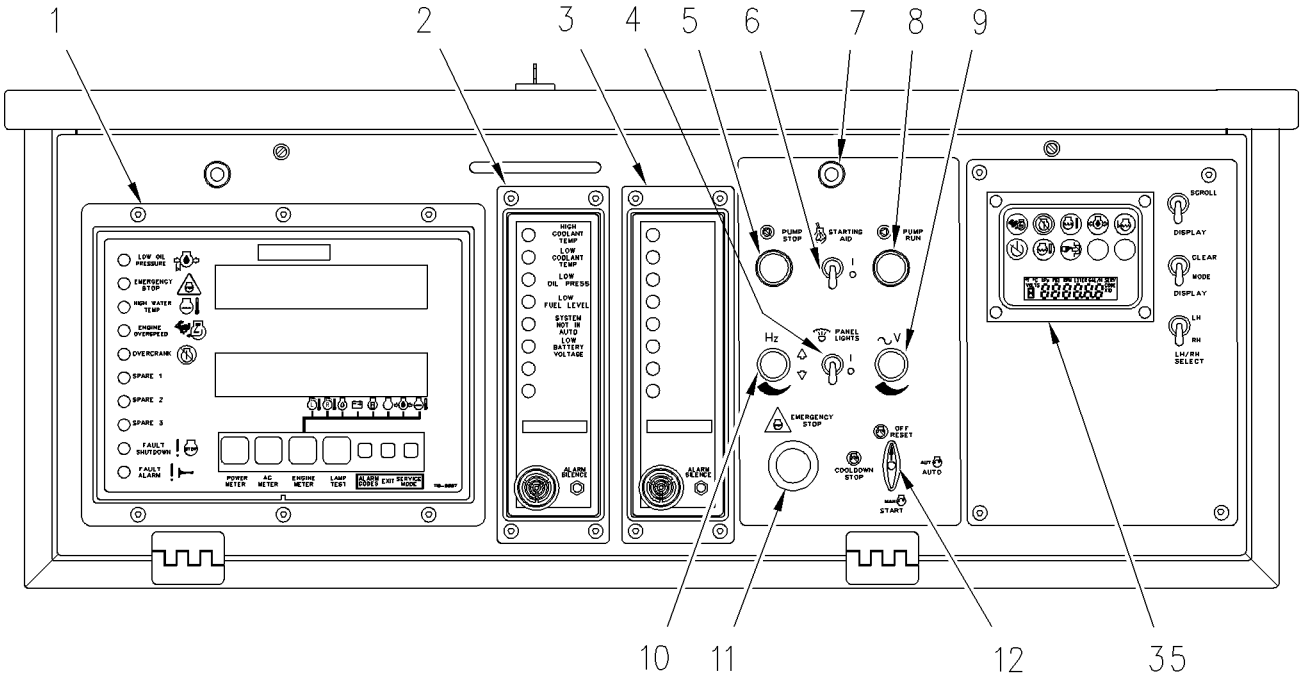

Illustration 55 g00638311

Electronic Modular Control Panel II+ (EMCP II+)

(1) Generator set control + (GSC+)
(2) Alarm module (ALM) (optional)
(3) Custom alarm module (CAM) (optional)
(4) Panel light switch (PLS)
(5) Pump stop switch
(6) Start aid switch (SAS) (optional)
(7) Panel lights (PL)
(8) Pump run switch (optional)
(9) Voltage adjust rheostat (VAR)
(10) Speed potentiometer (SP) (optional) or Governor switch (GS) (optional)
(11) Emergency stop push button (ESPB)
(12) Engine control switch (ECS)
(35) Caterpillar Monitoring System (optional)

The electronic modular control panel II+ (EMCP II+) is located above the generator distribution housing. The control panel consists of a main panel with indicators, meters and control switches. This control panel may be equipped with optional modules in order to match the customers' needs and requirements.

The left side of the control panel contains the generator set control + (GSC+). This is the main component of the system. The GSC+ displays generator output, fault conditions and key engine parameters. The center section of the control panel may be blank, or contain one or two of the optional alarm modules. The right side of the control panel may be blank, or contain the Caterpillar Monitoring System (35).

The main control panel may or may not contain all of the components which are shown in Illustration 55 . Some components are optional. The optional components may not be required for your particular application.

Generator Set Control + (1) – The generator set control + (GSC+) is the main component of the EMCP II+. See the topic “Generator Set Control + (GSC+)” in this section.

Alarm Module (2) – The alarm module (ALM) is optional. The function of ALM is to provide a visual and audible warning of engine conditions before these conditions become severe enough to shut the engine down or keep the engine from starting.

Custom Alarm Module (3) – The custom alarm module (CAM) is optional. The purpose of the CAM is to annunciate faults, alarms or other conditions from customer supplied inputs.

Panel Light Switch (4) – The panel lights switch (PLS) turns the panel lights (7) on or off.

Pump Stop Switch (5) – The pump stop switch is optional with 3406E and 3412C generator sets only. This push button switch is used with the generator mounted automatic fuel transfer system, if equipped. The pump stop switch is used to manually stop the fuel transfer pump. This switch is latched down when pushed. The red indicator will now be ON. The switch can be reset by pressing the switch again. The red indicator will now be OFF.

Start Aid Switch (6) – The start aid switch (SAS) is optional. The SAS is used to inject ether into the engine when you are starting the engine in cold weather conditions. When the SAS is in ON position, the switch energizes the starting aid solenoid valve (SASV) and meters a specific amount of ether in a holding chamber. When the SAS is released, the solenoid releases the ether to the engine.

NOTICE
The engine must be cranking before using the start aid switch. Damage to the engine is possible if ether is released to the engine but not exhausted or burned by the engine when cranking.

Panel Lights (7) – Panel lights (PL) are controlled by panel lights switch (4). The panel lights switch (4) is an ON/OFF switch.

Pump Run Switch (8) – The pump run switch is optional. This momentary push button switch is used with the generator set mounted automatic fuel transfer system, if equipped. Pushing this switch will cause the generator set mounted fuel transfer pump to fill the generator set day tank. The green indicator will be ON when the pump is running. The pump will automatically shut OFF when the fuel reaches the high fuel level. The pump can also be turned OFF manually by the pump stop switch (5). The pump stop switch must be reset. Reset the pump stop switch by pressing the switch again.

Voltage Adjust Rheostat (9) – The voltage adjust rheostat (VAR) is used to adjust the generator output voltage to the desired level.

Speed Potentiometer (10) – The speed potentiometer (SP) is optional. The SP can be used with the generator set that has an electric governor. When the governor is equipped with a speed adjust motor, the governor switch (GS) can be mounted instead of the SP. The GS is used to raise or lower the engine speed and frequency. The GS is also an option.

Emergency Stop Push Button (11) – The emergency stop push button (ESPB) is used to shut down the engine during an emergency situation. The ESPB shuts off the fuel and activates the optional air shutoff, if equipped.

Engine Control Switch (12) – The engine control switch (ECS) determines the status of the control panel. In the AUTOMATIC position (3 o'clock), the engine will start automatically whenever a remote initiating contact is closed. The engine will shutdown after the initiating contact opens and after a programmable cooldown time has elapsed. The cooldown time can be programmed to give a 0 to 30 minute cooldown period before the engine shuts down.

In the MANUAL START position (6 o'clock), the engine will start and run as long as the ECS switch remains in this position.

In the STOP position (9 o'clock), the fuel solenoid shuts the engine down, after a programmable cool down time period has elapsed.

In the OFF/RESET position (12 o'clock), the fault lights are reset and the engine shuts down immediately.

Caterpillar Monitoring System (35) – This system is the information center for the engine and related components. See the Operation Section, “Caterpillar Monitoring System” for more information.

Below, you can find the descriptions of the following main modules of the EMCP II+:

- Generator Set Control + (GSC+)
- Alarm Module (ALM)
- Custom Alarm Module (CAM)

Generator Set Control + (GSC+)

Functions and features of the GSC+

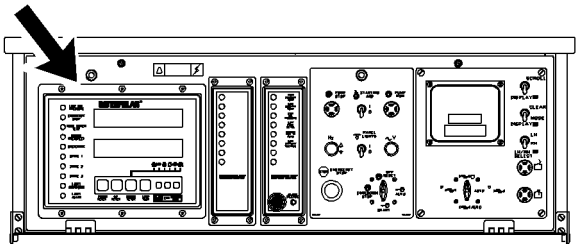

Illustration 56 g00634036

The Location of the GSC+ on the EMCP II+ Control Panel

The left side of the control panel contains the generator set control + (GSC+). The GSC+ is the main component of the system. The GSC+ displays generator output, generator set functions, fault conditions and key engine parameters. The GSC+ accepts information from the operator, magnetic pickup, oil pressure sensor, water temperature sensor and optional remote sources. This information is used to determine the “on/off” state of the engine's air, fuel, and starter.

In the very basic operating conditions, the GSC+ receives a signal to run the generator set. The GSC+ turns on the engine's fuel and starter. When the engine speed reaches the crank termination speed, the starter is disengaged. When the GSC+ receives a signal to stop the engine, the GSC+ shuts the fuel off.

The functions of the GSC+ are listed below.

- The GSC+ controls the normal starting and stopping of the engine.
- The GSC+ shows engine conditions and generator output information on two displays. The displays also show fault codes and GSC+ programming information.
- The GSC+ monitors the system for faults. If a fault occurs, the GSC+ performs a controlled fault shutdown or provides a fault alarm annunciation. The GSC+ uses indicators and displays in order to describe the fault.
- The GSC+ contains programmable features for certain applications or customer requirements.

The features of the GSC+ are listed below.

- **Cycle Crank** : The GSC+ can be programmed to crank for adjustable time periods. For programming instructions, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II + (EMCP II +)”.
- **Governor Control** : When the engine oil pressure increases past the low oil pressure set point, the GSC+ will indicate to the governor that the governor should increase the engine speed from idle rpm to rated RPM.
- **Cooldown** : Upon receiving a signal to perform a normal shutdown, the GSC+ will wait a preprogrammed amount of time before shutting the engine down by means of the fuel control.
- **Automatic Operation** : While in the automatic mode, the GSC+ can be started by a remote initiate signal (contact closure). Upon loss of the signal (contact opening), the GSC+ will perform a normal shutdown.
- **Alarm Module Communication** : The GSC+ can transmit fault and alarm conditions to an alarm module (AM).
- **Power Down** : The EMCP II+ system is designed to remove power from the GSC+ when the engine control switch (ECS) is in the OFF/RESET mode and when the proper jumper wire is removed. The GSC+ will not allow the power down until the crank termination relay and the fuel control relay are both off for about 70 seconds. If the wire is not removed, the GSC+ will remain powered up. For the wiring diagram and the location of the jumper wire, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II + (EMCP II+)”.
- **Fuel Solenoid Type** : The GSC+ can be programmed to work with either an energized to run (ETR) fuel system or an energized to shutdown (ETS) fuel system.

Fault indicators

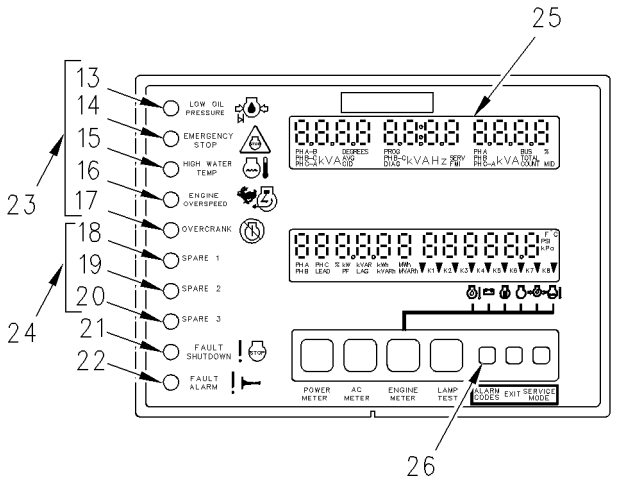

Illustration 57 g00643441

Display Area of the GSC+

(13) Low oil pressure indicator
(14) Emergency stop indicator
(15) High water temperature indicator
(16) Engine overspeed indicator
(17) Overcrank indicator
(18) Spare 1 indicator
(19) Spare 2 indicator
(20) Spare 3 indicator
(21) Fault shutdown indicator
(22) Fault alarm indicator
(23) Dedicated shutdown indicators
(24) Spare fault indicators
(25) Upper display
(26) The alarm codes key

The ten fault indicators are used in order to show and describe a fault that is present. The fault indicators are divided into four groups. The four groups are:

- fault alarm indicator (22)
- fault shutdown indicator (21)
- spare fault indicators (24)
- dedicated shutdown indicators (23)

The yellow fault alarm indicator (22) FLASHES when the GSC+ detects an alarm fault. The alarm fault does not cause the engine status to change. The engine can be started. The engine will continue operating only if the engine is running at the time of the alarm fault. Fault alarm indicator (22) is accompanied by an alarm fault code that is shown on the upper display (25) when the alarm codes key (26) is pressed. For the descriptions of the fault codes, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II + (EMCP II+)”.

The red fault shutdown indicator (21) FLASHES when the GSC+ detects a shutdown fault. The engine will be shut down if the engine is running. The engine will not be allowed to start. Fault shutdown indicator (21) is accompanied by a fault code that is immediately shown on the upper display (25). For the descriptions of the fault codes, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II + (EMCP II+)”.

The yellow spare fault indicators (24) FLASH when the conditions that are associated with that spare fault are active. The three spare faults can be programmed to show coolant loss, oil temperature, spare fault condition or no assignment. The spare fault condition may be a customer generated switch input. The yellow fault alarm indicator (22) or the red fault shutdown indicator (21) will accompany the spare fault indicators (24). The spare fault indicators will tell whether the spare fault input is programmed to be an alarm condition or a shutdown condition. For the descriptions of the fault codes, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II + (EMCP II+)”.

The red dedicated shutdown indicators (23) represent the following shutdown faults: low oil pressure, emergency stop, high water temperature, engine overspeed and engine overcrank. When the GSC+ detects a fault in one of these areas, the dedicated shutdown indicator (that corresponds to the fault) FLASHES. The engine is shutdown if the engine is running, and the engine is not allowed to start. No fault codes are associated with the dedicated shutdown indicators because each indicator has a descriptive label.

Many of the dedicated shutdown faults depend on certain setpoints in the GSC+. For the descriptions of the fault codes, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II + (EMCP II+)”.

The conditions that are required to activate the dedicated fault shutdowns and the results of each dedicated fault are in the following list.

Low Oil Pressure – The engine oil pressure drops below the setpoints for low oil pressure shutdown that are programmed into the GSC+. There are two low oil pressure setpoints. One setpoint is used when the engine is at idle speed. The other setpoint is used when the engine is at rated speed. When a low oil pressure fault occurs, the low oil pressure indicator FLASHES, and the engine is shut down. The engine is not allowed to start until the fault is corrected.

Emergency Stop – The operator presses the emergency stop push button (ESPB) on the front panel. When an emergency stop condition occurs, the emergency stop indicator FLASHES and the engine is shut down. The engine is not allowed to start until the condition is corrected.

High Water Temperature – The engine coolant temperature rises above the setpoint for high water temperature shutdown that is programmed into the GSC+. When the high water temperature fault occurs, the high water temperature indicator FLASHES. The engine is shutdown and the engine is not allowed to start until the fault is corrected.

Engine Overspeed – The engine speed exceeds the setpoint for engine overspeed that is programmed into the GSC+. When the engine overspeed fault occurs, the engine overspeed indicator FLASHES. The engine is shutdown and the engine is not allowed to start until the fault is corrected.

Overcrank – The engine does not start within the setpoint for total cycle crank time that is programmed into the GSC+. When the overcrank fault occurs, the overcrank indicator FLASHES. The engine is not allowed to start until the fault is corrected.

Note: The GSC+ can be programmed to override the shutdown for low oil pressure and high water temperature faults. When the operator overrides the shutdown faults, the GSC+ responds to the faults as though the faults are alarm faults. The corresponding dedicated shutdown indicator is ON CONTINUOUSLY and will not be flashing. The engine continues to run and can be restarted when necessary. When the dedicated shutdown indicator is ON CONTINUOUSLY, the setpoint for shutdown has been exceeded, but the GSC+ is programmed to override the shutdown fault. The GSC+ does not treat the shutdown fault as a shutdown fault. The GSC+ treats the shutdown fault as an alarm fault. At the factory, the GSC+ is programmed to treat a low oil pressure fault and a high water temperature fault as shutdown faults. The operator or the service technician must decide to override these shutdown faults. The operator or the service technician must program the GSC+ to treat the shutdown faults as alarm faults. For programming procedures, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Display

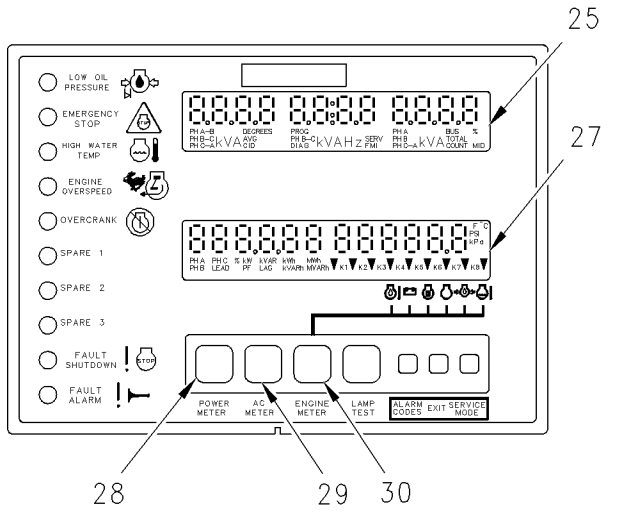

Illustration 58 g00643442

Display Area of the GSC+

(25) Upper display
(27) Lower display
(28) The power meter key
(29) The AC meter key
(30) The engine meter key

The display consists of the upper display and the lower display. Both displays are used for programming functions when in service mode. For more information, see Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Upper display

The upper display (25) shows: AC voltage, current and frequency. Several options are available on the upper display for AC metering. These options can be viewed one at a time by pressing the AC meter key (29) on the keypad. The options are listed below.

- Average voltage, generator frequency and total current
- Line to line voltage, generator frequency and line current for any one phase
- Line to line voltage for all three phases at once
- Line current for all three phases at once

Note: When total current increases above “9999A” , the GSC+ will show current in “kA” units.

- Line to neutral voltage for all three phases at once

Upper display (25) is also used to show the various fault codes for system faults. For more information on fault codes, see Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Note: Line to neutral voltages are not shown when the setpoint P032 is set to 1 for delta generator sets.

Lower display

The lower display (27) shows values for power metering, engine parameters and the relay status.

The left side of the lower display (27) serves as a power meter for the generator set. The following functions will scroll automatically.

- Total real power (kW)
- Total reactive power (KVAR)
- Percentage of rated power (%kW)
- Power factor (average)
- Total energy output (kW/h)

The display will stop scrolling when the operator presses the power meter key for less than five seconds. The display will show a particular parameter continuously. Additional power meter functions will scroll, if the power meter key (28) is held for more than five seconds and then released. The additional functions are shown below.

- Total real power (kW)
- Real power phase A (kW)
- Real power phase B (kW)
- Real power phase C (kW)
- Total apparent power (kVA)
- Total reactive power (KVAR)
- Percentage of rated power (%kW)
- Power factor (average)
- Power factor phase A
- Power factor phase B
- Power factor phase C
- Total energy output (kW/h)
- Total reactive energy output (kVARHr)

Note: All real power values are signed with a “+” or a “−” . A negative value indicates reverse power.

Note: Real power phase A, B, and C as well as power factor phase A, B, and C are not shown when setpoint P032 is set to 1 for delta generator sets.

Note: Total energy output that is greater than 999,999 kW/h will be shown as MW/h in two steps in order to maintain a resolution of 1 kW/h. The first step will show MW/h as a whole number up to six places. The second step will show MW/h as a decimal to three places. For example: 1,000,001 kW/h will be shown as 1000 MW/h (first step), followed by .001 MW/h (second step).

The right side of lower display (27) shows the value of certain engine parameters. The parameters are listed below.

- engine oil temperature (optional)
- system battery voltage
- engine hours
- engine speed
- engine oil pressure
- engine coolant temperature

The value for one of these conditions is shown on the display (27) for two seconds. The display then scrolls to the value for the next condition. A small pointer identifies the engine condition that corresponds to the value that is showing. When the engine meter key (30) is pressed, the lower display (27) stops scrolling. The lower display continuously shows one particular value. The pointer flashes above the value that is showing on the display. When the engine meter key (30) is pressed for the second time, the lower display will return to scrolling.

The relay status indicators are on the bottom of the lower display (27). When a GSC+ relay is activated, the corresponding indicator (K1, K2, etc) is shown on the lower display (27). When a relay is not activated, the corresponding indicator (K1, K2, etc) is not shown. For a description of the relay functions, see the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Keypad

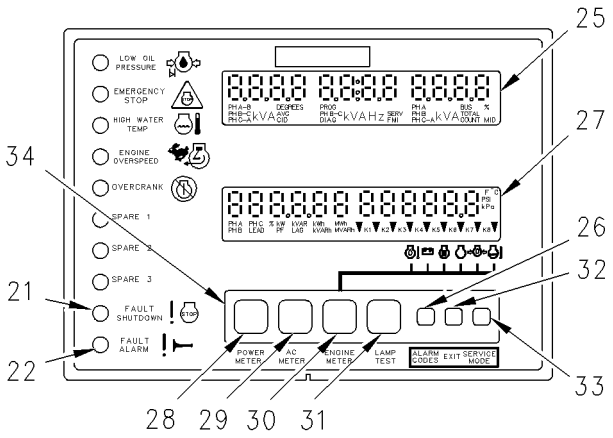

Illustration 59 g00643443

Keypad Area of the GSC+

(21) Fault shutdown indicator
(22) Fault alarm indicator
(25) Upper display
(26) Alarm codes key
(27) Lower display
(28) Power meter key
(29) AC meter key
(30) Engine meter key
(31) Lamp test key
(32) Exit key
(33) Service mode key
(34) Keypad

Keypad (34) is used to control the information that is shown on the upper display (25) and lower display (27). The seven keys have two sets of functions: normal functions and service functions. For a description of the service functions of the keys, see the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”. The normal functions of the keys are described in the following paragraphs.

Power Meter Key (28) – This key controls the viewing of power meter information. This information is shown on the lower display. Pressing the key for at least five seconds causes all the power meter data to scroll once. The default power meter data then resumes scrolling. If this key is pressed for less than five seconds, the display will stop scrolling the power meter functions until the key is pressed again.

AC Meter Key (29) – The AC meter key controls the viewing of the AC parameters on the upper display. Pressing the key causes the display to show a different set of parameters.

Engine Meter Key (30) – This key controls the viewing of engine parameters on the lower display. Pressing the key stops the scrolling of engine conditions. The value for one particular engine condition will show continuously. The pointer flashes indicating that the scrolling is stopped. The scrolling of the engine conditions will resume when the engine meter key is pressed again.

Lamp Test Key (31) – Pressing this key performs a lamp test on the GSC+ and the optional alarm module. On the GSC+, the ten fault indicators are ON CONTINUOUSLY. Every segment of upper display (5) and lower display (6) is ON. On the optional alarm module, all of the indicators are ON and the horn sounds. The lamp test function automatically turns off if an operator presses the key and holds the key for longer than ten seconds.

Alarm Codes Key (26) – If fault alarm indicator (22) is FLASHING, pressing this key causes upper display (25) to show the corresponding alarm fault code. If this key is pressed again, the generator AC output information will be shown on the upper display (25). If fault alarm indicator (22) is OFF, this key has no function.

Exit Key (32) – This key only functions when the GSC+ is in Service Mode. For more information, see the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Service Mode Key (33) – Pressing this key causes the GSC+ to enter service mode. For more information, see the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Alarm Module

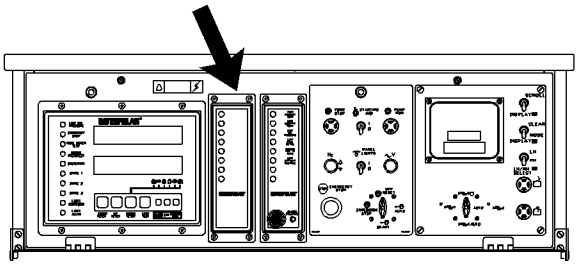

Illustration 60 g00635769

The Location of the Alarm Module (ALM) on the EMCP II+ Control Panel

The alarm module (ALM) is optional. The ALM is located in the center of the control panel. The function of the alarm module is to provide a visual and audible warning of engine conditions before these conditions become severe enough that the engine will shut down or will be unable to start.

One basic alarm module is used to satisfy the requirements for a standby NFPA 99 alarm module, standby NFPA 110 alarm module, NFPA 99 remote annunciator panel, and prime power alarm. This is accomplished by using different inputs to the module and different decals on the front of the module in order to indicate alarms or shutdown conditions. For all wiring and installation information, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”. Refer to the above manual for a listing of indicators and alarm (horn) functions.

The front of the alarm module consists of the following indicators.

- Four amber indicators, which can (depending on module configuration) indicate High Coolant Temperature, Low Coolant Temperature or Low Coolant Level, Low Oil Pressure, Generator On Load, Charger Malfunction, Low Oil Level and Low Fuel Level
- Four red indicators, which can (depending on module configuration) indicate a Not In AUTO condition, Low DC Voltage, Air Damper Closed, Low Oil Pressure Shutdown, Overcrank Shutdown, High Coolant Temperature Shutdown, and Overspeed Shutdown
- An audible alarm and Acknowledge/Silence switch

For more detailed information, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Custom Alarm Module

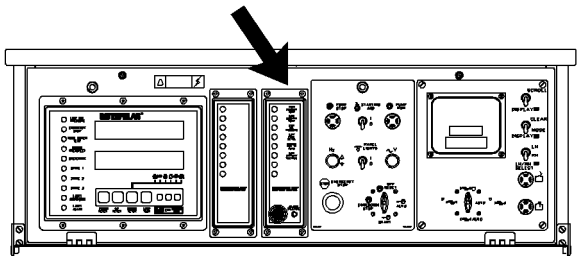

Illustration 61 g00635777

The Location of the Custom Alarm Module (CAM) on the EMCP II+ Control Panel

The custom alarm module (CAM) is optional. The CAM is located in the center of the control panel. The function of the custom alarm module is to provide a visual and audible warning of the conditions of the customer supplied inputs before these conditions become severe enough that the engine will shut down or will be unable to start. The CAM is equipped with a horn, alarm silence switch, a lamp test switch and 8 switched inputs for customer use. For all wiring and installation information, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”. Refer to the above manual for the names of input signals.

The front of the alarm module consists of the following indicators.

- Four amber indicators, which are used to display alarm conditions

- Four red indicators, which are used to display shutdown conditions

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Electronic Modular Control Panel II+ with Paralleling (EMCP II+P) (If Equipped)

SMCS Code: 4490

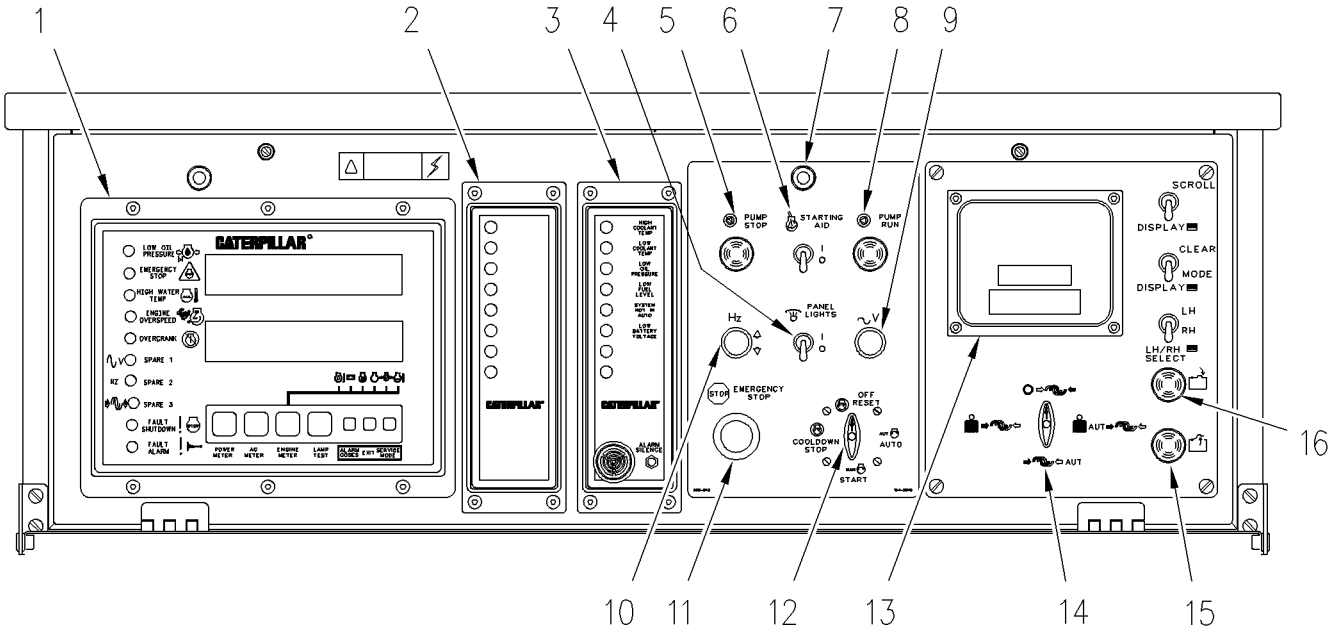

Illustration 62 g00639524

Electronic Modular Control Panel II+ With Paralleling (EMCP II+P)

(1) Generator set control + (GSC+)
(2) Alarm module (ALM) (optional)
(3) Custom alarm module (CAM)
(4) Panel light switch (PLS)
(5) Pump stop switch
(6) Start aid switch (SAS) (optional)
(7) Panel lights (PL)
(8) Pump run switch (optional)
(9) Voltage adjust rheostat (VAR)
(10) Speed potentiometer (SP) (optional) or Governor switch (GS) (optional)
(11) Emergency stop push button (ESPB)
(12) Engine control switch (ECS)
(13) Cat Monitoring System
(14) Synchronization mode switch
(15) Breaker open pushbutton/indicator
(16) Breaker close pushbutton/indicator

The electronic modular control panel II+ with paralleling (EMCP II+P) is located above the generator distribution housing. The control panel consists of a main panel with indicators, meters, and control switches. This control panel may be equipped with optional modules in order to match the needs and requirements of the customer.

The left side of the control panel contains the generator set control + (GSC+). This is the main component of the system. The GSC+ displays generator output, fault conditions and key engine parameters. The center section of the control panel may be blank, or contain one or two of the optional alarm modules. The right side of the control panel may be blank, or contain the Cat Monitoring System.

The main control panel may or may not contain all of the components which are shown in Illustration 62 . Some components are optional. The optional components may not be required for your particular application.

Generator Set Control + (1) – The generator set control + (GSC+) is the main component of the EMCP II+P. See the topic “Generator Set Control + (GSC+)” in this section.

Alarm Module (2) – The alarm module (ALM) is optional. The function of the ALM is to provide a visual and audible warning of engine conditions before these conditions become severe enough to shut down the engine or keep the engine from starting.

Custom Alarm Module (3) – The custom alarm module (CAM) is optional. The purpose of the CAM is to annunciate faults, alarms, or other conditions from customer supplied inputs.

Panel Light Switch (4) – The panel lights switch (PLS) turns the panel lights (7) on or off.

Pump Stop Switch (5) – The pump stop switch is optional with 3406E and 3412C generator sets only. This push-button switch is used with the generator mounted automatic fuel transfer system, if equipped. The pump stop switch is used to stop the fuel transfer pump manually. This switch is latched down when pushed. The red indicator will now be ON. The switch can be reset by pressing the switch again. The red indicator will now be OFF.

Start Aid Switch (6) – The start aid switch (SAS) is optional. The SAS is used to inject ether into the engine when you are starting the engine in cold weather conditions. When the SAS is in the ON position, the switch energizes the starting aid solenoid valve (SASV) and meters a specific amount of ether into a holding chamber. When the SAS is released, the solenoid releases the ether to the engine.

NOTICE
The engine must be cranking before using the start aid switch. Damage to the engine is possible if ether is released to the engine but not exhausted or burned by the engine when cranking.

Panel Lights (7) – Panel lights (PL) are controlled by the panel lights switch (4). The panel lights switch (4) is an ON/OFF switch.

Pump Run Switch (8) – The pump run switch is optional. This momentary push-button switch is used with the generator set mounted automatic fuel transfer system, if equipped. Pushing this switch will cause the generator set mounted fuel transfer pump to fill the generator set day tank. The green indicator will be ON when the pump is running. The pump will automatically shut OFF when the fuel reaches the high fuel level. The pump can also be turned OFF manually by the pump stop switch (5). The pump stop switch must be reset. Reset the pump stop switch by pressing the switch again.

Voltage Adjust Rheostat (9) – The voltage adjust rheostat (VAR) is used to adjust the generator output voltage to the desired level.

Speed Potentiometer (10) – The speed potentiometer (SP) is optional. The SP can be used with the generator set that has an electric governor. When the governor is equipped with a speed adjust motor, the governor switch (GS) can be mounted instead of the SP. The GS is used to raise or lower the engine speed and frequency. The GS is also optional.

Emergency Stop Push Button (11) – The emergency stop push button (ESPB) is used to shut down the engine during an emergency situation. The ESPB shuts off the fuel and activates the optional air shutoff, if equipped.

Engine Control Switch (12) – The engine control switch (ECS) determines the status of the control panel. In the AUTOMATIC position (3 o'clock), the engine will start automatically whenever a remote initiating contact is closed. The engine will shut down after the initiating contact opens and after a programmable cooldown time has elapsed. The cooldown time can be programmed to give a 0 to 30 minute cooldown period before the engine shuts down.

In the MANUAL START position (6 o'clock), the engine will start and run as long as the ECS switch remains in this position.

In the STOP position (9 o'clock), the fuel solenoid shuts down the engine after a programmable cool down time period has elapsed.

In the OFF/RESET position (12 o'clock), the fault lights are reset and the engine shuts down immediately.

Cat Monitoring System (13) – This system is the information center for the engine and related components. See the Operation Section, “Cat Monitoring System” for more information.

Synchronization Mode Switch (14) – The synchronization mode switch (14) is manually operated. The switch has four positions: the AUTO position, the SEMI-AUTO position, the MANUAL (PERMISSIVE) position, and the OFF position. Refer to Illustration 63 .

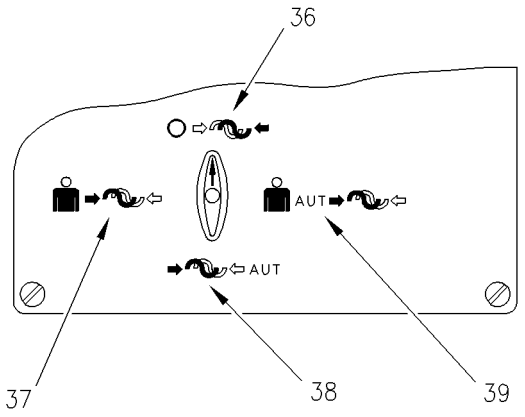

Illustration 63 g00692931

The Synchronization Mode Switch

(36) The OFF position
(37) The MANUAL (PERMISSIVE) position
(38) The AUTO position
(39) The SEMI-AUTO position

The AUTO position (6 o'clock) is used for complete automatic paralleling. The EMCP II+P brings the generator into sync with the bus and sends a signal to close the motor operated breaker. The EMCP II+P supports automatic paralleling to a dead bus. Automatic voltage matching is not provided.

When the synchronizer mode switch is in the SEMI-AUTO position (3 o'clock), the EMCP II+P brings the generator into sync with the bus and holds it there indefinitely. The operator brings the generator online by manually closing the breaker. Automatic voltage matching is not provided.

When the synchronizer mode switch is in the MANUAL (PERMISSIVE) position (9 o'clock), the operator adjusts the frequency and phase of the generator in order to match the bus. When the generator is in sync with the bus, the operator brings the generator online by manually closing the breaker.

When the synchronizer mode switch is in the OFF position (12 o'clock), all paralleling functions are disabled.

Breaker Open Pushbutton/Indicator (15) – When the generator is being taken off-line manually, the breaker open pushbutton must be pressed by the operator in order to open the breaker. When the breaker is open and the engine is running, the breaker open indicator (15) will light continuously.

Breaker Close Pushbutton/Indicator (16) – When the generator is being paralleled semi-automatically or manually, the breaker close pushbutton must be pressed by the operator in order to close the breaker. The system does not allow the breaker to close unless in sync. When the breaker is closed (generator is on line), the breaker close indicator (16) will light continuously.

Below, you can find the descriptions of the following main modules of the EMCP II+P:

- Generator Set Control + (GSC+)
- Alarm Module (ALM)
- Custom Alarm Module (CAM)

Generator Set Control + (GSC+)

Functions and Features of the GSC+

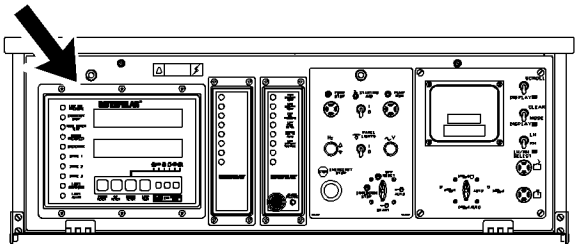

Illustration 64 g00634036

The Location of the GSC+ on the EMCP II+P Control Panel

The left side of the control panel contains the Generator Set Control + (GSC+). The GSC+ is the main component of the system. The GSC+ displays generator output, generator set functions, fault conditions and key engine parameters. The GSC+ accepts information from the operator, magnetic pickup, oil pressure sensor, water temperature sensor and optional remote sources. This information is used to determine the “ON/OFF” state of the engine's air, fuel, and starter.

In the basic operating conditions, the GSC+ receives a signal to run the generator set. The GSC+ turns on the engine's fuel and starter. When the engine speed reaches the crank termination speed, the starter is disengaged. When the GSC+ receives a signal to stop the engine, the GSC+ shuts off the fuel.

The functions of the GSC+ are listed below.

- The GSC+ controls the normal starting and stopping of the engine.

- The GSC+ shows engine conditions and generator output information on two displays. The displays also show fault codes and GSC+ programming information.
- The GSC+ monitors the system for faults. If a fault occurs, the GSC+ performs a controlled fault shutdown or provides a fault alarm annunciation. The GSC+ uses indicators and displays in order to describe the fault.
- The GSC+ contains programmable features for certain applications or customer requirements.

The features of the GSC+ are listed below.

- **Cycle Crank** : The GSC+ can be programmed to crank for adjustable time periods. For programming instructions, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II + (EMCP II +)”.
- **Governor Control** : When the engine oil pressure increases past the low oil pressure set point, the GSC+ will indicate to the governor that the governor should increase the engine speed from idle RPM to rated RPM.
- **Cooldown** : Upon receiving a signal to perform a normal shutdown, the GSC+ will wait a preprogrammed amount of time before shutting the engine down with the fuel control.
- **Automatic Operation** : While in the automatic mode, the GSC+ can be started by a remote initiate signal (contact closure). Upon loss of the signal (contact opening), the GSC+ will perform a normal shutdown.
- **Alarm Module Communication** : The GSC+ can transmit fault and alarm conditions to an alarm module (AM).
- **Power Down** : The EMCP II+P system is designed to remove power from the GSC+ when the engine control switch (ECS) is in the OFF/ RESET mode and when the proper jumper wire is removed. The GSC+ will not power down until the crank termination relay and the fuel control relay are both off for about 70 seconds. If the wire is not removed, the GSC+ will remain powered up. For the wiring diagram and the location of the jumper wire, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II + (EMCP II+)”.
- **Fuel Solenoid Type** : The GSC+ can be programmed to work with either an energized to run (ETR) fuel system or an energized to shut down (ETS) fuel system.

Fault indicators

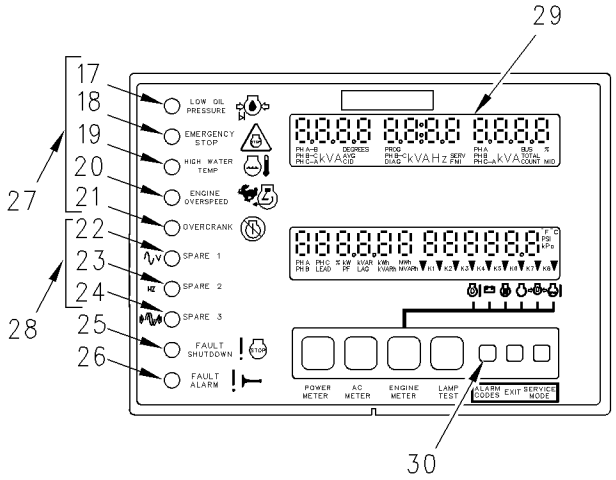

Illustration 65 g00634142

Display Area of the GSC+

(17) Low oil pressure indicator
(18) Emergency stop indicator
(19) High water temperature indicator
(20) Engine overspeed indicator
(21) Overcrank indicator
(22) Spare 1 indicator/Voltage match
(23) Spare 2 indicator/Frequency match
(24) Spare 3 indicator/Phasing match
(25) Fault shutdown indicator
(26) Fault alarm indicator
(27) Dedicated shutdown indicators
(28) Spare fault indicators
(29) Upper display
(30) The alarm codes key

The ten fault indicators are used in order to show and describe a fault that is present. The fault indicators are divided into four groups. The four groups are listed below.

- fault alarm indicator (26)
- fault shutdown indicator (25)
- spare fault indicators (28)
- dedicated shutdown indicators (27)

The yellow fault alarm indicator (26) FLASHES when the GSC+ detects an alarm fault. The alarm fault does not cause the engine status to change. The engine can be started. The engine will continue operating only if the engine is running at the time of the alarm fault. Fault alarm indicator (26) is accompanied by an alarm fault code that is shown on the upper display (29) when the alarm codes key (30) is pressed. For the descriptions of the fault codes, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II + (EMCP II+)”.

The red fault shutdown indicator (25) FLASHES when the GSC+ detects a shutdown fault. The engine will shut down if the engine is running. The engine will not be allowed to start. Fault shutdown indicator (25) is accompanied by a fault code that is immediately shown on the upper display (29). For the descriptions of the fault codes, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II + (EMCP II+)”.

The yellow spare fault indicators (28) can be used for paralleling as a redundant sync check. During the paralleling process and before the circuit breaker is closed, the lamps will indicate if the generator is in sync with the bus. The spare fault indicators are listed below.

- generator voltage match (spare 1 indicator)
- generator frequency match (spare 2 indicator)
- generator phasing match (spare 3 indicator)

If the generator parameters are not matched to the bus, the associated lamp will flash. When the generator and bus voltages, frequencies and phases are in sync, the lamps will light continuously.

When the control panel is not in a paralleling mode, the same three spare fault indicators (28) can be programmed by the customer. The three spare faults can be programmed to show coolant loss, oil temperature, spare fault condition, or no assignment. The yellow spare fault indicators (28) FLASH when the conditions that are associated with that spare fault are active. The yellow fault alarm indicator (26) or the red fault shutdown indicator (25) will accompany the spare fault indicators (28). The spare fault indicators will tell whether the spare fault input is programmed to be an alarm condition or a shutdown condition. For the descriptions of the fault codes, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II + (EMCP II+)”.

The red dedicated shutdown indicators (27) represent the following shutdown faults: low oil pressure, emergency stop, high water temperature, engine overspeed, and engine overcrank. When the GSC+ detects a fault in one of these areas, the dedicated shutdown indicator corresponding to the fault FLASHES. The engine is shut down if the engine is running, and the engine is not allowed to start. No fault codes are associated with the dedicated shutdown indicators because each indicator has a descriptive label.

Many of the dedicated shutdown faults depend on certain setpoints in the GSC+. For the descriptions of the fault codes, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II + (EMCP II+)”.

The conditions that are required to activate the dedicated fault shutdowns and the results of each dedicated fault are in the following list.

Low Oil Pressure – The engine oil pressure drops below the setpoints for low oil pressure shutdown that are programmed into the GSC+. There are two low oil pressure setpoints. One setpoint is used when the engine is at idle speed. The other setpoint is used when the engine is at rated speed. When a low oil pressure fault occurs, the low oil pressure indicator FLASHES, and the engine is shut down. The engine is not allowed to start until the fault is corrected.

Emergency Stop – The operator presses the Emergency Stop Push Button (ESPB) on the front panel. When an emergency stop condition occurs, the emergency stop indicator FLASHES and the engine is shut down. The engine is not allowed to start until the condition is corrected.

High Water Temperature – The engine coolant temperature rises above the setpoint for high water temperature shutdown that is programmed into the GSC+. When the high water temperature fault occurs, the high water temperature indicator FLASHES. The engine is shut down and the engine is not allowed to start until the fault is corrected.

Engine Overspeed – The engine speed exceeds the setpoint for engine overspeed that is programmed into the GSC+. When the engine overspeed fault occurs, the engine overspeed indicator FLASHES. The engine is shut down and the engine is not allowed to start until the fault is corrected.

Overcrank – The engine does not start within the setpoint for total cycle crank time that is programmed into the GSC+. When the overcrank fault occurs, the overcrank indicator FLASHES. The engine is not allowed to start until the fault is corrected.

Note: The GSC+ can be programmed to override the shutdown for low oil pressure and high water temperature faults. When the operator overrides the shutdown faults, the GSC+ responds to the faults as though the faults are alarm faults. The corresponding dedicated shutdown indicator is ON CONTINUOUSLY and will not be flashing. The engine continues to run and can be restarted when necessary. When the dedicated shutdown indicator is ON CONTINUOUSLY, the setpoint for shutdown has been exceeded, but the GSC+ is programmed to override the shutdown fault. The GSC+ does not treat the shutdown fault as a shutdown fault. The GSC+ treats the shutdown fault as an alarm fault. At the factory, the GSC+ is programmed to treat a low oil pressure fault and a high water temperature fault as shutdown faults. The operator or the service technician must decide to override these shutdown faults. The operator or the service technician must program the GSC+ to treat the shutdown faults as alarm faults. For programming procedures, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Display

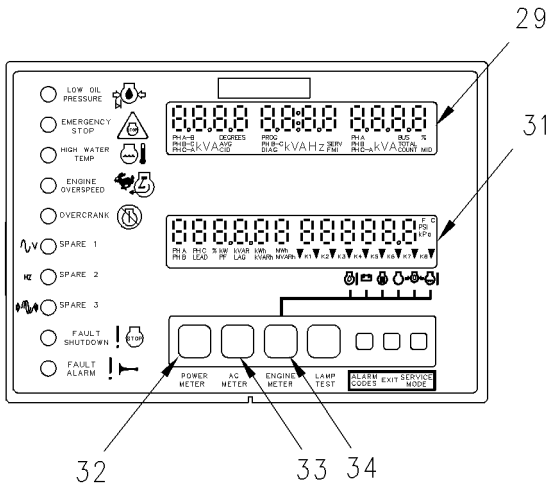

Illustration 66 g00634182

Display Area of the GSC+

(29) Upper display
(31) Lower display
(32) The power meter key
(33) The AC meter key
(34) The engine meter key

The display consists of the upper display and the lower display. Both displays are used for programming functions when in service mode. For more information, see the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Upper display

The EMCP II+P upper display (29) displays voltage and frequency. The voltage and frequency alternate between the generator output and the bus. The word “bus” or “gen” appears in the right side of the window. This word indicates which parameter is displayed.

Several options are available on the upper display for AC metering. These options can be viewed one at a time by pressing the AC meter key (33) on the keypad. The options are listed below.

- Average voltage, generator frequency and total current
- Line to line voltage, generator frequency and line current for any one phase
- Line to line voltage for all three phases at once
- Line current for all three phases at once

Note: When total current increases above “9999A” , the GSC+ will show current in “kA” units.

- Line to neutral voltage for all three phases at once

Upper display (29) is also used to show the various fault codes for system faults. For more information on fault codes, see the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Note: Line to neutral voltages are not shown when the setpoint P032 is set to 1 for delta generator sets.

Lower display

The EMCP II+P lower display (31) displays the synchronoscope. This unique display allows a simultaneous visual indication of both frequency and phase of the generator set, in reference to the bus. Additionally, the three spare indicator lamps are used to indicate the synchronization status.

The lower display (31) shows values for power metering, engine parameters, and the relay status.

The left side of the lower display (31) serves as a power meter for the generator set. The following functions will scroll automatically.

- Total real power (kW)
- Total reactive power (KVAR)
- Percentage of rated power (%kW)

- Power factor (average)
- Total energy output (kW/h)

The display will stop scrolling when the operator presses the power meter key for less than 5 seconds. The display will show a particular parameter continuously. Additional power meter functions will scroll if the power meter key (32) is held for more than 5 seconds and then released. The additional functions are shown below.

- Total real power (kW)
- Real power phase A (kW)
- Real power phase B (kW)
- Real power phase C (kW)
- Total apparent power (kVA)
- Total reactive power (KVAR)
- Percentage of rated power (%kW)
- Power factor (average)
- Power factor phase A
- Power factor phase B
- Power factor phase C
- Total energy output (kW/h)
- Total reactive energy output (kVARHr)

Note: All real power values are signed with a “+” or a “−” . A negative value indicates reverse power.

Note: Real power phase A, B, and C as well as power factor phase A, B, and C are not shown when setpoint P032 is set to 1 for delta generator sets.

Note: Total energy output that is greater than 999,999 kW/h will be shown as MW/h in two steps in order to maintain a resolution of 1 kW/h. The first step will show MW/h as a whole number up to six places. The second step will show MW/h as a decimal to three places. For example: 1,000,001 kW/h will be shown as 1000 MW/h (first step), followed by .001 MW/h (second step).

The right side of lower display (31) shows the value of certain engine parameters. The parameters are listed below.

- engine oil temperature (optional)
- system battery voltage
- engine hours
- engine speed
- engine oil pressure
- engine coolant temperature

The value for one of these conditions is shown on the display (31) for two seconds. The display then scrolls to the value for the next condition. A small pointer identifies the engine condition that corresponds to the value that is showing. When the engine meter key (34) is pressed, the lower display (31) stops scrolling. The lower display continuously shows one particular value. The pointer flashes above the value that is showing on the display. When the engine meter key (34) is pressed for the second time, the lower display will return to scrolling.

The relay status indicators are on the bottom of the lower display (31). When a GSC+ relay is activated, the corresponding indicator (K1, K2, etc) is shown on lower display (31). When a relay is not activated, the corresponding indicator (K1, K2, etc) is not shown. For a description of the relay functions, see the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Keypad

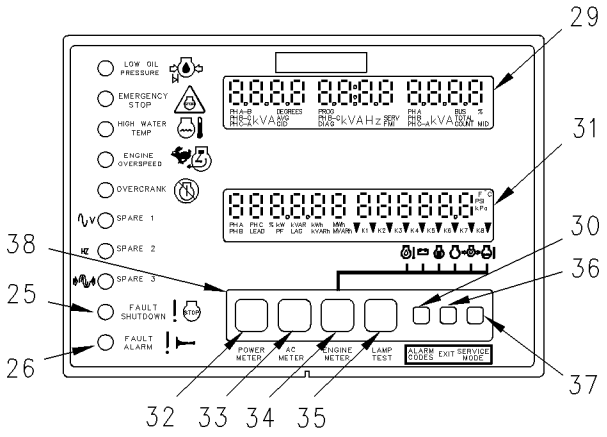

Illustration 67 g00634183

Keypad Area of the GSC+

(25) Fault shutdown indicator
(26) Fault alarm indicator
(29) Upper display
(30) Alarm codes key
(31) Lower display
(32) Power meter key
(33) AC meter key
(34) Engine meter key
(35) Lamp test key
(36) Exit key
(37) Service mode key
(38) Keypad

Keypad (38) is used to control the information that is shown on upper display (29) and lower display (31). The seven keys have two sets of functions: normal functions and service functions. For a description of the service functions of the keys, see the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”. The normal functions of the keys are described in the following paragraphs.

Alarm Codes Key (30) – If fault alarm indicator (26) is FLASHING, pressing this key causes the upper display (29) to show the corresponding alarm fault code. If this key is pressed again, the generator AC output information will be shown on the upper display (29). If fault alarm indicator (26) is OFF, this key has no function.

Power Meter Key (32) – This key controls the viewing of power meter information. This information is shown on the lower display. Pressing the key for at least five seconds causes all the power meter data to scroll once. The default power meter data then resumes scrolling. If this key is pressed for less than 5 seconds, the display will stop scrolling the power meter functions until the key is pressed again.

AC Meter Key (33) – The AC meter key controls the viewing of the AC parameters on the upper display. Pressing the key causes the display to show a different set of parameters.

Engine Meter Key (34) – This key controls the viewing of engine parameters on the lower display. Pressing the key stops the scrolling of engine conditions. The value for one particular engine condition will show continuously. The pointer flashes indicating that the scrolling is stopped. The scrolling of the engine conditions will resume when the engine meter key is pressed again.

Lamp Test Key (35) – Pressing this key performs a lamp test on the GSC+ and the optional alarm module. On the GSC+, the ten fault indicators are ON CONTINUOUSLY. Every segment of upper display (5) and lower display (6) is ON. On the optional alarm module, all of the indicators are ON and the horn sounds. The lamp test function automatically turns off if an operator presses the key and holds the key for longer than 10 seconds.

Exit Key (36) – This key only functions when the GSC+ is in Service Mode. For more information, see the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Service Mode Key (37) – Pressing this key causes the GSC+ to enter service mode. For more information, see the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Alarm Module

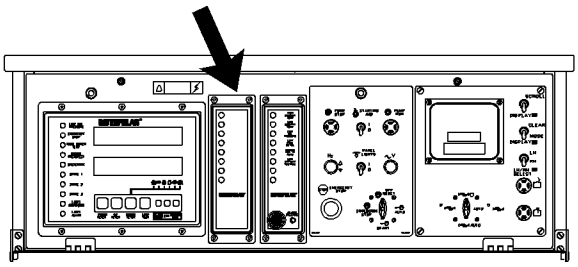

Illustration 68 g00635769

The Location of the Alarm Module (ALM) on the EMCP II+P Control Panel

The alarm module (ALM) is optional. The ALM is located in the center of the control panel. The function of the alarm module is to provide a visual and audible warning of engine conditions before these conditions become severe enough that the engine will shut down or will be unable to start.

One basic alarm module is used to satisfy the requirements for a standby NFPA 99 alarm module, standby NFPA 110 alarm module, NFPA 99 remote annunciator panel, and prime power alarm. This is accomplished by using different inputs to the module and different decals on the front of the module in order to indicate alarms or shutdown conditions. For all wiring and installation information, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”. Refer to the above manual for a listing of indicators and alarm (horn) functions.

The front of the alarm module consists of the following indicators.

- Four amber indicators, which can (depending on module configuration) indicate High Coolant Temperature, Low Coolant Temperature or Low Coolant Level, Low Oil Pressure, Generator On Load, Charger Malfunction, Low Oil Level, and Low Fuel Level
- Four red indicators, which can (depending on module configuration) indicate a Not In AUTO condition, Low DC Voltage, Air Damper Closed, Low Oil Pressure Shutdown, Overcrank Shutdown, High Coolant Temperature Shutdown, and Overspeed Shutdown
- An audible alarm and Acknowledge/Silence switch

For more detailed information, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”.

Custom Alarm Module

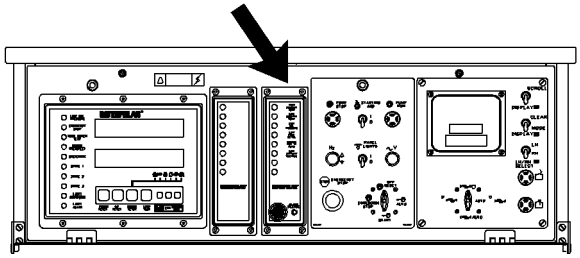

Illustration 69 g00635777

The Location of the Custom Alarm Module (CAM) on the EMCP II+P Control Panel

The Custom Alarm Module (CAM) is located in the center of the control panel. The function of the custom alarm module is to provide a visual and audible warning of the conditions of the customer supplied inputs before these conditions become severe enough that the engine will shut down or will be unable to start. The CAM has eight indicators, an audible horn, acknowledge/silence switch, and the lamp test switch. Four of the indicator lamps are yellow. These yellow indicator lamps are used to indicate a fault shutdown. For all wiring and installation information, refer to the Systems Operation, Testing and Adjusting, RENR2484, “Electronic Modular Control Panel II+ (EMCP II+)”. Refer to the above manual for the names of input signals.

Note: If an optional alarm module is ordered, the audible horn, acknowledge/silence switch, and lamp test switch will come standard with the optional alarm module.

The front of the alarm module consists of the following indicators.

- Four amber indicators, which are used to display alarm conditions

- Four yellow indicators, which are used to display shutdown conditions

i02363881

Electronic Modular Control Panel 3 (EMCP 3)
(If Equipped)

SMCS Code: 4490

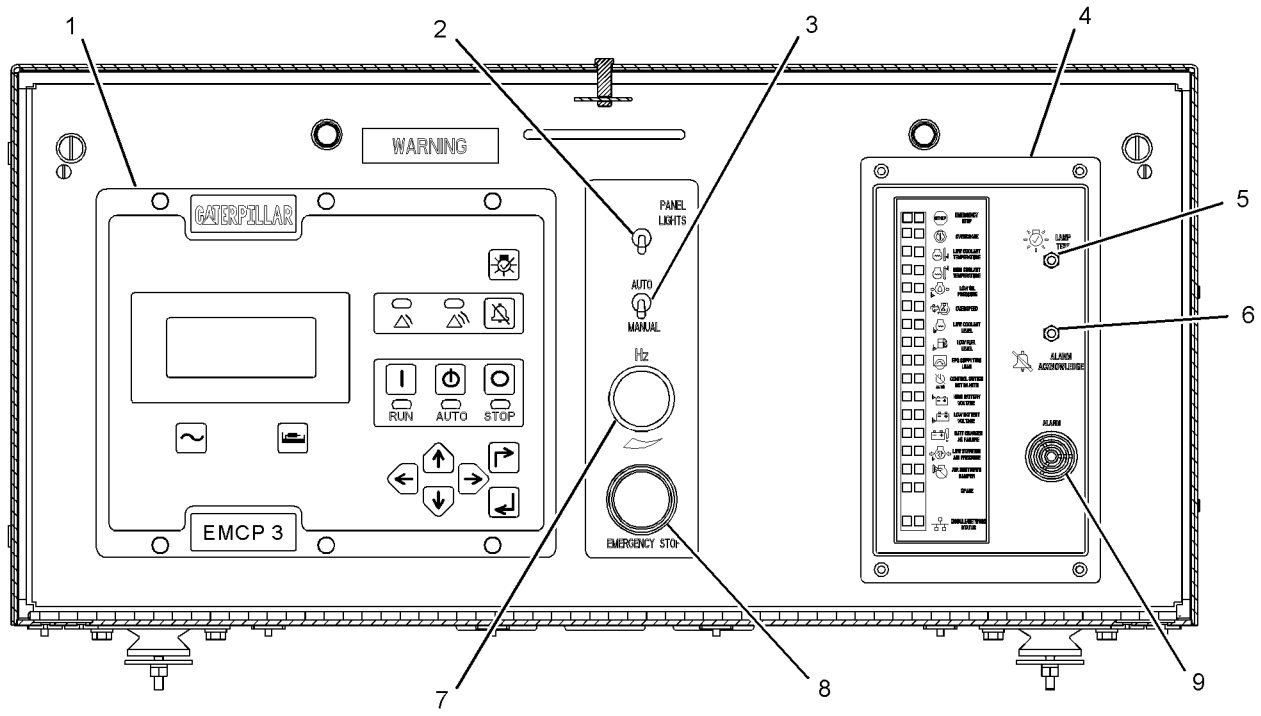

Illustration 70 g01101389

View of EMCP 3

(1) Electronic Control Module (ECM) for the Generator Set
(2) Panel Light Switch
(3) Starting Aid Auto/Manual Switch (optional)
(4) Annunciator Module
(5) Lamp Test Switch
(6) Alarm Acknowledge Switch
(7) Speed Potentiometer (optional)
(8) Emergency Stop Push Button
(9) Alarm Horn

For detailed information about the control panel, see Systems Operation, Troubleshooting, Testing and Adjusting, RENR7902, “3508B, 3512B, 3516 and 3516B Engines EMCP3”.

Electronic Control Module (Generator Set)

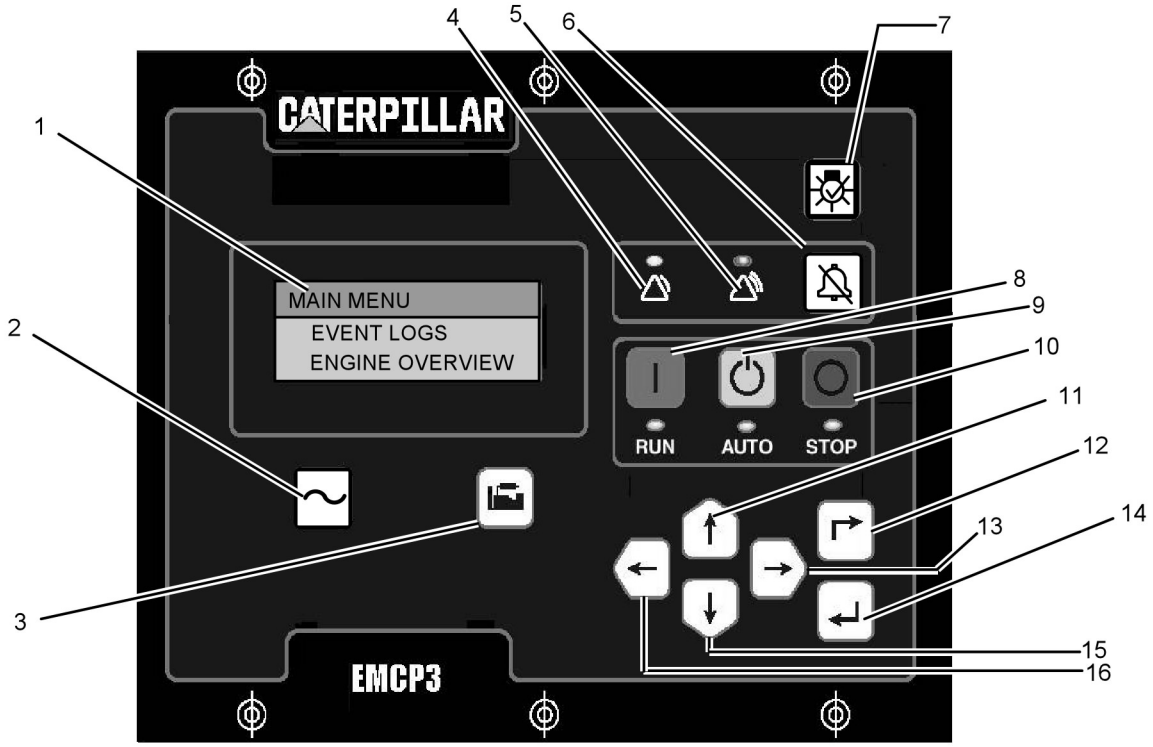

Illustration 71 g01045431

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

Navigation Keys

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

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

Acknowledge Key (6) – Pressing the “ACKNOWLEDGE” key will cause the horn relay to turn off. This will silence the horn. Pressing this key will also cause any red or yellow flashing lights to either turn off or to come on continuously, depending on the active status of the alarms. The “ACKNOWLEDGE” key may also be configured to send out a global alarm silence on the J1939 Data Link, which will silence the horns on the annunciators.

Lamp Test Key (7) – Pressing and holding the “LAMP TEST” key will cause each LED and the display screen pixels to turn on continuously until the key is released.

RUN Key (8) – Pressing the “RUN” key will cause the engine to enter the “RUN” mode.

AUTO Key (9) – Pressing the “AUTO” key will cause the engine to enter the “AUTO” mode.

STOP Key (10) – Pressing the “STOP” key will cause the engine to enter the “STOP” mode.

Up Key (11) – The “UP” key is used to navigate through the various menus and monitoring screens. The “UP” key is also used when a setpoint is entered. When entering numeric data, the “UP” key is used in order to increment the digits (0-9). If the setpoint

requires selection from a list, the “UP” key is used to navigate UP through the list.

Escape Key (12) – The “ESCAPE” key is used in order to navigate through the menus. When the key is pressed, the user moves backward or the user moves upward through the menus. The “ESCAPE” key is also used to exit out of entering data when the user is programming the setpoints. If the “ESCAPE” key is pressed while the users is programming the setpoints, none of the changes made on the screen will be saved to memory.

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

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

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

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

Alarm Indicators

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

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

Digital Inputs

Note: There are 8 digital inputs on “EMCP 3.2” and “EMCP 3.3” . There are 6 digital inputs on “EMCP 3.1” .

Digital Input 1 – Digital Input 1 is used for the emergency stop. This input should be wired to GROUND through an Emergency Stop switch. The input can be set to activate on an active high (normally closed contact) or an active low (normally open contact). Activating the emergency stop input will cause the generator set to stop immediately. The emergency stop input will also prevent the generator set from starting. Once Digital Input 1 goes active, the engine will not start until the event is cleared. Refer to System Operation, Troubleshooting, Testing and Adjusting, “Digital Input Resetting”.

Digital Input 2 – Digital Input 2 is used for remotely starting and stopping the generator set. This input should be wired to GROUND through a switch that can be initiated remotely. The input can be set to activate on an active high (normally closed contact) or an active low (normally open contact). If the input is active and the engine is in AUTO, the engine will attempt to start. Once the input becomes inactive the engine will enter into cooldown (if programmed) and then stop.

The remainder of the inputs can be configured. The main purpose for the other “DIGITAL” inputs is to add additional monitoring capabilities of the parameters for the engine or generator. The inputs can be configured by going to the “EVENT I/P FUNCTIONS” parameter under the “SETPOINTS” menu. The “DIGITAL INPUTS” parameter can only be set to “ACTIVE HIGH” or “ACTIVE LOW” in order to initiate a High Warning, Low Warning, High Shutdown, Low Shutdown, or Status.

The inputs can be programmed to monitor the following parameters or components. Refer to System Operation, Troubleshooting, Testing and Adjusting, “Digital Input Programming”.

Pressures

- Air Filter Differential Pressure
- Engine Oil Pressure
- Fire Extinguisher Pressure
- Fuel Filter Differential Pressure
- Oil Filter Differential Pressure
- Starting Air Pressure

Temperatures

- Ambient Air Temperature
- Engine Coolant Temperature
- Engine Oil Temperature
- Exhaust Temperature
- Rear Bearing Temperature
- Right Exhaust Temperature
- Left Exhaust Temperature

Levels

- Engine Coolant Level
- Engine Oil Level
- Fuel Level
- External Fuel Tank Level

Other

- Air Damper Closed
- ATS in Normal Position
- ATS in Emergency Position
- Battery Charger Failure
- Generator Breaker Closed
- Utility Breaker Closed
- Fuel Leak Detected
- Custom Event

For detailed information about the electronic control module, see Systems Operation, Troubleshooting, Testing and Adjusting, RENR7902, “3508B, 3512B, 3516 and 3516B Engines EMCP3”.

Annunciator Module

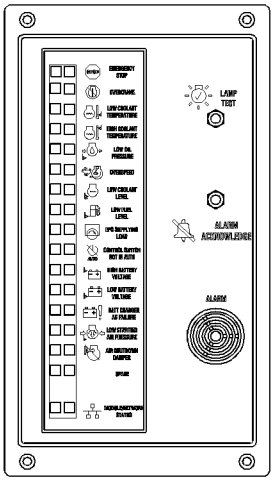

Illustration 72 g01101388

General Information

The annunciator module is used to indicate various system events and conditions. The annunciator module uses indicator lights and an audible horn to give the operator information about the current status of the system. The annunciator module can be used to announce faults and/or status signals to the operator. The annunciator module allows the operator to silence the horn. The annunciator module also allows the operator to acknowledge faults to the system.

There are seventeen pair of LED indicators on the annunciator's front panel. Sixteen pair of LED indicators are used to announce events, diagnostics, and ready signals. The seventeenth pair of LED indicators is used as a combined network/module status LED. The seventeenth pair of LED indicators can tell the operator if there is a problem with the J1939 data link connection.

Basic Operation

Each pair of LED indicators on the annunciator consists of two of the following three colors: green, yellow and red. For example, a pair of red and yellow LED indicators may be configured for engine oil pressure. If a low engine oil pressure warning is read over the data link, the annunciator will flash the yellow LED and the audible horn will sound. If the low engine oil pressure shutdown is read over the data link, the annunciator will flash the red LED and the audible horn will sound.

To acknowledge the shutdown and alarm conditions or to silence the horn, press the “Alarm Acknowledge” button that is located near the middle of the annunciator.

To test the LED indicators or to test the horn when the data link is connected or the data link is disconnected, hold in the “Lamp Test” button that is located near the top of the annunciator.

Configuration

The annunciator module can be customized in order to signal many different conditions that are related to the system. Each pair of LEDs must be configured by using the appropriate service tool. Once the service tool has been connected to the annunciator, the user must enter the “Configuration” screen. Each pair of LEDs has four settings: SPN, Trigger Type, Trigger Severity Level and Failure Mode Identifier (FMI).

For detailed information about the annunciator module, see Systems Operation, Troubleshooting, Testing and Adjusting, RENR7902, “3508B, 3512B, 3516 and 3516B Engines EMCP3”.

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Electronic Modular Control Panel 4 (EMCP 4)

(EMCP 4.1/4.2 If equipped)

SMCS Code: 4490

Electronic Control Module (Generator Set)

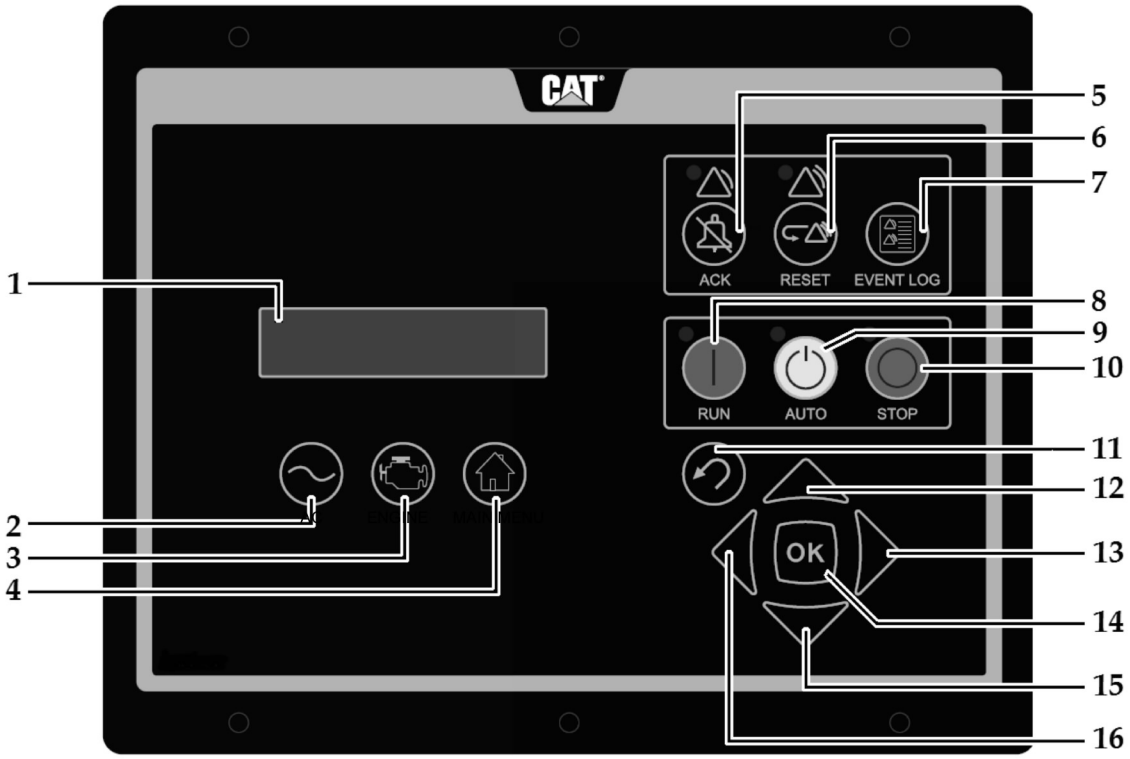

Illustration 73 g02082653

EMCP 4 Control System Panel

(1) Display screen
(2) AC overview key
(3) Engine overview key
(4) Main menu key
(5) Alarms acknowledge key
(6) Reset shut down Key
(7) Event log
(8) Run key
(9) Auto key
(10) Stop key
(11) Escape key
(12) Up key
(13) Right key
(14) OK key
(15) Down key
(16) Left key

Navigation Keys

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Alarm Indicators

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

Red Shutdown Lamp – A red shutdown lamp is located above the “RESET” key. A flashing red light indicates that there are active shutdowns that have not been acknowledged. A continuous red light indicates that there are active shutdowns that have been acknowledged. If there are any active shutdowns, the red light will change from flashing red to continuous red after the “ACKNOWLEDGE” key is pressed. Any condition that has caused a shutdown must be manually reset. If there are no longer any active shutdowns, the red light will turn off.

Digital Inputs

There are several digital inputs and outputs on “EMCP 4.1” and “EMCP 4.2” . For detailed information about the inputs on this electronic control module, see Systems Operation, Troubleshooting, Testing, and Adjusting, UENR1209, “EMCP4.1/4.2”.

Control Panel

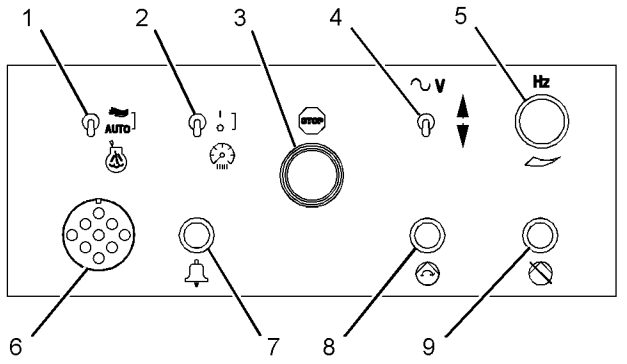

Illustration 74 g01185966

(1) Starting aid auto/manual switch (if equipped)
(2) Panel light switch
(3) Emergency stop push button
(4) Voltage adjust switch (if equipped)
(5) Speed potentiometer (if equipped)
(6) Customer connection (if equipped)
(7) Horn (if equipped)
(8) Pump run switch (if equipped)
(9) Pump stop switch (if equipped)

Starting Aid Auto/Manual Switch (1) – The starting aid switch is optional. The starting aid switch is used to inject ether into the engine when you are starting the engine in cold-weather conditions. When the starting aid switch is in the ON position, the solenoid valve is energized. The switch then meters a specific amount of ether into a holding chamber. When the starting aid switch is released, the solenoid releases the ether to the engine.

Panel Light Switch (2) – The panel lights switch turns on or the panel lights switch turns off the panel lights.

Emergency Stop Push Button (3) – The emergency stop push button (ESPB) is used to shut down the engine during an emergency situation. If equipped, the ESPB shuts off the fuel and the ESPB activates the optional air shutoff.

Voltage Adjust Switch (4) – This switch can be used to raise the voltage. The switch can also be used to lower the voltage.

Speed Potentiometer (5) – The speed potentiometer is optional. The speed potentiometer can be used with the generator set that has an electronic governor.

Customer Connection (6) – The customer connection is a 9-pin connector for connecting the Cat Electronic Technician.

Horn (7) – The horn provides an audible alarm.

Pump Run Switch (if equipped)(8) – Under normal circumstances, the fuel transfer process is automatic. In some instances, a manual operation may be required. Press the pump run switch once in order to start the pump manually.

Pump Stop Switch (if equipped)(9) – The pump stop switch is a push-button switch that locks into position. The pump stop switch will stop the pump if the switch is locked into position. Releasing the switch will place the pump back into the run mode.

Annunciator Module

Illustration 75 g02111119

(20) Alarm acknowledge button

General Information

The annunciator module is used to indicate various system events and conditions. The annunciator module uses indicator lights and an audible horn to give the operator information about the status of the system. The annunciator module can be used to announce faults and/or status signals to the operator. The annunciator module allows the operator to silence the horn. The annunciator module also allows the operator to acknowledge faults to the system.

There are 17 pairs of LED indicators on the front panel of the annunciator. The 16 pairs of LED indicators are used to announce events, diagnostics, and ready signals. The 17th pair of LED indicators is used as a combined network/module status LED. The 17th pair of LED indicators can tell the operator if there is a problem with the J1939 data link connection.

Basic Operation

Each pair of LED indicators on the annunciator consists of two of the following three colors: green, yellow and red. For example, a pair of red and yellow LED indicators may be configured for engine oil pressure. If a low engine oil pressure warning is read over the data link, the annunciator will flash the yellow LED. The audible horn will then sound. If the low engine oil pressure shutdown is read over the data link, the annunciator will flash the red LED. The audible horn will then sound.

To acknowledge the shutdown and alarm conditions or to silence the horn, press the “Alarm Acknowledge” button (20).

To test the LED indicators or the horn when the data link is either connected or disconnected, hold the “Lamp Test” button in.

Configuration

The annunciator module can be customized in order to signal many different conditions that are related to the system. Each pair of LEDs must be configured by using the appropriate service tool. Once the service tool has been connected to the annunciator, the user must enter the “Configuration” screen. Each pair of LEDs has four settings: SPN, Trigger Type, Trigger Severity Level and Failure Mode Identifier (FMI).

For detailed information about the annunciator module, see Systems Operation, Troubleshooting, Testing, and Adjusting, UENR1209, “EMCP4.1/4.2”.

Control Cabinet (If Equipped)

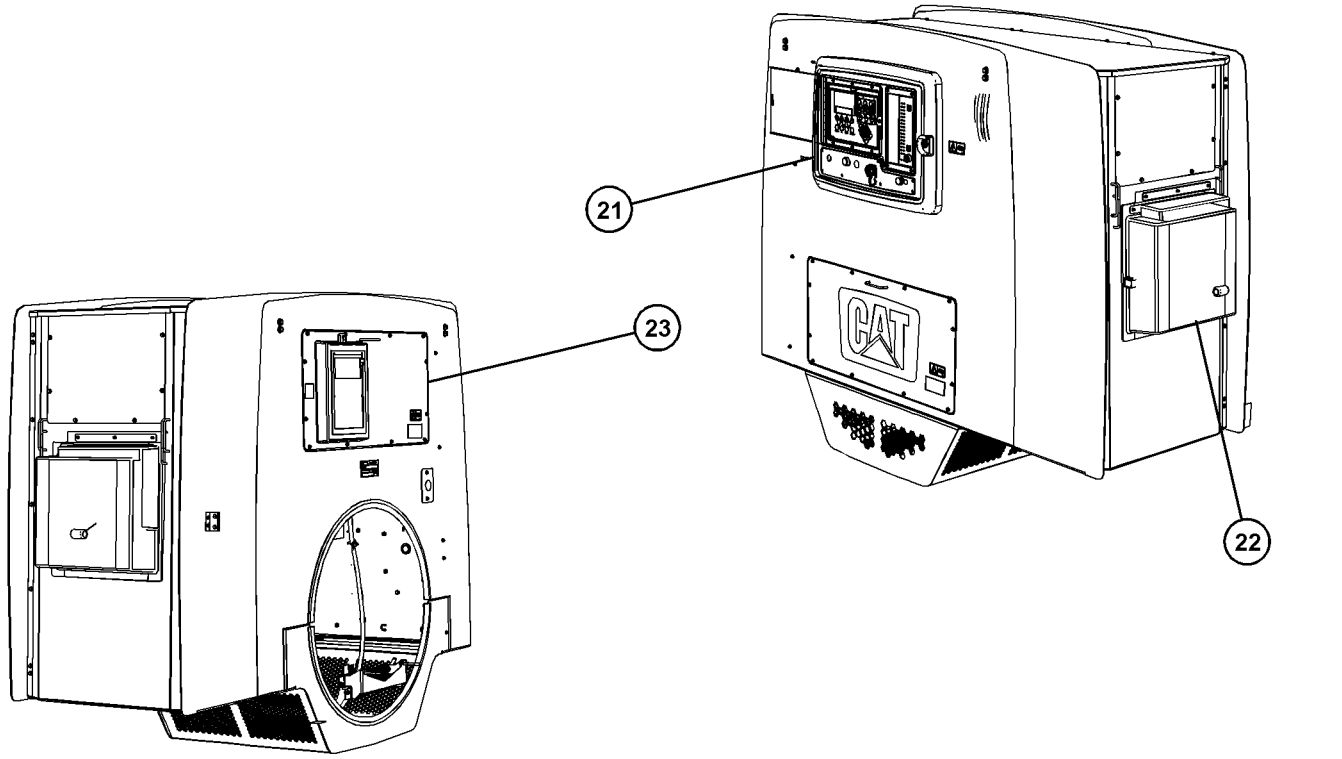

Illustration 76 g06017850

(21) Electronic Modular Control Panel (EMCP)
(22) Circuit breaker
(23) Access panel

i03646563

Battery Disconnect Switch (If Equipped)

SMCS Code: 1411; 1411-B11

The battery disconnect switch and the engine start switch perform different functions. Turn off the battery disconnect switch in order to disable the entire electrical system. The battery remains connected to the electrical system when you turn off the engine start switch.

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

Also turn the battery disconnect switch to the OFF position and remove the key when the engine will not be used for an extended period of a month or more. This will prevent drainage of the battery.

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

To ensure that no damage to the engine occurs, verify that the engine is fully operational before cranking the engine. Do not crank an engine that is not fully operational.

Perform the following procedure in order to check the battery disconnect switch for proper operation:

1. With the battery disconnect switch in the ON position, verify that electrical components are functioning. Verify that the hour meter is displaying information. Verify that the engine will crank.
2. Turn the battery disconnect switch to the OFF position.

3. Verify that the following items are not functioning: electrical components, hour meter and engine cranking. If any of the items continue to function with the battery disconnect switch in the OFF position, consult your Caterpillar dealer.

i01927889

Engine Shutoffs and Engine Alarms

SMCS Code: 1900; 7400; 7418

Shutoff and Alarm Systems

Shutoffs and alarms are electrically operated or mechanically operated. The operation of all electric shutoffs and alarms utilize components which actuate switches in a sensing unit.

Shutoffs are set at more critical levels for the operating temperature, operating pressure, operating coolant level, and operating speed (rpm) than the alarms. The particular shutoff may need to be reset before the engine will start.

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

Be familiar with the following items:

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

Alarm switches consist of a sensor and a contactor. Examples of sensors are the magnetic pickup for detecting speed, and the pressure and temperature sensors. Sensors are wired to contactors. The contactors activate alarm circuits in the annunciator panel.

Alarm switches are set at less critical levels than the shutoffs. The alarms warn the operator that an unsafe operating condition is occurring. The engine will continue to run when an alarm sounds.

When an alarm is activated, corrective measures must be taken before the situation becomes an emergency in order to avoid possible engine damage. If corrective measures are not taken within a reasonable time, engine damage could result. Alternatively, a corresponding shutdown device (if equipped) will stop the engine. The alarm will continue until the condition is corrected or the alarm is reset by the operator.

A switch may be installed in the alarm circuit for silencing the alarm while the engine is stopped for repairs. Before starting, be sure that the switch is moved to the closed ON. Be sure that the warning lamps will operate. The engine will not be protected if the switch is left in the open OFF position.

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

Air Shutoff Solenoid (If Equipped)

This optional solenoid is located on top of the engine. The air shutoff is part of the air inlet system. When the solenoid is activated, the solenoid mechanically shuts off the inlet air to the engine. The solenoid can be activated only by the overspeed switch or by the emergency stop push button (ESPB). The air shutoff must be reset before the engine is restarted.

Fuel Shutoff Solenoid

The fuel shutoff solenoid is located on the governor or the fuel shutoff solenoid is located on the fuel injection pump. When the fuel shutoff solenoid is activated, the solenoid moves the fuel rack “OFF” . The fuel shutoff solenoid moves the fuel rack directly or the fuel shutoff solenoid moves the fuel rack through the governor.

Mechanical Oil Pressure and Water Temperature Shutoff

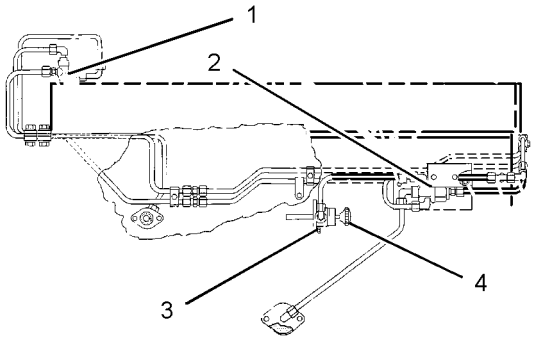

Illustration 77 g01009004

(1) Water temperature sensing valve
(2) Oil pressure sensing valve
(3) Shutdown cylinder
(4) Shutdown cylinder knob

A mechanical shutoff system (if equipped) provides protection for low oil pressure and for high water temperature. The main components are a water temperature sensing valve (1), a oil pressure sensing valve (2), and a shutdown cylinder (3). Pull out the shutdown cylinder knob (4) while you start the engine. Hold the knob out until the engine develops enough oil pressure. When the engine has developed enough pressure, the knob will stay in place. If low oil pressure or if high water temperature is sensed, the knob will be released and the plunger in the governor housing will hold the fuel rack in the “FUEL OFF” position.

Oil Pressure Switches

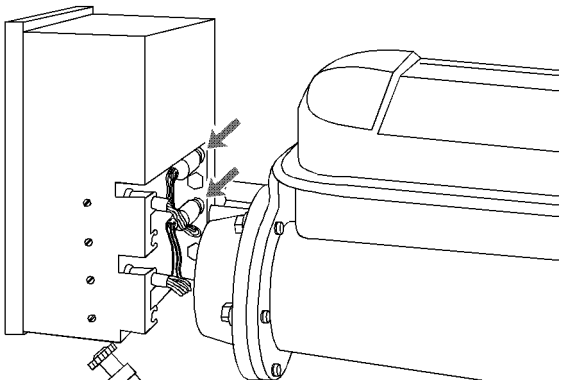

Illustration 78 g01008923

Typical example

An oil pressure switch has wires that are connected to the electrical system for the alarm and/or for the shutoff. The oil pressure switch senses oil pressure at the bearing oil gallery. If sufficient oil pressure is not achieved after engine starting, or if the engine is running and then loses oil pressure, the fuel shutoff solenoid is energized to shut the engine off. No resetting procedure is required.

Engine Step Oil Pressure

This is an adjustable engine speed setting that protects the engine from a failure that is caused by too little oil pressure for a specified speed range. This option requires two different oil pressure switches. One switch has a high pressure rating. When the engine is running above the speed setting, the engine must maintain oil pressure higher than the rating of the switch. The other switch has a low pressure rating. When the engine is running below the speed setting, the engine must maintain oil pressure above the rating of the switch. In an automatic start/stop system, an automatic reset switch is used.

Overspeed Shutoffs

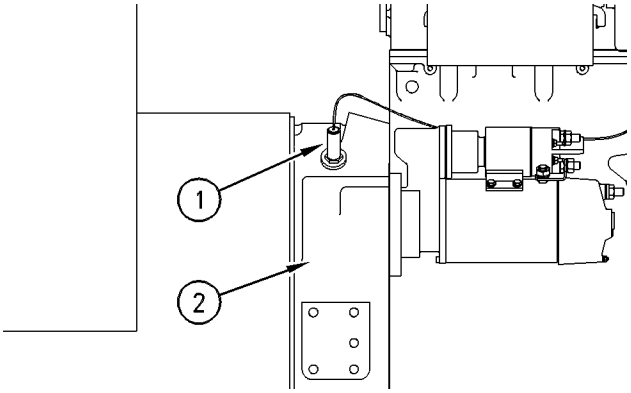

Illustration 79 g00293335

(1) Magnetic pickup
(2) Flywheel housing

The magnetic pickup senses the passage of the teeth that are on the flywheel ring gear. The Electronic Overspeed Switch is set at 118 percent of the rated engine speed. If the engine speed increases above the overspeed setting, the magnetic pickup will sense the overspeed. A signal is sent to the Electronic Overspeed Switch. The Electronic Overspeed Switch activates both the air shutoff solenoid (if equipped) and the fuel shutoff solenoid.

The shutoffs must be reset before the engine will restart. The air shutoff lever that is located at the top of the air inlet housing must be manually reset. The cause of the overspeed must be determined before the engine is restarted.

Water Temperature Contactor Switch

The water temperature contactor switch is located in the cylinder head. High water temperature closes the switch which activates an alarm or fuel shutoff. No resetting is required. The switch will open as the coolant cools.

NOTICE
Coolant level must be maintained in order for the shutoff to function, because the sensing element must be submerged in the coolant to operate.

Coolant Loss Sensor (If Equipped)

The optional coolant loss sensor is usually mounted near the top of the expansion tank or radiator. The sensor monitors the coolant level.

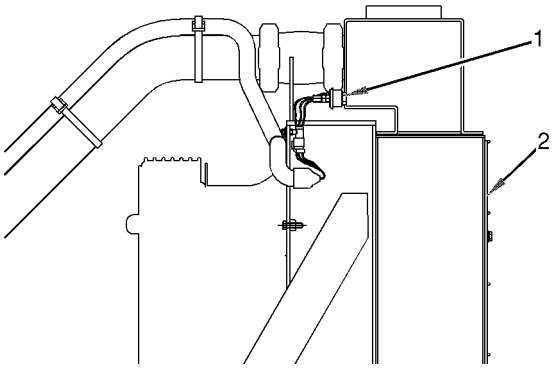

Illustration 80 g01009211

(1) Typical coolant loss sensor
(2) Radiator

If the coolant drops below the minimum level, the sensor may sound an alarm, or the sensor may cause a shutoff to avoid engine overheating or possible engine damage. Coolant must be added to the radiator or the expansion tank in order to reset the condition.

Testing the Shutoff and Alarm System

Most control panels are equipped with a lamp test switch. Turn the switch to the ON position in order to check the indicator lights for proper operation. Replace worn bulbs immediately.

The shutoffs and alarms should be tested every 1000 service hours or twice a year for proper operation by authorized, experienced service personnel.

NOTICE
During testing, abnormal operating conditions must be simulated. Perform the tests correctly in order to help prevent possible engine damage.

Refer to the Service Manual for more information on testing procedures or consult your Caterpillar dealer.

Testing of the Overspeed Switch

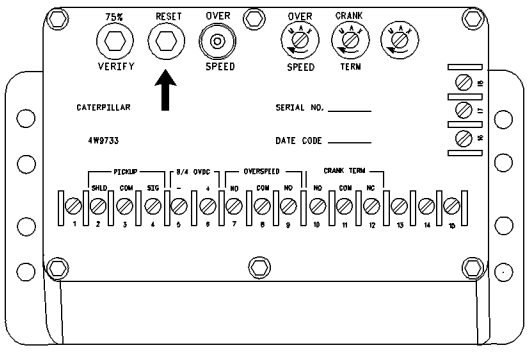

Illustration 81 g00291056

Electronic Overspeed Switch

The overspeed shutoff switch is located in the junction box. The overspeed shutoff switch must be reset before you can restart the engine. To reset the switch, push the “RESET” button. The button will remain in this position unless an overspeed condition occurs.

The Electronic Overspeed Switch with Cranking Termination has a 75 percent “VERIFY” button, a “RESET” button, and an “OVERSPEED” indicator lamp.

The Electronic Overspeed Shutoff Switch with Cranking Termination has a sensing circuit which prevents the starter pinion from remaining engaged in the flywheel at excessive rpm. Crank Termination has an adjustable engine speed setting. This signals the starter motor when the engine is firing and cranking must be terminated. Once the speed setting is reached, a switch opens. This will start the engine hour meter.

Once the starting motor cranks the engine, the pinion gear can remain engaged with the flywheel as the engine speed increases. The magnetic pickup opens the circuit to the starting motor at 400 rpm. This will allow the pinion gear to disengage.

The circuit will remain open until the flywheel stops. This prevents energizing the starting motor circuit again while the flywheel is turning.

The engine may be equipped with either an Overspeed Shutoff Switch or an Electronic Overspeed Switch with Cranking Termination. Both switches can be checked for proper operation at 75 percent of overspeed condition. Use the following procedure:

1. Determine full load speed (rpm) from the Engine Information Plate.

2. Operate the engine at the corresponding speed (rpm) that is shown for the engine. Refer to table 3 .

3. Maintain the test speed (rpm). Press the “VERIFY” button and hold the “VERIFY” button. The engine should stop. If the engine does not stop at the specified test speed (rpm), contact your Caterpillar dealer.

Table 3

GENERATOR SET OVERSPEED TEST RPM		
Full Load RPM	**Test RPM For Overspeed**(1)	**Actual RPM Of Overspeed**(2)
1500	1328	1770
1800	1593	2124

(1) The Test RPM for Overspeed is slower than the Full Load RPM. Multiply the Full Load RPM by 0.885. The product is the Test RPM.
(2) Multiply the Full Load RPM by 1.18. The product is the Actual RPM of Overspeed.

Note: The “OVERSPEED” lamp will illuminate as the engine stops. Push the “RESET” button before you restart the engine.

i00688850

Air Shutoff

SMCS Code: 1078

This optional solenoid is located on top of the engine. The air shutoff is part of the air inlet system. When the solenoid is activated, the solenoid mechanically shuts off the inlet air to the engine. The solenoid can be activated only by the overspeed switch or by the emergency stop push button (ESPB). The Generator Set Control (GSC) and the air shutoff must be reset before the engine can be restarted. The cause of the shutoff should be determined before the engine is restarted.

i00705809

Fuel Shutoff

SMCS Code: 1259; 1704

The fuel shutoff solenoid is located on the governor or the fuel shutoff solenoid is located on the fuel injection pump. When the fuel shutoff solenoid is activated, the solenoid moves the fuel rack “OFF” . The fuel shutoff solenoid moves the fuel rack directly or the fuel shutoff solenoid moves the fuel rack through the governor.

i00689135

Overspeed

SMCS Code: 1900; 1907; 1912; 7427

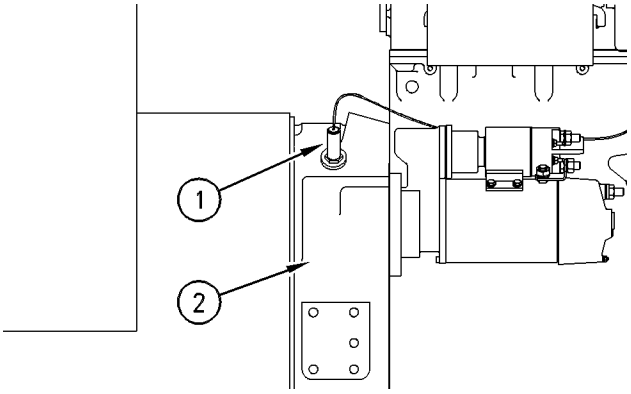

Illustration 82 g00293335

(1) Magnetic pickup
(2) Flywheel housing

The magnetic pickup senses the passage of the teeth that are on the flywheel ring gear. The Electronic Overspeed Switch is set at 118 percent of the rated engine speed. If the engine speed increases above the overspeed setting, the magnetic pickup will sense the overspeed. A signal is sent to the Electronic Overspeed Switch. The Electronic Overspeed Switch activates both the air shutoff solenoid (if equipped) and the fuel shutoff solenoid.

The shutoffs must be reset before the engine will restart. The air shutoff lever that is located at the top of the air inlet housing must be manually reset. The cause of the overspeed must be determined before the engine is restarted.

i03951109

Voltage Regulators

SMCS Code: 4467

VR6

⚠ 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.

For generators with Auxiliary Winding Regulation Excitation Principle (AREP), the voltage regulator is powered by two auxiliary windings. These windings are independent from the circuit for detection of voltage. The first winding is labeled as “X1” and “X2” . This winding has a voltage that is proportional with the output voltage of the generator. The second winding is labeled 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.

For generators with PMG excitation, a permanent magnet generator is added to the generator at the rear of the generator. The PMG supplies the voltage regulator with a voltage that is independent of the main generator winding. The generator has a short circuit capability of 3 X In for 10 seconds. The generator also has good immunity to distortion from the generator load.

The voltage regulator monitors the output voltage and the voltage regulator corrects the output voltage of the generator by adjusting the excitation current.

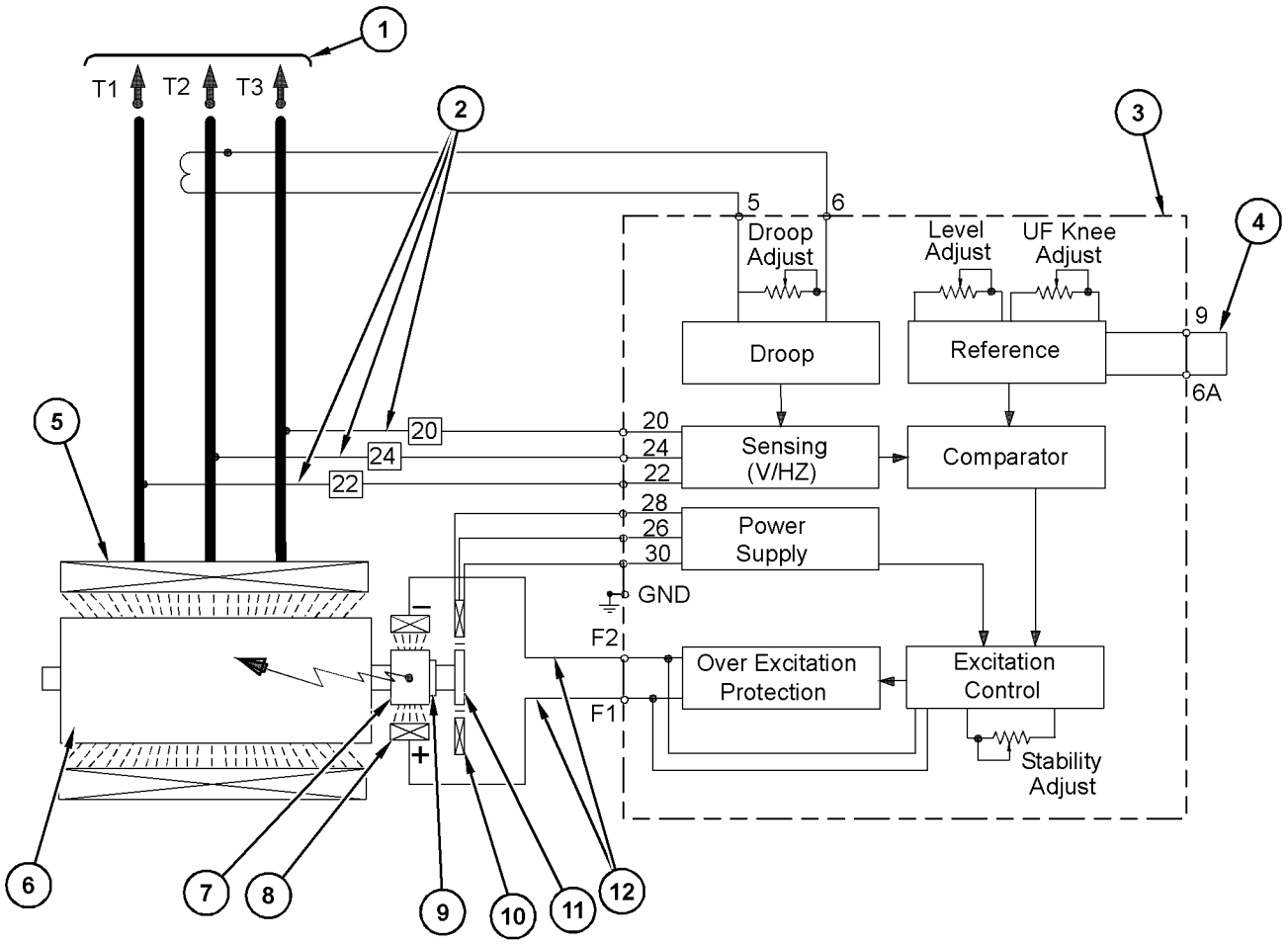

Illustration 83 g02197113

Typical Block Diagram of SR4B Permanent Magnet Permanently Excited (PMPE) Generator with VR6 Voltage Regulator

(1) Generator lines (output voltage)
(2) Generator lines (sensing voltage and AC power)
(3) VR6 voltage regulator
(4) Jumper (removed when external voltage adjust potentiometer is installed)
(5) Main stator
(6) Main rotor
(7) Exciter rotor
(8) Exciter stator
(9) Three-phase rectifiers
(10) Permanent magnet stator
(11) Permanent magnet
(12) Generator lines (DC excitation voltage)

The VR6 voltage regulator is used on 4/6 and 10/12 lead self-excited generators and permanent magnet generators, and also used on AREP generators. The VR6 regulator is typically located in the generator terminal box. The regulator may also be located in the marshaling box. In some applications, the regulator may be remotely mounted.

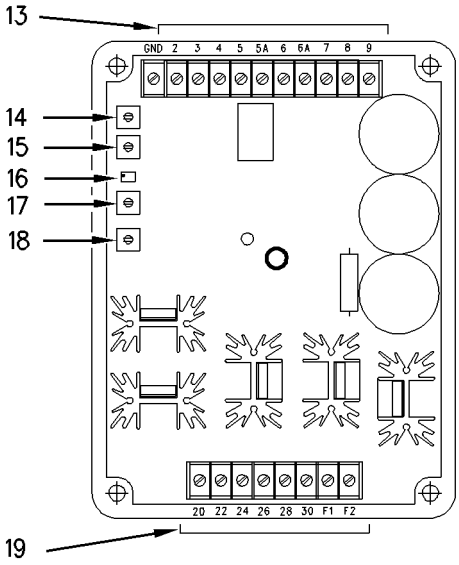

Illustration 84 g00779058

The VR6 Voltage Regulator

(13) Terminal strip for attachments
(14) Droop adjustment
(15) Factory calibration of the voltage adjustment range
(16) Voltage adjustment
(17) Knee frequency adjustment
(18) Stability adjustment
(19) Terminal strip for sensing and power

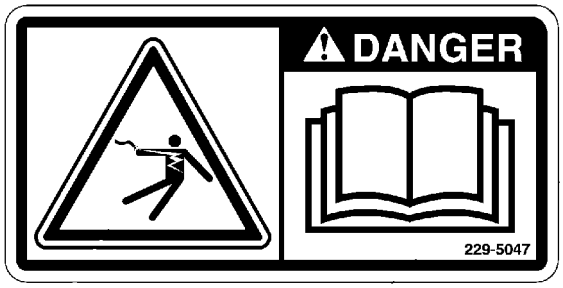

Illustration 85 g00928349

DANGER

The Cat VR6 presents an electrical shock/ electrocution hazard. This hazard will cause serious injury or death.

Service by trained personnel only.

The terminals and heat sinks are live at hazardous voltages when power is applied and for up to 8 minutes after power is removed.

There are five adjustments on the VR6 voltage regulator:

- Droop adjustment (14)
- Factory calibration of the voltage adjustment range (15)
- Voltage adjustment (16)
- Knee frequency adjustment (17)
- Stability adjustment (18)

The factory calibration of the voltage adjustment range (15) should not be adjusted by the user. For the other adjustments, refer to Specifications, Systems Operation, Testing and Adjusting, RENR2480, “VR6 Voltage Regulator”.

The VR6 voltage regulator can operate in one of the following modes:

- three-phase sensing
- single-phase sensing

The terminal strip for attachments (13) accommodates the following optional connections:

- KVAR/PF controller
- External voltage adjust potentiometer
- Droop current transformer (CT)
- Selection of the under frequency slope
- Selection of the sensing phase

Adjusting the VR6

Refer to Specifications, Systems Operation, Testing and Adjusting, RENR2480, “VR6 Voltage Regulator”

i05949130

Voltage Regulators

SMCS Code: 4467

Except for the oilfield generators, all Caterpillar SR4B generators are provided with voltage regulators. The voltage regulator controls the generator output voltage.

VR3F

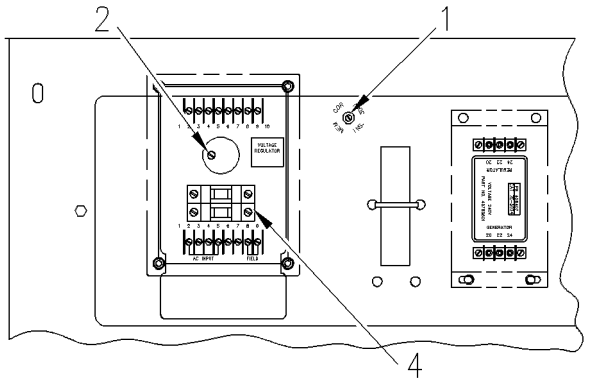

Illustration 86 g00626331

Adjustment Controls of the VR3F Regulator

(1) Voltage droop potentiometer
(2) Voltage level potentiometer
(4) Fuse(s)

The VR3F regulator has voltage droop capability (1). The VR3F regulator has the voltage level control (2). However, the VR3F regulator does not have voltage gain capability.

Voltage droop and voltage level are controlled by multiturn potentiometers. The adjustment screws on the potentiometers do not have a fixed stop. When the potentiometer reaches the end of adjustment, a ratchet action begins. The beginning of a ratchet action can be felt with the adjusting tool. The adjustment screw can be turned past the potentiometer stop (ratchet action) without further changing the potentiometer setting.

Digital Voltage Regulator

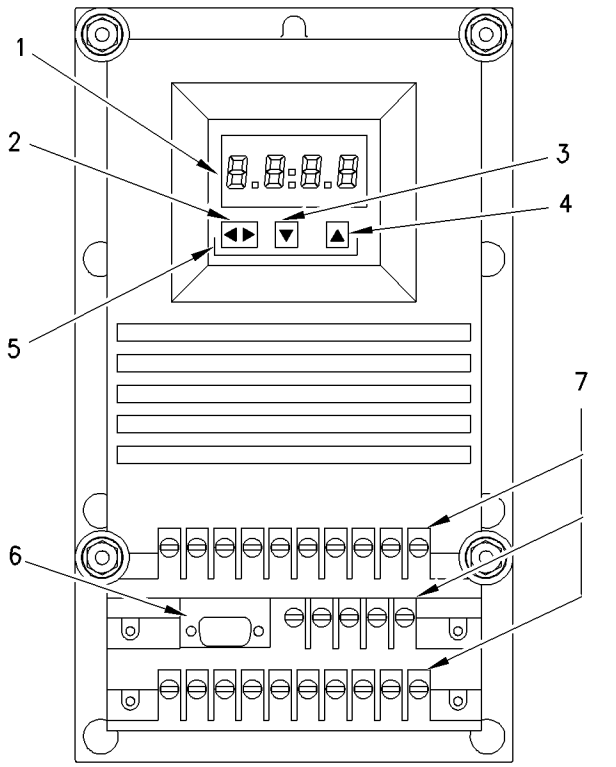

Illustration 87 g00883469

Digital Voltage Regulator (DVR)

(1) Display
(2) Function key
(3) Scroll down key
(4) Scroll up key
(5) Keypad
(6) J1 connector
(7) Screw terminals

The digital voltage regulator (DVR) is a microprocessor-based voltage regulator. The parameters are preset at the factory or the parameters can be modified in order to meet the specific requirements on the site. Certain system parameters can also be monitored on the display (1) of the DVR. Keypad (5) is used to change the information that is shown on the display. J1 connector (6) is used to join the DVR to a personal computer. Screw terminals (7) are used to join the DVR to the generator and various customer options.

Adjustment Procedure for the Voltage Regulators

VR3F

Note: The VR3F regulator is protected by a fuse(s). The VR3F regulator also has a solid-state overcurrent protection. If a fuse becomes open, contact a Caterpillar dealer.

1. Remove the access panel of the generator.

2. Loosen the locknut on the voltage droop potentiometer (1). Remove the protective screw from the voltage level potentiometer (2).

3. Turn voltage droop potentiometer (1) counterclockwise to zero droop. Tighten the locknut. Voltage droop potentiometer (1) is located next to the regulator.

4. Perform required maintenance on the engine before you start the engine.

5. Start the engine. Allow the engine to warm up. Refer to the Safety Section, “Engine Starting”.

6. Increase engine speed to full governed rated speed (high idle).

7. Observe the voltmeter reading. If the desired voltage is not indicated, set the no-load voltage with the voltage level potentiometer (2) or the voltage adjust rheostat. The voltage adjust rheostat is located on the control panel.

8. Close the load circuit breaker. Apply full load gradually. Adjust the governor control until the nameplate frequency is on the frequency meter or until the rated speed is displayed on the tachometer. The unit of measurement for frequency is Hertz. The unit of measurement for the rated speed is RPM.

9. Remove the load. If necessary, adjust the voltage level potentiometer (2) in order to obtain the desired voltage.

10. Apply the load. Observe the voltmeter reading. Repeat Steps 8 and 9 until the voltage at no load equals the voltage at full load.

11. Tighten the locknuts. Install the protective screws on the respective potentiometers. Install the access panel of the generator. STOP.

Digital Voltage Regulator (DVR)

Refer to the Specifications, Systems Operation, Testing and Adjusting, SENR5833, “Digital Voltage Regulator”.

The digital voltage regulator (DVR) can be set up for a specific application by using the configured parameters. Parameters are preset at the factory. Parameters may need adjustment in order to meet the specific requirements of a site. The DVR also detects faults. When a fault is detected, the DVR sets the appropriate alarm or caution. Certain system parameters can also be monitored on the display of the DVR.

Display (1) and keypad (5) are used to select parameter values. The display and the keypad are also used to manipulate the parameter values that control the operation of the digital voltage regulator. The display of the digital voltage regulator has four digits. When one of these digits is a colon, the number that is showing is a parameter code. When a colon is not present, the number that is showing is a parameter value. A decimal point in the display is used to indicate the precision of the parameter value.

Keypad (5) has three keys. The keys are listed below.

- Function key (2)
- Scroll down key (3)
- Scroll up key (4)

Display (1) has two modes. These modes are the parameter code mode and the parameter value mode. Function key (2) is used to toggle back and forth between the two modes. Scroll down key (3) and scroll up key (4) are used to change the value of the parameters on the display. The scroll down key will decrease the parameter number or the scroll down key will decrease the value. The scroll up key will increase the parameter number or the scroll up key will increase the value.

Table 4

Parameter Code	Parameter Value
:01	0480
	0481
	0482
	0483

(continued)

(Table 4, contd)

Parameter Code	Parameter Value
:02	0001
	0002
	0003
	0004
:03	0004
	0003
	0002
:04	0100
	0099
	0100
	0101

The operation of display (1) and keypad (5) is shown in Table 4 . Pressing function key (2) toggles the display between the two columns of the table (parameter code and parameter value). The display is in the parameter code mode when a colon is present. If a colon is not present, the display is in parameter value mode.

When you press scroll up key (3), the number that is displayed will increase to the next higher number within the column. When you press scroll down key (4), the number that is displayed will decrease to the next lower number within the column. The scroll keys will not cause the display to change columns.

To configure a parameter code, follow the procedure below:

1. To select the desired parameter code, press scroll key (3) or scroll key (4).

2. Access the parameter value by pressing function key (2).

3. Select the desired parameter value by pressing scroll key (3) or (4).

4. Enter the selected value into the memory of the digital voltage regulator, by pressing the function key (2).

i06191154

Voltage Regulators

SMCS Code: 4467

Cat Digital Voltage Regulator (Cat DVR)

⚠ DANGER

The Cat Digital Voltage Regulator presents an electrical shock/electrocution hazard. This hazard will cause serious injury or death.

Service by trained personnel only.

The terminals and heat sinks are live at hazardous voltages when power is applied and for up to 8 minutes after power is removed.

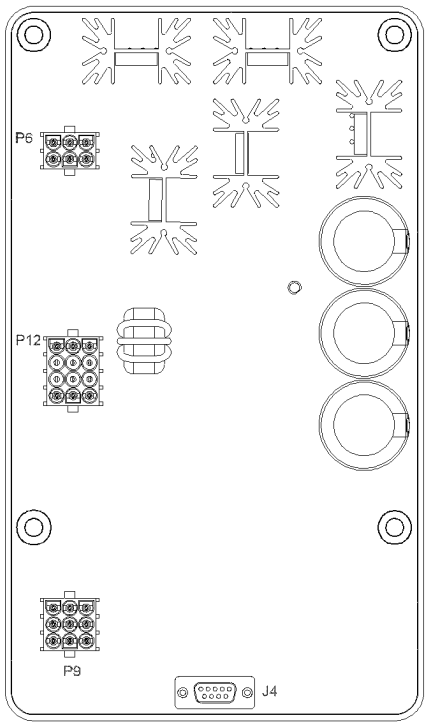

Illustration 88 g03844029

The Cat DVR is a microprocessor-based voltage regulator. Control power for the Cat DVR is supplied from an external source of 24 VDC. The power stage of the Cat DVR is supplied from a multiple pole high frequency permanent magnet generator. The multiple pole high frequency permanent magnet generator is mounted on the end of the generator shaft. Connections to the Cat DVR are made through three connectors. The communication between the Cat DVR and the service tool is accomplished by using a CANBUS protocol.

The Cat DVR has the following features:

- Three control modes:

1. Automatic voltage regulation (AVR)

2. Power factor (PF) regulation

3. Reactive power (VAR) regulation

- Programmable stability settings

- Soft start control with an adjustable time setting in AVR mode
- Dual slope voltage versus frequency (V/Hz) characteristic
- Three-phase or single-phase voltage sensing
- Single-phase current sensing
- Field current sensing and field voltage sensing
- Ten protection functions

Adjusting the Cat DVR

In order to view and configure the parameters of the Cat DVR, a PC with the Cat DVR software is required.

Refer to Specifications, Systems Operation, Testing and Adjusting, RENR7941, “Cat Digital Voltage Regulator” for complete information.

Integrated Voltage Regulator (IVR)

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

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

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

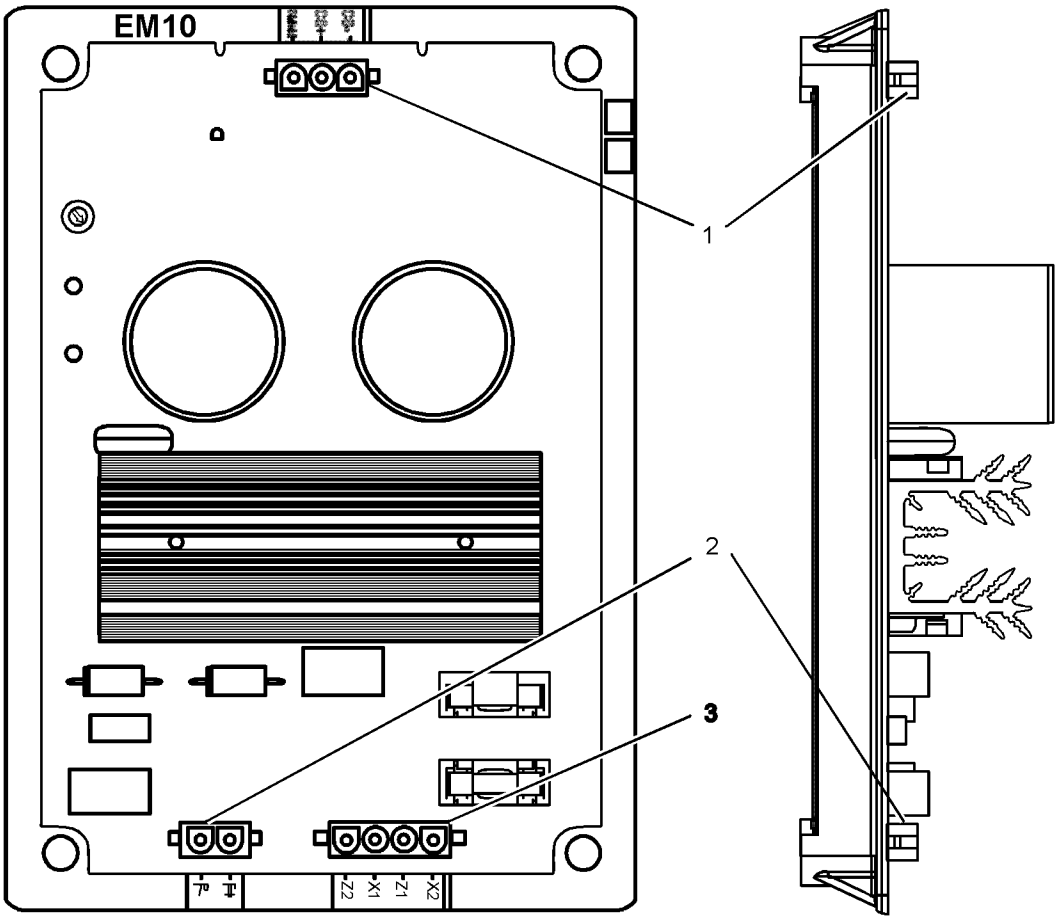

Illustration 89 g03844853

Excitation Module 10 (EM10)

(1) Connector P3 (2) Connector P2 (3) Connector P4

EMCP IVR Connection

To regulate the generator terminal voltage, the EMCP communicates the desired excitation command to the excitation module through a pulse width modulation (PWM) signal. A twisted pair of shielded cable must be used for the communication link. Table 5 details the connections to be made between the EMCP and Excitation Module.

Table 5

EMCP 4.1 and EMCP 4.2 Connections to Excitation Module (70-pin connector)			
EMCP 4.1 and EMCP 4.2 70-Pin Connector		Excitation Module 3-Pin Connector	
Digital Output #2 / IVR CS+	68	CS+	P3-2
Battery negative splice	60 or 65	CS-	P3-3
Battery negative splice	60 or 65	Shield	P3-1
EMCP 4.3 and EMCP 4.4 Connections to Excitation Module (120-pin connector)			
EMCP 4.3 and EMCP 4.4 120-Pin Connector		Excitation Module 3-Pin Connector	
PWM Output #2 Positive	28	CS+	P3-2
PWM Output #2 Negative	8	CS-	P3-3
Shield	19	Shield	P3-1

(continued)

Table 6 provides information on the technical specification of the EM10 and EM15 modules. Selection of the appropriate module must be determined by the following:

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

Table 6

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

(1) Internal Excitation (IE is also referred to as “Auxiliary Regulation Excitation Principle”(AREP)

IVR Excitation Module Connections

The EM10 and EM15 excitation modules have three plug type multiple-pin connectors. The connectors are labeled P2, P3, and P4 as shown in illustration 89 . Table 7 describes the signal and function of each connector pin.

Table 7

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

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

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

Refer to Illustration 88 for an example under-frequency roll-off (loading) profile.

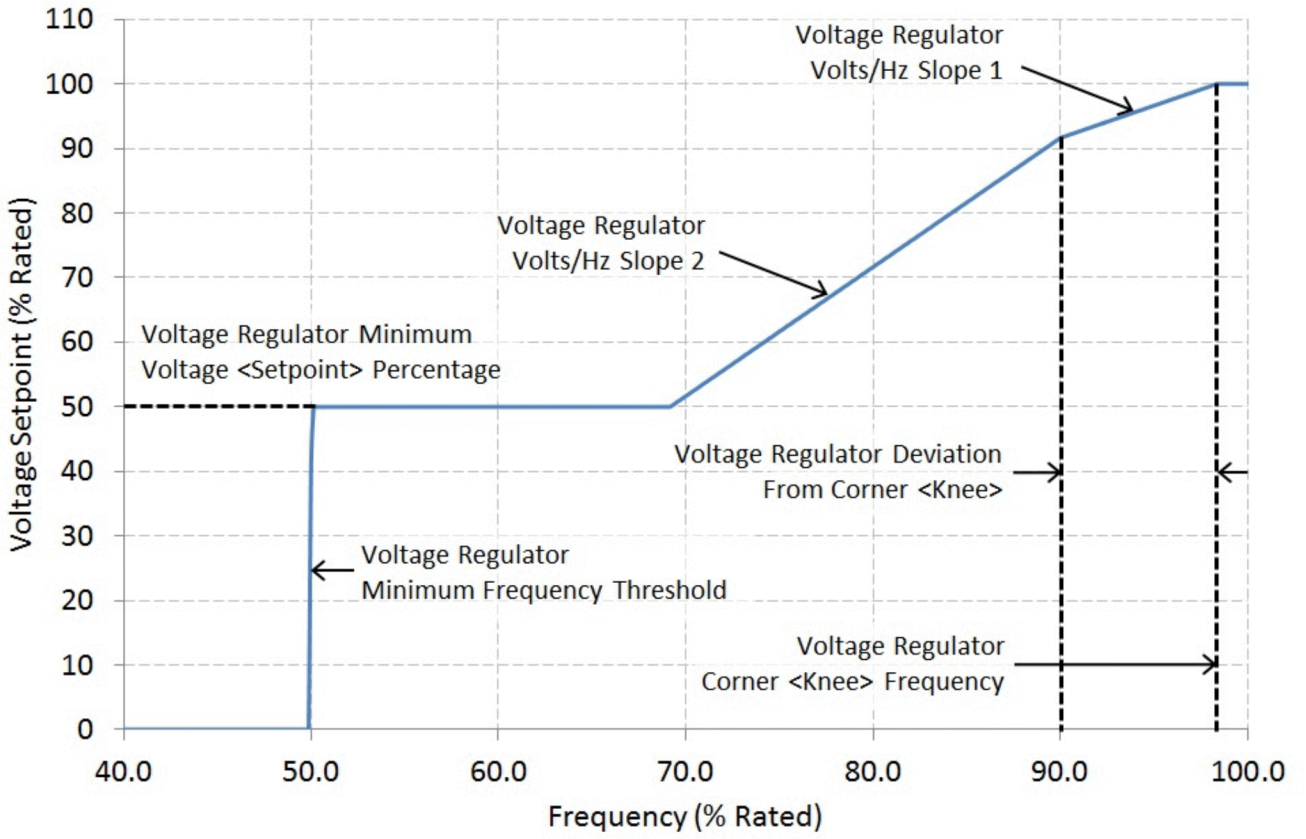

Illustration 90 g03487998

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

Engine Starting

i01233590

Before Starting Engine

SMCS Code: 1000; 1400; 1450

Perform the required daily maintenance and other periodic maintenance before the engine is started. Inspect the engine compartment. This inspection can help prevent major repairs at a later date. Refer to the Operation and Maintenance Manual for more information.

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

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

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

⚠ WARNING

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

- Do not start the engine or move any of the controls if there is a “DO NOT OPERATE” warning tag or similar warning tag attached to the start switch or to the controls.
- Ensure that the areas around the rotating parts are clear.
- All of the guards must be put in place. Check for damaged guards or for missing guards. Repair any damaged guards. Replace damaged guards and/or missing guards.
- Disconnect any battery chargers that are not protected against the high current drain that is created when the electric starting motor (if equipped) is engaged. Check electrical cables and check the battery for poor connections and for corrosion.
- Reset all of the shutoffs or alarm components.
- Check the engine lubrication oil level. Maintain the oil level between the “ADD” mark and the “FULL” mark on the oil level gauge.
- Check the coolant level. Observe the coolant level in the coolant recovery tank (if equipped). Maintain the coolant level to the “FULL” mark on the coolant recovery tank.
- If the engine is not equipped with a coolant recovery tank maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level in the sight glass.
- Observe the air cleaner service indicator (if equipped). Service the air cleaner when the yellow diaphragm enters the red zone, or when the red piston locks in the visible position.
- Ensure that any driven equipment has been disengaged. Remove any electrical loads.

Starting the Engines, Operating the Engines, and Stopping the Engines that are Equipped with Control Panels

For information regarding the generator control panel that is used, refer to the Operation and Maintenance Manual that is for the generator and the control panel.

i02762059

Starting the Engine (EMCP II and EMCP II+ (If Equipped))

SMCS Code: 1000; 1450

⚠ WARNING

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

Note: The crank cycle and the number of crank cycles are programmable. The crank cycle is the amount of time for engagement of the starting motor. This also includes the amount of time for cooling of the starting motor between crank cycles. If the engine does not start within the number of crank cycles that are programmed, the fuel system is disabled. The “OVERCRANK” indicator will illuminate in order to warn the operator of an overcrank.

Automatic Starting

⚠ 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.

The position for the engine control switch depends on the type of control panel. The engine control switch must be in the “AUTO” position for the EMCP II and the EMCP II+ control panel. For the Switchgear Conversion control panel, the engine control switch must be in the “REMOTE” position.

The engine will automatically start when the remote start/stop initiate contact closes.

Manual Starting

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.

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

Ensure that no one will be endangered before the engine is started and when the engine is started.

1. Perform all of the procedures that are described in this Operation and Maintenance Manual (Operation Section), “Before Starting 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.

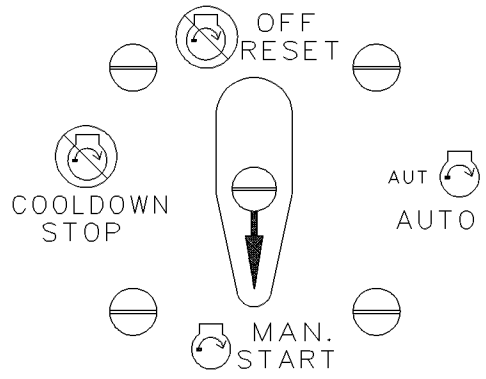

Illustration 91 g00319402

Engine control switch in the “MAN. START” position

This engine control switch is used for the EMCP II and for the EMCP II+ control panel.

2. To start an engine with the EMCP II or the EMCP II + control panel, turn the engine control switch to the “MAN. START” position.

i00735665

Cold Weather Starting

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

Note: Oil pan immersion heaters are not recommended for heating the lube oil. To ensure the compatibility of the components, only use equipment that is recommended by Caterpillar.

Startability will be improved at temperatures below 16 °C (60 °F) with a starting aid. A jacket water heater may be needed and/or the crankcase oil may need to be warmed.

A jacket water heater is available as an option for starting in temperatures as low as 0 °C (32 °F). The jacket water heater can maintain the water temperature at approximately 32 °C (90 °F). The heated water will help to keep the oil in the engine block warm enough to flow when the engine is started.

Maintain the proper level of electrolyte in the batteries. Keep the batteries fully charged.

To maximize the battery power, heat the battery compartment or store the batteries in a warm location. Typically, batteries only have 50 percent of the capability at −10 °C (14 °F) versus 27 °C (80 °F) .

Extra battery capacity may be necessary for very cold temperatures.

When No. 2 diesel fuel is used, a fuel heater will maintain the temperature of the fuel above the cloud point. Fuel line insulation will help to maintain the fuel temperature.

Consult your Caterpillar dealer for more information on the starting aids that are available for cold weather starting.

Starting With the Starting Aid Switch

⚠ 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.

NOTICE
Excessive starting fluid can cause piston and ring damage.

Use starting fluid for cold starting purposes only.

Do not use excessive starting fluid during starting or after the engine is running.

The optional ether starting aid which is located on the control panel is the only system that is recommended for the injection of starting fluid.

Perform the procedures that are described in this Operation and Maintenance Manual (Operation Section), “Before Starting Engine”.

1. Turn the Engine Control Switch to the “MAN. START” position. The engine will crank.

2. Ether will automatically be injected if the following conditions are met:

a. The “STARTING AID” switch is in the AUTOMATIC position.

b. The jacket water temperature is less than 21 °C (70 °F).

Note: Additional injections may be necessary in order to start the engine. Additional injections may also be necessary in order to achieve low idle.

3. If additional injection is necessary, toggle the “STARTING AID” switch to the MANUAL position. For additional injection, the jacket water temperature must be less than 21 °C (70 °F).

4. The “STARTING AID” switch is a momentary switch. To stop the injection, release the “STARTING AID” switch.

i03640789

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
Use a battery that is sourced 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 the negative battery cable last and remove the negative battery cable first.

When an external electrical source is used to start the engine, turn the control switch on the generator set 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 jump start cables are attached to the engine that is being started.

1. Turn the start switch on the stalled engine to the OFF position. Turn off all accessories.
2. Connect one positive end of the jump start cable to the positive cable terminal of the discharged battery. Connect the other positive end of the jump start cable to the positive cable terminal of the charging or starting source.
3. Connect one negative end of the jump start cable to the negative cable terminal of the charging or starting source. Connect the other negative end of the jump start cable to the stalled engine block or to the chassis ground. This procedure helps to prevent potential sparks from igniting combustible gases that are produced by some batteries.
4. Charge the batteries. The engine will not continue to run after starting if the batteries have not been charged.
5. Start the engine.
6. Immediately after the stalled engine is started, disconnect the jump start cables in reverse order.

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

i01646248

After Starting Engine

SMCS Code: 1000

Note: In temperatures from 0 to 60°C (32 to 140°F), the warm-up time is approximately three minutes. In temperatures below 0°C (32°F), additional warm-up time may be required.

Note: Ensure that the self test for the monitoring system (if equipped) is completed before operating the engine under load.

When the engine idles during warm-up, observe the following conditions:

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

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

Engine Operation

i06545704

Engine Operation

SMCS Code: 1000

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

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

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

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

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

i00613522

Engine Warm-up

SMCS Code: 1000

1. Run the engine at low idle for three to five minutes, or run the engine at low idle until the jacket water temperature starts to rise.

   More time may be necessary when the temperature is below −18°C (0°F).

2. Check all of the gauges during the warm-up period.
3. Perform another walk-around inspection. Check the engine for fluid leaks and air leaks.
4. Increase the rpm to the rated rpm. Check for fluid leaks and air leaks. The engine may be operated at full rated rpm and at full load when the jacket water temperature reaches 60°C (140°F).

i00165110

Fuel Conservation Practices

SMCS Code: 1000; 1250

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

- Avoid spilling fuel.

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

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

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

- Observe the service indicator frequently. Keep the air cleaner elements clean.
- Ensure that the turbochargers are operating correctly so that the proper air/fuel ratio is maintained. Clean exhaust indicates proper functioning.
- Maintain a good electrical system.

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

- Ensure that the belts are properly adjusted. The belts should be in good condition.
- Ensure that all of the connections of the hoses are tight. The connections should not leak.
- Ensure that the driven equipment is in good working order.

- Cold engines consume excess fuel. Utilize heat from the jacket water system and the exhaust system, when possible. Keep cooling system components clean and keep cooling system components in good repair. Never operate the engine without water temperature regulators. All of these items will help maintain operating temperatures.
- Settings for the fuel system and the limits for the operating altitude are stamped on the Engine Information Plate. If an engine is moved to a higher altitude, the settings must be changed by a Caterpillar dealer. Changing the settings will help prevent damage to the turbocharger. Changing the settings will help to provide the maximum efficiency for the engine. Engines can be operated safely at higher altitudes, but the engines will deliver less horsepower. The fuel settings should be changed by a Caterpillar dealer in order to obtain the rated horsepower.

i00651421

Full Load Operation

SMCS Code: 1000

Applying the Load

1. While the engine is operating at full load, check that the gauges are in the normal range. Always increase the engine speed to the rated speed before applying the load.

2. Adjust the voltage and the frequency.

3. Close the main circuit breaker.

4. Apply the load. Begin operating the engine at low load. Check the gauges and the equipment for proper operation. After normal oil pressure is reached and the temperature gauge begins to move, the engine may be operated at full load. Adjust the voltage and the frequency in order to compensate for the load, if necessary.

The governor will adjust the engine speed if the load varies, or if the load is cyclic, as required.

Extended operation at low idle or extended operation at a reduced load may cause increased oil consumption and carbon buildup in the cylinders. Carbon buildup in the cylinders can result in loss of power and/or poor performance. When the engine is operated at a reduced load, operate the engine at a full load in order to remove carbon buildup from the cylinders. Operate the engine at a full load at every four hours. Check the gauges and check the equipment frequently while the engine is under a load.

Engine Stopping

i06171418

Emergency Stopping

SMCS Code: 1000; 7418

NOTICE
Emergency shutoff controls are for EMERGENCY use ONLY. DO NOT use emergency shutoff devices or controls for normal stopping procedure.

Ensure that any components for the external system that support the engine operation are secured after the engine is stopped.

Emergency Stop Button (If Equipped)

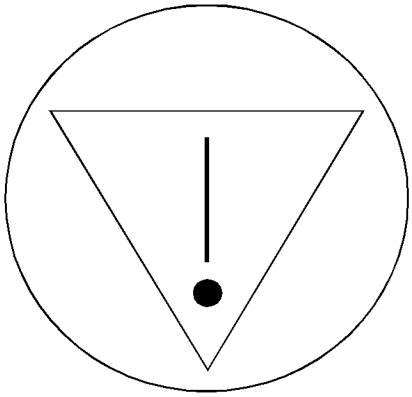

Illustration 92 g03835626

Typical emergency stop symbol located near the emergency stop button

The emergency stop button is in the OUT position for normal engine operation. Push the emergency stop button. The engine will not start when the button is locked. Turn the button clockwise in order to reset.

Refer to Operation and Maintenance Manual, “Features and Controls” for the location and the operation of the emergency stop button.

i02302747

After Stopping Engine

SMCS Code: 1000

- Check the engine crankcase oil level. Maintain the oil level between the “ADD” and “FULL” marks on the “ENGINE STOPPED” side of the oil level gauge. Complete all of the lubrication recommendations that are listed in Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations”.
- If necessary, perform minor adjustments. Repair any leaks and tighten loose bolts.
- Note the service hour meter reading. Perform the maintenance that is in the Operation and Maintenance Manual, “Maintenance Interval Schedule”.
- Fill the fuel tank in order to help prevent accumulation of moisture in the fuel. Do not overfill the fuel tank.

Note: Only use the antifreeze coolant solutions that are recommended in Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations”. Failure to follow the recommendations in Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” can cause engine damage.

- Allow the engine to cool. Check the coolant level. Maintain the cooling system at 13 mm (0.5 inch) from the bottom of the pipe for filling.
- If freezing temperatures are expected, check the coolant for proper antifreeze protection. The cooling system must be protected against freezing to the lowest expected outside temperature. See Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations”. Add the proper coolant/water mixture, if necessary.
- Perform all required periodic maintenance on the generator. The generator maintenance is outlined in the Operation and Maintenance Manual that is supplied with the generator.

Cold Weather Operation

i05264084

Fuel and the Effect from Cold Weather

SMCS Code: 1000; 1250

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

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

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

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

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

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

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

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

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

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

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

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

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

i01250450

Fuel Related Components in Cold Weather

SMCS Code: 1000; 1250

Fuel Tanks

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

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

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

Drain the water and sediment from any fuel storage tank at the following intervals: weekly, oil changes and refueling of the fuel tank. This will help prevent water and/or sediment from being pumped from the fuel storage tank and into the engine fuel tank.

Fuel Filters

It is possible that a primary fuel filter is installed between the fuel tank and the engine fuel inlet. After you change the fuel filter, always prime the fuel system in order to remove air bubbles from the fuel system. Refer to the Operation and Maintenance Manual in the Maintenance Section for more information on priming the fuel system.

The micron rating and the location of a primary fuel filter is important in cold weather operation. The primary fuel filter and the fuel supply line are the most common components that are affected by cold fuel.

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

Fuel Heaters

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

The following fuel heaters are recommended for Caterpillar engines:

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

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

Disconnect the fuel heater in warm weather.

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

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

Generator Operation

i02231520

Generator Operation

SMCS Code: 4450

Loading of the Generator

When a generator is installed or reconnected, be sure that the total current in one phase does not exceed the nameplate rating. Each phase should carry the same load. This allows the engine to work at the rated capacity. If one phase current exceeds the nameplate amperage, an electrical unbalance can result in an electrical overload and overheating .

Allowable combinations of unbalanced loads are shown in Illustration 93 . When you operate with significant single-phase loads, the combinations of single-phase load and three-phase load may be used. Such combinations should be located below the line on the graph.

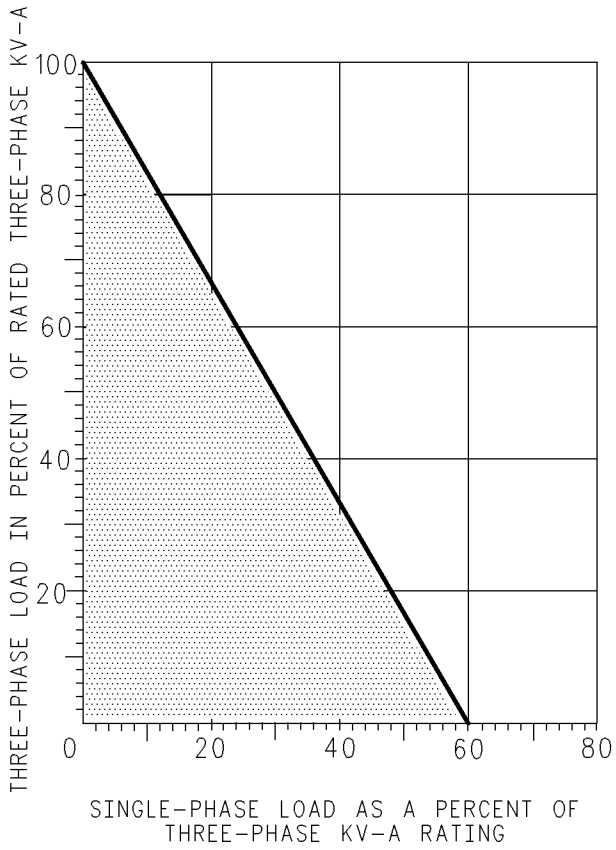

Illustration 93 g00627416

Allowable Combinations of Unbalanced Loads

Block Loading

Block loading is the instantaneous application of an electrical load to a generator set. This load may be anywhere from a moderate percentage of the rated load up to the rated load.

The block loading capability of a generator set depends on the following factors.

- Engine transient response
- Voltage regulator response
- Type of the voltage regulator
- Altitude of operation of the generator set
- Type of load
- Percent of load before the block load is applied

If derating for the block load is required, refer to ISO 3046 Standards or SAE J1349 Standards. Also, reference Engine Data Sheet, LEKX4066, “Loading Transient Response” and Engine Data Sheet, LEKX4067, “Block and Transient Response”.

Note: ISO stands for International Standards Organization.

Power Factor

The power factor represents the efficiency of the load. Power factor is the ratio of apparent power to total power. The power factor is expressed as a decimal. The power factor represents that portion of the current which is doing useful work. The portion of current which is not doing useful work is absorbed in maintaining the magnetic field in motors or other devices.

In most applications, electric motors and transformers determine the power factor of the system. Induction motors usually have a 0.8 or smaller power factor. Incandescent lighting is a resistive load of about 1.0 power factor, or unity.

The power factor of a system may be determined by a power factor meter or by calculations. Determine the power requirement in kW by multiplying the power factor by the kVA that is supplied to the system. As the power factor increases, the total current supplied to a constant power demand will decrease. For example, a 100 kW load at a 0.8 power factor will draw more current than a 100 kW load at 0.9 power factor. High power factor will result in full engine load at less than the rated amperage of the generator. A lower power factor increases the possibility of overloading the generator.

Note: Caterpillar generators are designed for a 0.8 power factor unless otherwise specified.

Excitation Systems

Self-Excited Generators

Self-excited (SE) generators receive power for excitation and voltage sensing for the regulator from the output of the main armature of the generator. The voltage regulator senses the generator output voltage. The voltage regulator provides the regulated output to the exciter of the generator. The exciter then provides power to the main rotating field. As the main field rotates, a voltage is induced into the main armature. This voltage is a generator output voltage.

Note: The main armature is also called the stator. The main rotating field is also called the rotor.

Permanent Magnet Pilot Excited Generators

Permanent Magnet Pilot Excited (PMPE) generators receive power for the voltage regulator from a pilot exciter, rather than the main armature. The pilot exciter consists of a permanent magnet rotor and a permanent magnet stator. The pilot exciter operates independently from the generator output voltage. Constant excitation during a large load application is possible because the irregularities that occur in generator output voltage are not fed back into the exciter. Such irregularities can be caused by load conditions. The independent operation also allows the generator to better sustain an overload for a short duration. The pilot exciter also ensures that the generator will start properly even if the rotating field becomes completely demagnetized.

Low Idle Adjustment

Generator sets normally have a higher low idle setting than industrial engines. Low idle will be approximately 66% of the full load speed of 60 Hz units. Low idle will be approximately 80% of the full load speed of 50 Hz units.

There is no low idle stop on generator sets with electronic governors. On generator sets with mechanical governors and natural gas generator sets, the low idle is set at the factory. The low idle should only be adjusted by your Caterpillar dealer if adjustment is required.

Note: Operating the generator set at low idle speed for an extended time will cause some voltage regulators to shut off. The generator set must be completely shut down. Then, the generator set must be restarted. This will allow the voltage regulator to again produce an output.

Standby Generator Sets

Most standby units are installed with controls that will start the unit automatically. Standby units start, pick up the load, run, and stop without an operator in attendance.

Standby units can not change the governor (speed) control, or change the voltage level settings automatically. The governor speed and voltage level must be preset for the proper operation of the standby unit. Whenever the set is operated manually, be sure that the governor speed and voltage levels are correct for automatic operation. Check all switches for the proper setting. The start select switch should be in the AUTOMATIC position. Emergency Stop Switches should be in RUN position.

Generator Options

Space Heaters

Most of the SR4B generators are provided with space heaters. These space heaters are installed for operation in high humidity conditions. For more information on space heaters, refer to Maintenance Section, “Space Heater - Check”.

Embedded Temperature Detectors

SR4B generators are available with embedded temperature detectors. The detectors are installed in the slots of the main armature. The main armature is also called a stator. The detectors are used with the equipment that is provided by the customer. Thus, the temperature of the main armature winding can be measured or monitored. Three types of temperature detectors are available. Contact your Caterpillar dealer for more information.

Bearing Temperature Detectors

Bearing temperature detectors are available as an option on SR4B generators. Bearing temperature detectors measure main bearing temperature. Bearing temperature detectors are used with the equipment that is provided by the customer. Thus, the temperature of the bearing can be measured or monitored. Bearing temperature measurements may help to prevent premature bearing failure. Two types of temperature detectors are available. Contact your Caterpillar dealer for more information.

Oilfield Generators

Oilfield generators are available for some generator sets. Oilfield generators are used with SCR controlled electric oil rigs. Oilfield generators are not provided with a voltage regulator. The function of the generator control is performed by the drilling electrical control system. Consult the builder of the drilling rig for any questions that pertain to generator control such as voltage regulation, paralleling, load sharing, etc.

Maintenance Section

Refill Capacities

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Refill Capacities and Recommendations

SMCS Code: 1348; 1395; 7560

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 specifications for the capacity of the auxiliary oil filter.

1EZ1-UP

Table 8

3412C Generator Set Engine		
Compartment or System	**Liters**	**Quarts**
Engine Oil Sump(1)	139	147

(1) These values are the approximate capacities for the crankcase oil sump. This includes the standard factory installed oil filters. Engines with auxiliary oil filters will require additional oil. Refer to the specifications for the capacity of the auxiliary oil filter.

BLG1-UP, BPG1-UP, and 3FZ1–621

Table 9

3412C Generator Set Engine		
DITTA(1) Engines DITT(2) Engines Only		
Compartment or System	**Liters**	**Quarts**
Engine Oil Sump	139	147

(1) DITTA refers to the following definition: Direct Injection, Twin Turbocharged and Aftercooled
(2) DITT refers to the following definition: Direct Injection and Twin Turbocharged

Table 10

3412C Generator Set Engine		
DIT(1) Engines		

(continued)

(Table 10, contd)

Compartment or System	Liters	Quarts
Engine Oil Sump	60	64

(1) DIT refers to the following definition: Direct Injection and Turbocharged

3FZ622–UP

Table 11

3412C Generator Set Engine		
Compartment or System	**Liters**	**Quarts**
Engine Oil Sump	60	64

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

Refer to Table 12 (maximum temperature) in order to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

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

Table 12

Engine Oil Viscosity		
Cat DEO Multigrade API CH-4 API CG-4 Viscosity Grade	**Ambient Temperature**	
	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 (104 °F)
SAE 10W-30	−18 °C (0 °F)	40 °C (104 °F)
SAE 15W-40	−9.5 °C (15 °F)	50 °C (122 °F)

For additional information on selecting an oil, refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations”.

Cooling System

To maintain the cooling system, the Total Cooling System capacity must be known. The approximate coolant capacity for the engine is shown in Table 13 . External System capacities will vary among applications. Refer to the specifications for the External System capacity. This capacity information will be needed in order to determine the amount of coolant/antifreeze that is required for the Total Cooling System.

Coolant Capacities

Table 13

3412C Generator Set Engine		
Approximate Refill Capacities		
	Liters	**Quarts**
Engine Only	58	62

Coolant Recommendations

NOTICE
Do not use a commercial coolant/antifreeze that only meets the ASTM D3306 or D4656 specification. This type of coolant/antifreeze is made for light duty automotive applications.

The following coolants are the primary types of coolants that are used in Caterpillar Engines:

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

Acceptable – Cat DEAC Diesel Engine Antifreeze/ Coolant or a commercial heavy-duty coolant/ antifreeze that meets “ASTM D4985” or “ASTM D5345” specifications

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

Note: Cat DEAC DOES NOT require a treatment with an SCA at the initial fill. Commercial heavy-duty coolant/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.

Table 14

Caterpillar Minimum Acceptable Water Requirements		
Property	**Maximum Limit**	**ASTM Test**
Chloride (Cl)	40 mg/L (2.4 grains/US gal)	“D512”, “D4327”
Sulfate (SO_4)	100 mg/L (5.9 grains/US gal)	“D516”
Total Hardness	170 mg/L (10 grains/US gal)	“D1126”
Total Solids	340 mg/L (20 grain/US gal)	“D1888”
Acidity	pH of 5.5 to 9.0	“D1293”

In stationary engine applications that do not require protection from boiling or freezing, a mixture of SCA and water is acceptable. **Caterpillar recommends a minimum of six percent to a maximum of eight percent SCA concentration in those cooling systems.** Distilled water or deionized water is preferred. Water which has the required properties may be used. For the water properties, refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” for additional information that relates coolant.

Note: The service life of coolant is limited by use of service hours. Refer to the specific engine's Operation and Maintenance Manual, “Maintenance Interval Schedule” (Maintenance Section). **To achieve this service life, the coolants must be properly maintained. The maintenance program includes S·O·S coolant analysis.**

Table 15

Coolant Service Life	
Coolant Type	**Service Life (1)**
Cat ELC	Six Years
Cat DEAC	Three Years
Commercial Heavy-Duty Coolant/Antifreeze that meets “ASTM D5345”	Two Years
Commercial Heavy-Duty Coolant/Antifreeze that meets “ASTM D4985”	One Year
Caterpillar SCA and Water	Two Years
Commercial SCA and Water	One Year

(continued)

(Table 15, contd)

(1) The service life of coolant is also limited by use (service hours). Refer to the specific engine's Operation and Maintenance Manual, “Maintenance Interval Schedule” (Maintenance Section).

Fuel

Fuel Recommendations

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

The preferred fuels provide maximum engine service life and performance. The preferred fuels are distillate fuels. These fuels are commonly called diesel fuel, furnace fuel, gas oil, or kerosene.

The permissible fuels are crude oils or blended fuels. Use of these fuels can result in higher maintenance costs and in reduced engine service life.

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.

Refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” for additional information that relates to diesel fuel.

Maintenance Recommendations

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General Maintenance Information

SMCS Code: 4450; 7000

Note: Read the warnings and read the instructions that are contained in the Safety Section of this manual. These warnings and instructions must be understood before you perform any operation or any maintenance procedures.

Rotating electric machines are complex structures that are exposed to the following forms of stress:

- mechanical
- electrical
- thermal
- environmental

These stresses may be of varying magnitudes. The electrical insulation systems are susceptible to damage that is caused by the stresses that are listed above. Exposure to these stresses may shorten the effective life of the electrical insulation system. Therefore, the service life of an electric machine will largely depend on the serviceability of the electrical insulation systems. An inspection program and a testing procedure are recommended. An inspection program and a testing procedure will ensure that the equipment is maintained in satisfactory condition. This will increase field reliability.

A regular maintenance and inspection program can provide an evaluation of the present condition of the equipment. A regular maintenance program and a regular inspection program can also reveal future problems. The frequency of this maintenance program will depend on the following factors:

- application
- environmental conditions
- experience level of the operator
- philosophy of the operator

A regular maintenance program is strongly recommended. This program would involve the following steps:

- periodic disassembly
- knowledgeable visual examination of the equipment
- the application of electrical tests

Never perform a test over the rated potential. These tests can damage insulation that is contaminated or insulation that is in marginal condition. For more information, refer to “I.E.E.E. Standard 432-1992” or consult a Cat dealer.

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System Pressure Release

SMCS Code: 1250; 1300; 1350; 5050

Coolant System

⚠ WARNING

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

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

Fuel System

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

High Pressure Fuel Lines (If Equipped)

⚠ WARNING

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

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

This is because of the following differences:

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

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

1. Stop the engine.

2. Wait for ten minutes.

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

Engine Oil

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

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Welding on Engines with Electronic Controls

SMCS Code: 1000

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

Proper welding procedures are necessary in order to avoid damage to the engine ECM, sensors, and associated components. When possible, remove the component from the unit and then weld the component. If removal of the component is not possible, the correct procedure must be followed. When welding on a unit that is equipped with a Cat Electronic Engine, the following is considered to be the safest procedure:

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

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

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

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

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

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

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

4. Disconnect any component with a microprocessor from the engine harness, such as:

- Engine ECM
- Product Link
- Cell/Sat Radio
- DOC Identity Modules

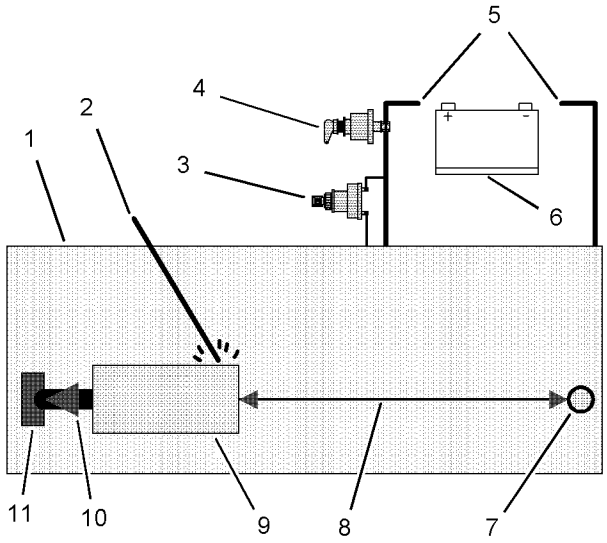

Illustration 94 g01075639

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

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

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

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

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

7. Use standard welding practices to weld the materials.

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Generator Start-up Checklist

SMCS Code: 4450

Table 16

GENERATOR START-UP CHECKLIST							
RATING INFORMATION							
Engine Serial Number: _____				Arrangement Number: _____			
Generator Serial Number: _____				Arrangement Number: _____			
GENERATOR NAME PLATE INFORMATION							
Voltage: _____			Package (prime, continuous, standby): _____				
Amperage: _____			Kilowatts: _____				
Storage Location:							
Main Stator Megohmmeter Reading:		Before Storage:			After Storage:		
Generator dried for 24 hours prior to startup?			(Y/N)		Drying method:		
SPACE HEATERS		**Yes**	**No**	**Comments**			
Space heaters operating properly?							
Space heater operated 48 hrs. before startup?							
MEGOHMMETER TEST (SEHS9124)		30 sec. reading	60 sec. reading	30 sec. corrected	60 sec. corrected	Ambient temp.	Comments
Beginning of Storage	Main Stator						
	Main Rotor						
	Exciter Stator						
	Exciter Rotor						
	PMG Stator						
Start-up	Main Stator						

(continued)

(Table 16, contd)

GENERATOR START-UP CHECKLIST							
	Main Rotor						
	Exciter Stator						
	Exciter Rotor						
	PMG Stator						
Regulator		**Voltage**	**Amps**	**Comments**			
No Load	F1 to F2	DC					
	20 to 22	AC					
	20 to 24	AC					
	22 to 24	AC					
	24 to 30 (SE only)	AC					
	26 to 28 (PM only)	AC					
	26 to 30 (PM only)	AC					
	28 to 30 (PM only)	AC					
Full Load	Generator Excitation Name Plate Information:	DC		Compare with F1 to F2			
	F1 to F2	DC					
	20 to 22	AC					
	20 to 24	AC					
	22 to 24	AC					
	24 to 30 (SE only)	AC					
	26 to 28 (PM only)	AC					
	26 to 30 (PM only)	AC					
	28 to 30 (PM only)	AC					

Table 17

GENERATOR START-UP CHECKLIST (CONT.)				
ELECTRICAL		**Yes**	**No**	**Comments**
	Unit properly grounded			
	Check diodes			
	Over current protection			
	Over voltage protection			
	Check for loose wiring			
	Adjust voltage			
	Adjust frequency			
MECHANICAL		**Data**		**Comments**
	Bearing temperature readings at full load	Front _____ Rear _____		
	Stator temperature readings at full load	A0 _____ B0 _____ C0 _____		

(continued)

(Table 17, contd)

	Air gap on main stator				Top _____ Bottom _____			
	Air gap on exciter stator				Top _____ Bottom _____			
	Air gap of PMG				Top _____ Bottom _____			
	Ambient air to generator at full load				Temperature _____			
	Supplier air opening to generator				Size of Opening _____			
SWITCH GEAR/PARALLEL OPERATION								
	Manufacturer:							
		Setting 1		**Setting 2**		**Setting 3**	**Comments**	
	Circuit breaker type							
	Overload setting							
	Reverse power relay							
	VAR/PF Controller							
	Load share							
INSTALLATION & LOAD INFORMATION								
	Neutral grounding system				UPS			
	Enclosure type				- Size			
	Motor:				Other loads:			
	- Total SKVA				- Lighting			
	- Total HP				- Computers			
					- Welding			
					- Non-linear			
					- Other			
FULL LOAD DATA								
Voltage	Amps		KW	KVARS	P.F.			

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Maintenance Interval Schedule

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

Daily

Every Week

Every 100 Service Hours or 3 Months

Every 250 Service Hours

Every 2000 Service Hours

Every 2000 Service Hours or 6 Months

Every 2000 Service Hours or 1 Year

Every Year

Every 6000 Service Hours or 3 Years

Every 12 000 Service Hours or 6 Years

Every 9500 L (2500 US gal) of Fuel or 250 Service Hours or Yearly

First 19 000 L (5000 US gal) of Fuel or 250 Service Hours

Every 19 000 L (5000 US gal) of Fuel or 250 Service Hours

Every 19 000 L (5000 US gal) of Fuel or 500 Service Hours

PM Level 2 - Every76 000 L (20 000 US gal) of Fuel or 1000 Service Hours

PM Level 3 - Every 228 000 L (60 000 US gal) of Fuel or 3000 Service Hours

Every 379 000 L (100 000 US gal) of Fuel or 5000 Service Hours

Overhaul

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Aftercooler Core - Clean/Test

SMCS Code: 1064-070; 1064-081

1. Remove the core. Refer to the Service Manual for the procedure.
2. Turn the aftercooler core upside-down in order to remove debris.

NOTICE
Do not use a high concentration of caustic cleaner to clean the core. A high concentration of caustic cleaner can attack the internal metals of the core and cause leakage. Only use the recommended concentration of cleaner.

3. Back flush the core with cleaner.

   Caterpillar recommends the use of Hydrosolv liquid cleaner. Table 18 lists Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 18

Hydrosolv Liquid Cleaners(1)		
Part Number	**Description**	**Size**
1U-5490	Hydrosolv 4165	19 L (5 US gallon)
174-6854	Hydrosolv 100	19 L (5 US gallon)

(1) Use a two to five percent concentration of the cleaner at temperatures up to 93°C (200°F). Refer to Application Guide, NEHS0526 or consult your Caterpillar dealer for more information.

4. Steam clean the core in order to remove any residue. Flush the fins of the aftercooler core. Remove any other trapped debris.
5. Wash the core with hot, soapy water. Rinse the core thoroughly with clean water.

⚠ WARNING

Personal injury can result from air pressure.

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

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

6. Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.
7. Inspect the core in order to ensure cleanliness. Pressure test the core. Many shops that service radiators are equipped to perform pressure tests. If necessary, repair the core.
8. Install the core. Refer to the Service Manual for the procedure.

For more information on cleaning the core, consult your Caterpillar dealer.

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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.

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/Adjust/Replace

SMCS Code: 1357-039

Inspection

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

After the initial check, the belt tension should be checked at Every 250 Service Hours or Three Months.

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

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

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

To check the belt tension, apply 110 N (25 lb) of force midway between the pulleys. A correctly adjusted belt will deflect 13 to 19 mm (0.50 to 0.75 inch).

Adjustment

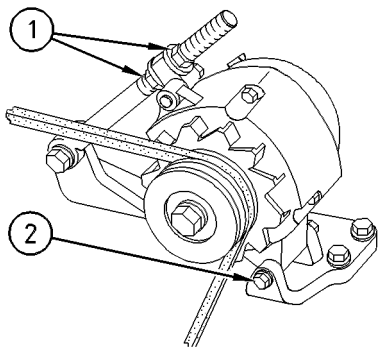

Illustration 95 g00290209

Typical illustration: (1) Adjusting nuts. (2) Mounting bolts.

1. Loosen mounting bolts (2) and adjusting bolt (1).
2. Move the alternator in order to increase or decrease the belt tension.
3. Tighten adjusting bolt (1). Tighten mounting bolts (2). Refer to the Service Manual for the proper torques.

If new belts are installed, check the belt tension again after 20 hours of engine operation.

Replacement

Refer to the Service Manual for more information on the procedures for the following topics: belt removal and belt installation procedure.

i06103470

Battery - Replace

SMCS Code: 1401-510

⚠ WARNING

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

⚠ WARNING

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

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

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

1. Turn the key start switch to the OFF position. Remove the key and all electrical loads.
2. Turn OFF the battery charger. Disconnect the charger.
3. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the ground plane. Disconnect the cable from the NEGATIVE “-” battery terminal.
4. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.
5. Remove the used battery.
6. Install the new battery.

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

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

i06064262

Battery Electrolyte Level - Check

SMCS Code: 1401-535

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

⚠ WARNING

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

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

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

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

3. Keep the batteries clean.

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

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

   Thoroughly rinse the battery case with clean water.

   Use the 1U-9921 Battery Service Tool to clean the battery terminals. Use a wire brush to clean the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to fit improperly. Coat the clamps and the terminals with 5N-5561 Silicone Lubricant, petroleum jelly or MPGM.

i01492654

Battery or Battery Cable - Disconnect

SMCS Code: 1402-029

⚠ WARNING

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

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

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.
2. Disconnect the negative battery terminal at the battery that goes to the start switch. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, the negative side of two batteries must be disconnected.
3. Tape the leads in order to help prevent accidental starting.
4. Proceed with necessary system repairs. Reverse the steps in order to reconnect all of the cables.

i05793911

Cooling System Coolant (DEAC) - Change

SMCS Code: 1350-070; 1395-044

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

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

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

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

Drain

⚠ WARNING

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

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

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

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

Allow the coolant to drain.

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

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

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

Flush

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

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

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

3. Fill the cooling system with a mixture of clean water and Cat Quick Flush cooling system cleaner. Refer to the directions for the cleaner. For additional information on cooling system cleaners, refer to the One Safe Source catalog. Install the cooling system filler cap.

4. Start and run the engine at low idle for a minimum of 30 minutes. The coolant temperature should be at least 82 °C (180 °F).

NOTICE
Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. If equipped, be sure to flush the heater and any related supply and return lines. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

Cooling Systems with Heavy Deposits or Plugging

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

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

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

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

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

3. Fill the cooling system with a mixture of clean water and Cat Fast Acting Cooling System Cleaner. Add 0.5 L (1 pt) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity. Install the cooling system filler cap.

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

NOTICE
Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

Fill

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

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

2. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at high idle for 1 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 cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.

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

i03292691

Cooling System Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

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

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

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

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

Drain

⚠ WARNING

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

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

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

Allow the coolant to drain.

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

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

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

Flush

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

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

2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. For the proper torque, refer to the Specifications Manual, SENR3130, “Torque Specifications”.

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

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

Fill

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

1. Fill the cooling system with Extended Life Coolant (ELC). See Special Publication, SEBU6385, “Caterpillar On-highway Diesel Truck Engine Fluids Recommendations” for more information on cooling system specifications. Do not install the cooling system filler cap.
2. Start and run the engine at low idle for 5 minutes. Then, 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.
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.

i01197583

Cooling System Coolant Level - Check

SMCS Code: 1395-082

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

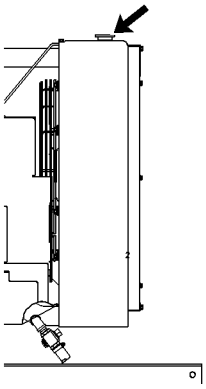

Illustration 96 g00285520
Cooling system filler cap

⚠ 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.

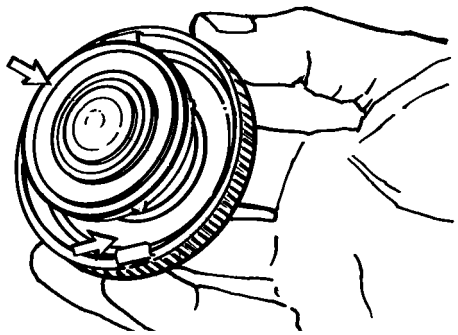

Illustration 97 g00103639
Typical filler cap gaskets

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.

i04035949

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 filled with Cat ELC should have a Coolant Sample (Level 2) that is obtained at the recommended interval as stated in the maintenance interval schedule.

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

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

Table 19

Recommended Interval		
Type of Coolant	Level 1	Level 2

(continued)

(Table 19, contd)

Cat DEAC	Every 250 service hours	Every year(1)
Conventional heavy duty-coolant		
Commercial coolant that meets the requirements of the Caterpillar EC-1 standard		
Cat ELC or conventional EC-1 coolant	Optional	Every year(1)

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

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

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

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

Use the following guidelines for proper sampling of the coolant:

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

Submit the sample for Level 1 analysis.

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

i02224620

Cooling System Coolant Sample (Level 2) - Obtain

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

Obtain the sample of the coolant as close as possible to the recommended sampling interval. Supplies for collecting samples can be obtained from your Caterpillar dealer.

Reference: 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.

Reference: For additional information about coolant analysis, refer to Special Publication, SEBU6250, “Caterpillar Machine Fluids Recommendations” or consult your Caterpillar dealer.

i02456600

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

SMCS Code: 1352-045; 1395-081

⚠ WARNING

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

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

Test for SCA Concentration

Coolant and SCA

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

Use the 8T-5296 Coolant Conditioner Test Kit or use the 4C-9301 Coolant Conditioner Test Kit in order to check the concentration of the SCA. Refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” for more information.

Water and SCA

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

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Refer to the Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” for more information.

S·O·S Coolant Analysis

S·O·S coolant samples can be analyzed at your Caterpillar dealer. S·O·S Coolant Analysis is a program that is based on periodic samples.

Level 1

Level 1 is a basic analysis of the coolant. The following items are tested:

- Glycol Concentration
- Concentration of SCA
- pH
- Conductivity

The results are reported, and recommendations are made according to the results. Consult your Caterpillar dealer for information on the benefits of managing your equipment with an S·O·S Coolant Analysis.

Level 2

This level coolant analysis is recommended when the engine is overhauled. Refer to this Operations and Maintenance Manual, “Overhaul Considerations” for further information.

Add the SCA, If Necessary

NOTICE
Do not exceed the recommended amount of supplemental coolant additive concentration. Excessive supplemental coolant additive concentration can form deposits on the higher temperature surfaces of the cooling system, reducing the engine's heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components. Excessive supplemental coolant additive concentration could also result in radiator tube blockage, overheating, and/or accelerated water pump seal wear. Never use both liquid supplemental coolant additive and the spin-on element (if equipped) at the same time. The use of those additives together could result in supplemental coolant additive concentration exceeding the recommended maximum.

⚠ WARNING

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

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

Note: Always discard drained fluids according to local regulations.

2. If necessary, drain some coolant from the cooling system into a suitable container in order to allow space for the extra SCA.
3. Add the proper amount of SCA. Refer to the Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engines Fluids Recommendations” for more information on SCA requirements.
4. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets are damaged, replace the old cooling system filler cap with a new cooling system filler cap. Install the cooling system filler cap.

i03645060

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. Refer to this Operation and Maintenance Manual, “Maintenance Interval Schedule” for the proper maintenance interval.

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

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

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

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

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

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

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

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

Note: If 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.

i06103521

Crankshaft Vibration Damper - Inspect

SMCS Code: 1205-040

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

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

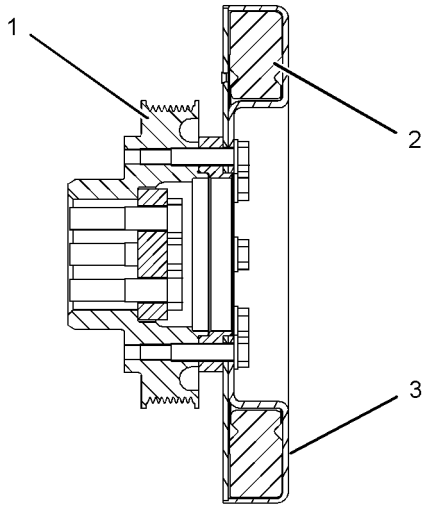

Illustration 98 g01134779

Viscous vibration damper

Typical example

(1) Crankshaft pulley
(2) Weight
(3) Case

Inspection

Inspect the damper for the following conditions:

- The damper is dented, cracked, or fluid is leaking from the damper.
- The paint on the damper is discolored from excessive heat.
- The damper is bent.
- The bolt holes are worn or there is a loose fit for the bolts.
- The engine has had a crankshaft failure due to torsional forces.
- Extreme wear of the gear train.

Replace the damper if any of these conditions exist.

Removal and Installation

Refer to this Operation and Maintenance Manual, “Belts - Inspect/Adjust/Replace” for information on removing and on installing the belt. Refer to the Disassembly and Assembly Manual, “Vibration Damper and Pulley - Remove and Install” for information on removing and installing the damper.

i01228274

Electrical Connections - Check

SMCS Code: 4459-535

Check all exposed electrical connections for tightness.

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

- transformers
- fuses
- capacitors
- lightning arrestors

Check all lead wires and electrical connections for proper clearance.

i01866598

Engine - Clean

SMCS Code: 1000-070

⚠ WARNING

Personal injury or death can result from high voltage.

Moisture could create paths of electrical conductivity.

Make sure the unit is off line (disconnected from utility and/or other generators), locked out and tagged "Do Not Operate".

NOTICE
Water or condensation can cause damage to generator components. Protect all electrical components from exposure to water.

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.

Do not steam clean the generator. Water may damage the generator.

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

i01089660

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

SMCS Code: 1054-510; 1054-037

Perform the Operation and Maintenance Manual, “Engine Air Cleaner Service Indicator-Inspect” procedure and perform the Operation and Maintenance Manual, “Engine Air Precleaner Check/Clean” procedure (if equipped) before performing the following procedure.

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

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

Servicing the Air Cleaner Elements

If the air cleaner element becomes plugged, the air can split the material of the air cleaner element. Unfiltered air will drastically accelerate internal engine wear. Your Caterpillar dealer has the proper air cleaner elements for your application. Consult your Caterpillar dealer for the correct air cleaner element.

- Check the precleaner (if equipped) daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.
- Operating conditions (dust, dirt and debris) may require more frequent service of the air cleaner element.
- The air cleaner element may be cleaned up to six times if the element is properly cleaned and inspected.
- The air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

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

Air Cleaners With Dual Elements

An air cleaner with a dual element contains a primary air cleaner element and a secondary air cleaner element. The primary air cleaner element can be used up to six times if the element is properly cleaned and inspected. The primary air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

The secondary air cleaner element is not serviceable or washable. The secondary air cleaner element should be removed and discarded for every three cleanings of the primary air cleaner element. When the engine is operating in environments that are dusty or dirty, air cleaner elements may require more frequent replacement.

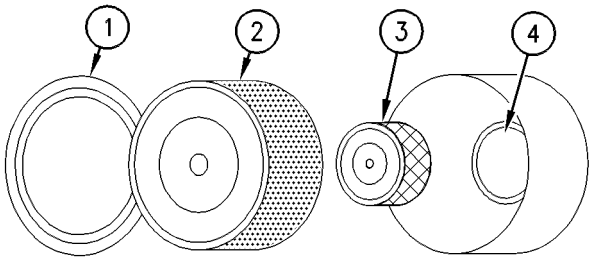

Illustration 99 g00123209

(1) Cover. (2) Primary air cleaner element. (3) Secondary air cleaner element. (4) Turbocharger air inlet.

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

2. The secondary air cleaner element should be removed and discarded for every three cleanings of the primary air cleaner element.

Note: Refer to “Cleaning the Primary Air Cleaner Elements”.

3. Cover the turbocharger air inlet with tape in order to keep dirt out.

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

5. Remove the tape for the turbocharger air inlet. Install the secondary air cleaner element. Install a primary air cleaner element that is new or cleaned.

6. Install the air cleaner cover.

7. Reset the service indicator.

Cleaning the Primary Air Cleaner Elements

The primary air cleaner element can be used up to six times if the element is properly cleaned and inspected. When the primary air cleaner element is cleaned, check for rips or tears in the filter material. The primary air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Use clean primary air cleaner elements while dirty elements are being cleaned.

NOTICE
Do not clean the air cleaner elements by bumping or tapping. This could damage the seals. Do not use elements with damaged pleats, gaskets or seals. Damaged elements will allow dirt to pass through. Engine damage could result.

Visually inspect the primary air cleaner elements before cleaning. Inspect the air cleaner elements for damage to the seal, the gaskets, and the outer cover. Discard any damaged air cleaner elements.

There are four common methods that are used to clean primary air cleaner elements:

- Pressurized water
- Pressurized air
- Vacuum cleaning
- Washing with nonsudsing detergent

Pressurized Water

Pressurized water will clean the primary air cleaner element unless carbon and oil have accumulated on the surface of the primary air cleaner element. The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi). Do not use a spray nozzle.

Note: When the primary air cleaner element is cleaned, always begin with the clean side (inside) in order to force dirt particles toward the dirty side (outside).

Aim the hose so that the water flows inside the element along the length of the filter in order to help prevent damage to the paper pleats. Do not aim the stream of water directly at the primary air cleaner element. Dirt could be forced further into the pleats.

Note: Refer to “Drying the Primary Air Cleaner Elements”. Refer to “Inspecting the Primary Air Cleaner Elements”.

Pressurized Air

Pressurized air can be used to clean primary air cleaner elements that have not been cleaned more than two times. Pressurized air will not remove deposits of carbon and oil. Use filtered, dry air with a maximum pressure of 207 kPa (30 psi).

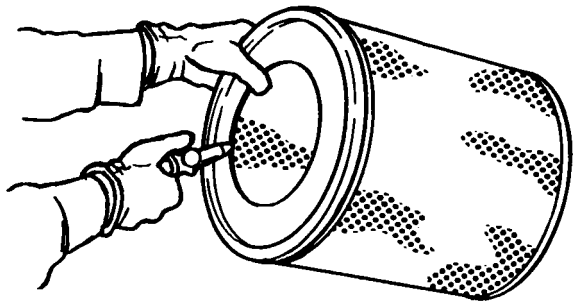

Illustration 100 g00281692

Note: When the primary air cleaner elements are cleaned, always begin with the clean side (inside) in order to force dirt particles toward the dirty side (outside).

Aim the hose so that the air flows inside the element along the length of the filter in order to help prevent damage to the paper pleats. Do not aim the stream of air directly at the primary air cleaner element. Dirt could be forced further into the pleats.

Note: Refer to “Inspecting the Primary Air Cleaner Elements”.

Vacuum Cleaning

Vacuum cleaning is a good method for cleaning primary air cleaner elements which require daily cleaning because of a dry, dusty environment. Cleaning with pressurized air is recommended prior to vacuum cleaning. Vacuum cleaning will not remove deposits of carbon and oil.

Note: Refer to “Inspecting the Primary Air Cleaner Elements”.

Washing the Primary Air Cleaner Elements with Nonsudsing Detergent

⚠ WARNING

Do not wash air cleaner elements in any flammable solution such as diesel fuel or gasoline. Doing so can cause fire or an engine runaway and can result in personal injury.

Washing with nonsudsing detergent is effective for cleaning primary air cleaner elements that have deposits of carbon or oil. Use a cleaning agent that is specifically manufactured for cleaning primary air cleaner elements. Cleaning with pressurized water, pressurized air, or a vacuum is recommended prior to washing with nonsudsing detergent.

1. Place the primary air cleaner element into a wash tank so that the gasket is up. The wash tank should be equipped with a rack so that the primary air cleaner element does not sit on the bottom of the wash tank.

Note: Caterpillar does not recommend a process for washing the primary air cleaner element which includes vigorously shaking. By vigorously shaking the element, carbon particles may be distributed.

2. Fill the wash tank with the cleaning agent and warm water to a maximum temperature of 60°C (140°F). Follow the manufacturers recommendations for the cleaning agent. Allow the primary air cleaner element to soak for six hours.
3. Drain the wash tank. Do not use the cleaning agent more than one time. Remove the primary air cleaner element from the wash tank. Rinse the primary air cleaner element with the method for using pressurized water.

Note: Refer to “Drying the Primary Air Cleaner Elements”. Refer to “Inspecting the Primary Air Cleaner Elements”.

Drying the Primary Air Cleaner Elements

The oven method may be used in order to dry primary air cleaner elements. If an oven is used, do not expose the primary air cleaner elements to temperatures that exceed 82°C (160°F).

Note: Do not use compressed air in order to dry the primary air cleaner elements.

Primary air cleaner elements may be allowed to air dry. Allow two days for the primary air cleaner elements to air dry before the elements are inspected and installed.

Inspecting the Primary Air Cleaner Elements

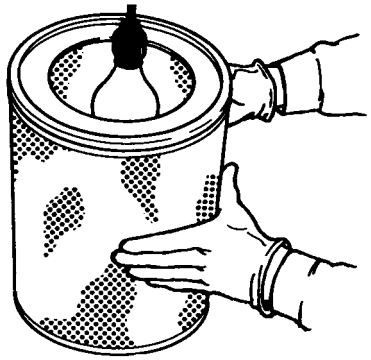

Illustration 101 g00281693

Inspect the clean, dry primary air cleaner element. Use a 60 watt blue light in a dark room or in a similar facility. Place the blue light in the primary air cleaner element. Rotate the primary air cleaner element. Inspect the primary air cleaner element for tears and/or holes. Inspect the primary air cleaner element for light that may show through the filter material. If it is necessary in order to confirm the result, compare the primary air cleaner element to a new primary air cleaner element that has the same part number.

Do not use a primary air cleaner element that has any tears and/or holes in the filter material. Do not use an primary air cleaner element with damaged pleats, gaskets or seals. Discard damaged primary air cleaner elements.

Storing Primary Air Cleaner Elements

If a primary air cleaner element that passes inspection will not be used, the primary air cleaner element can be stored for future use.

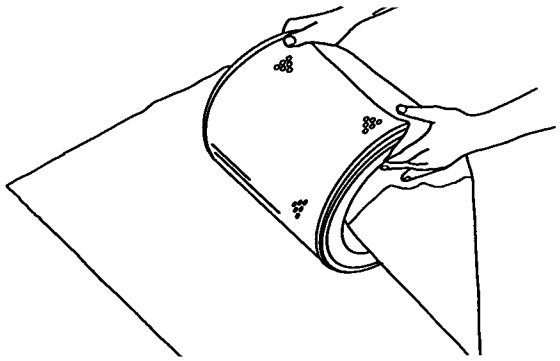

Illustration 102 g00281694

Do not use paint, a waterproof cover, or plastic as a protective covering for storage. Restricted air flow may result. To protect against dirt and damage, wrap the primary air cleaner elements in Volalite Corrosion Inhibited (VCI) paper.

Place the primary air cleaner element into a box for storage. For identification, mark the outside of the box and mark the primary air cleaner element. Include the following information:

- Date of the cleaning
- Number of cleanings

Store the box in a dry location.

For more detailed information on cleaning the primary air cleaner element, refer to Special Publication, SEBF8062, “Procedure to Inspect and Clean Air Filters”.

i06103548

Engine Air Cleaner Service Indicator - Inspect
(If Equipped)

SMCS Code: 7452-040

Some engines may be equipped with a different service indicator.

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

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

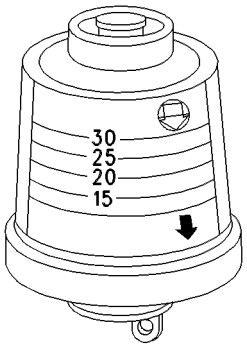

Illustration 103 g00103777

Typical service indicator

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

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

Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.
- Check the movement of the service indicator core when the engine is run at full load speed. The core should latch approximately at the greatest vacuum that is attained.

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

If necessary, replace the service indicator more frequently in environments that are severely dusty. Replace the service indicator annually regardless of the operating conditions. Replace the service indicator when the engine is overhauled, and whenever major engine components are replaced.

Note: When a new service indicator is installed, excessive force may crack the top of the service indicator. Tighten the service indicator to a torque of 2 N·m (18 lb in).

i02263740

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

NOTICE
Perform this maintenance with the engine stopped.

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

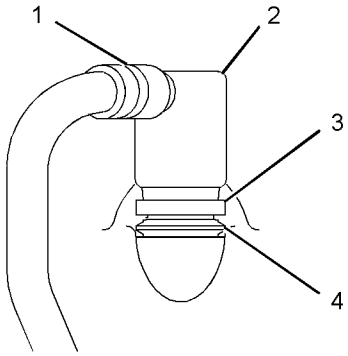

Illustration 104 g01136454

Typical example

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

1. Loosen hose clamp (1) and remove the hose from breather assembly (2).
2. Loosen retaining clamp (3). Remove the breather assembly and seal (4).
3. Wash the breather element in solvent that is clean and nonflammable. Allow the breather element to dry before installation.
4. Install a breather element that is clean and dry. Install the seal, the breather assembly, and the clamp. Refer to the Specifications, SENR3130 in order to locate the proper torques.
5. Install the hose. Install the hose clamp. Refer to the Specifications, SENR3130 in order to locate the proper torques.

i02139969

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 the Specifications Manual, SENR3130, “Torque Specifications”. Refer to your Caterpillar dealer for more information.

i00623423

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

⚠ WARNING

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

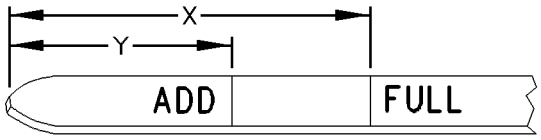

Illustration 105 g00110310

(Y) “ADD” mark. (X) “FULL” mark.

NOTICE
Perform this maintenance with the engine stopped.

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

i04237495

Engine Oil Sample - Obtain

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

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

Obtain the Sample and the Analysis

⚠ WARNING

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

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

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

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

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

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

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

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

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

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

i05264147

Engine Oil and Filter - Change

SMCS Code: 1318-510; 1348-044

⚠ WARNING

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

Do not drain the oil when the engine is cold. As the oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with the draining cold oil. Drain the crankcase with the engine stopped. Drain the crankcase 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 Oil

After the engine has been run at the normal operating temperature, stop the engine. Use one of the following methods to drain the engine crankcase oil:

- 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 in order to allow the oil to drain. If the engine is equipped with a shallow sump, 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.

Replace the Oil Filter

NOTICE
Cat oil filters are built to Caterpillar specifications. Use of an oil filter not recommended by Caterpillar could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

1. Remove the oil filter with a 1U-8760 Chain Wrench.
2. Cut the oil filter open with a 175-7546 Oil Filter Cutter Gp. 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 Cat dealer in order to arrange for a further analysis if an excessive amount of debris is found in the oil filter.

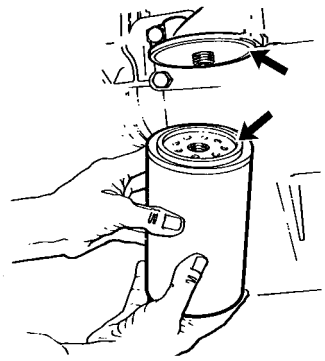

Illustration 106 g00103713
Typical filter mounting base and filter gasket

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

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

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

5. Install the oil filter. Tighten the oil filter until the oil filter gasket contacts the base. Tighten the oil filter by hand according to the instructions that are shown on the oil filter. Do not overtighten the oil filter.

Fill the Engine Crankcase

1. Remove the oil filler cap. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” or Operation and Maintenance Manual, “Refill Capacities”for more information.

NOTICE
If equipped with an auxiliary oil filter system or a remote oil filter system, follow the OEM or filter manufacturer's recommendations. Under filling or overfilling the crankcase with oil can cause engine damage.

NOTICE
To prevent crankshaft bearing damage, crank the engine with the fuel OFF. This will fill the oil filters before starting the engine. Do not crank the engine for more than 30 seconds.

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

3. Stop the engine and allow the oil to drain back to the sump for a minimum of 10 minutes.

4. Remove the oil level gauge in order to check the oil level. Maintain the oil level between the “ADD” and “FULL” marks on the oil level gauge.

i05264151

Engine Protective Devices - Check

SMCS Code: 7400-535

Alarms and shutoffs must function properly. Alarms provide timely warning to the operator. Shutoffs help to prevent damage to the engine. Determining if the engine protective devices are in good working order during normal operation is impossible. Malfunctions must be simulated in order to test the engine protective devices.

A calibration check of the engine protective devices will ensure that the alarms and shutoffs activate at the setpoints. Ensure that the engine protective devices are functioning properly.

NOTICE
During testing, abnormal operating conditions must be simulated.

The tests must be performed correctly in order to prevent possible damage to the engine.

To prevent damage to the engine, only authorized service personnel or your Cat dealer should perform the tests.

Visual Inspection

Visually check the condition of all gauges, sensors, and wiring. Look for wiring and components that are loose, broken, or damaged. Damaged wiring or components should be repaired or replaced immediately.

i03840829

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

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

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

NOTICE
Only qualified service personnel should perform this maintenance. Refer to the Systems Operation/Testing and Adjusting Manual, “Valve Lash and Valve Bridge Adjustment” article or consult 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 cannot be started while this maintenance is being performed. To help prevent possible injury, do not use the starting motor to turn the flywheel.

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

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.

i01597115

Engine Valve Rotators - Inspect

SMCS Code: 1109-040

WARNING

When inspecting the valve rotators, protective glasses or face shield and protective clothing must be worn, to help prevent being burned by hot oil or spray.

Engine valve rotators rotate the valves when the engine runs. This helps to prevent deposits from building up on the valves and the valve seats.

Perform the following steps after the engine valve lash is set, but before the valve covers are installed:

1. Start the engine according to Operation and Maintenance Manual, “Engine Starting” (Operation Section) for the procedure.
2. Operate the engine at low idle.
3. Observe the top surface of each valve rotator. The valve rotators should turn slightly when the valves close.

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

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

i02784507

Fan Drive Bearing - Lubricate

SMCS Code: 1359-086-BD

Some of the fan drives have grease fittings and some of the fan drives do not have grease fittings. If there is no grease fitting, periodic lubrication is not required. The fan drive requires grease only if the fan drive is equipped with a zerk.

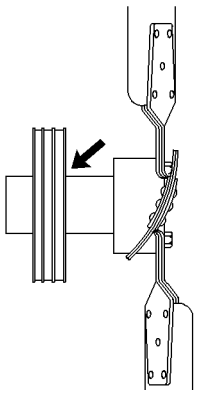

Illustration 107 g00746166

Typical location of the grease fitting (if equipped) that is for the fan drive bearing

The pulley is shown with the belt guards that have been removed.

Lubricate the grease fitting that is on the fan drive bearing with High Speed Ball Bearing Grease or the equivalent.

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

i00705823

Fuel Control Linkage - Check/ Lubricate

SMCS Code: 1257-535; 1257-086

Check the fuel control linkage for proper operation. If necessary, adjust the fuel control linkage . Refer to the Service Manual for the adjustment procedures.

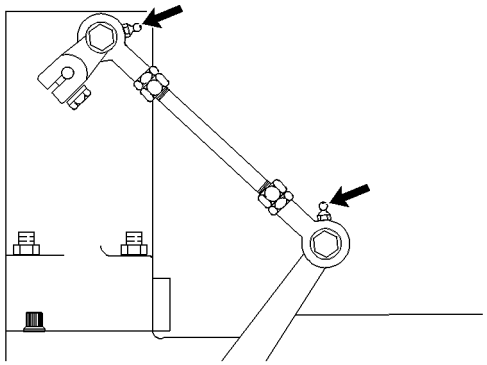

Illustration 108 g00309003

Typical grease fittings on the fuel control linkage

Some fuel control linkages require lubrication. Lubricate the grease fittings with 1P-0808 Multipurpose Grease or the equivalent.

i00626014

Fuel Injection Nozzles - Test/ Exchange

SMCS Code: 1254-081; 1254-013

⚠ WARNING

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

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.

Fuel injection nozzles are subject to tip wear. Tip wear is a result of fuel contamination. Tip wear can cause the following problems:

- Increased fuel consumption
- Black smoke
- Misfire
- Rough running

Fuel Injection nozzles should be cleaned, inspected, tested, and replaced, if necessary. Refer to Special Instruction, SEHS7292 for using the 8S-2245 Injection Cleaning Tool Group. Consult your Caterpillar dealer about cleaning the fuel injection nozzle and testing the fuel injection nozzle.

NOTICE
Never wire brush or scrape a fuel injection nozzle. Wire brushing or scraping a fuel injection nozzle will damage the finely machine orifice. Proper tools for cleaning and testing the fuel injection nozzles can be obtained from Caterpillar dealers.

The following items are symptoms of a malfunction of the fuel injection nozzle:

- Abnormal engine operation
- Smoke emission
- Engine knock

Each fuel injection nozzle must be isolated one at a time in order to determine the malfunctioning fuel injection nozzle.

1. Start the engine.

2. Loosen each fuel line nut one at a time at the fuel injection pump. A cloth or similar material must be used in order to prevent fuel from spraying on the hot exhaust components. Tighten each nut before loosening the next nut.

3. A defective fuel injection nozzle may be identified when a fuel line nut is loosened and the following conditions are present:

- The exhaust smoke is partially eliminated or the exhaust smoke is completely eliminated.
- Engine performance is not affected.

A fuel injection nozzle that is suspected of being defective should be removed. A new fuel injection nozzle should be installed in the cylinder in order to determine if the removed fuel injection nozzle is defective.

Removal and Installation of the Fuel Injection Nozzles

For the removal and the installation of fuel injection nozzles, special tooling is required. Refer to the Service Manual for more information. Consult your Caterpillar dealer for assistance.

i00891826

Fuel System - Prime

SMCS Code: 1258-548

⚠ WARNING

Personal injury or death can result from a fire.

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

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

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

Prime the fuel system in order to fill dry fuel filters. You must also prime the fuel system after any one of the following conditions exist:

- The fuel system has run dry.
- The engine has been in prolonged storage.
- The fuel filter has been cleaned.
- The fuel filter has been replaced.

Note: If the engine does not have a fuel priming pump, refer to Step 4.

1. Unlock the priming pump, and operate the priming pump until a resistance is felt. This procedure will probably require a considerable amount of priming.

2. Push in the plunger, and hand tighten the plunger.

NOTICE
Do not crank the engine for more than 30 seconds. Allow the starter to cool for two minutes before cranking again. Turbocharger damage can result if the engine rpm is not kept low until the oil gauge display verifies that the oil pressure is sufficient.

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3. Crank the engine.

If the engine starts and the engine runs rough, run the engine at low idle. Continue running the engine until the engine runs smoothly.

NOTICE
During periodic service, DO NOT remove the fuel filter plug that is in the fuel filter base in order to purge air from the fuel system. The periodic removal of the fuel filter plug will result in increased wear on the threads in the fuel filter base. This wear leads to fuel leakage.

---

4. Open the vent valve (if equipped) on the fuel injection pump's housing.

5. Operate the priming pump until the flow of fuel from the vent valve is continuous and the flow of fuel is free of air bubbles.

If the engine does not have a fuel priming pump, crank the engine. Crank the engine until the fuel flows freely and until the fuel is free of air bubbles.

6. Close the vent valve. Then, push in the plunger. Hand tighten the plunger.

7. Crank the engine. If the engine starts and if the engine runs rough, run the engine at low idle. Continue running the engine until the engine runs smoothly.

Note: If the engine will not start, more priming is necessary. If the engine continues to run rough, more priming is necessary as well.

NOTICE
Do not let the tops of fuel nozzles turn when the fuel line nuts are loosened or tightened.

The nozzles will be damaged if the top of the nozzle turns in the body.

The engine will be damaged if a defective fuel injection nozzle is used because the shape of fuel (spray pattern) that comes out of the nozzles will not be correct.

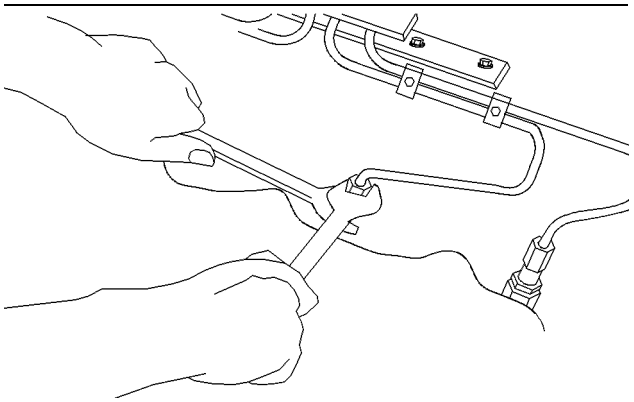

Illustration 109 g00290109

8. Loosen the fuel line nuts at the valve cover base. Loosen these line nuts one at a time.

9. Operate the priming pump until the flow of fuel from the fuel line is continuous and the flow of fuel is free of air bubbles.

10. Push in the plunger, and hand tighten the plunger. If the engine does not have a fuel priming pump, crank the engine.

11. Tighten each fuel line nut before you loosen the next fuel line nut. Tighten the fuel line nuts to a torque of 40 ± 7 N·m (30 ± 5 lb ft).

Continue this procedure until all of the fuel lines have been cleared of any air. Before you start the engine, make sure that the fuel line nuts are properly tightened. Also make sure that the priming is locked.

i05264163

Fuel System Primary Filter (Water Separator) Element - Replace

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

Water in the fuel can cause the engine to run rough. Water in the fuel may cause an electronic unit injector to fail. If the fuel has been contaminated with water, the element should be changed before the regularly scheduled interval.

The primary filter/water separator also provides filtration in order to help extend the life of the secondary fuel filter. The element should be changed regularly. Install a vacuum gauge. Change the element for the primary filter/water separator if the pressure is at 50 to 70 kPa (15 to 20 inches Hg).

Replace the Element

⚠ WARNING

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

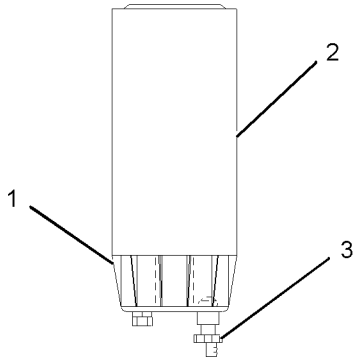

Illustration 110 g03130076

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

1. Stop the engine.

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

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

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

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

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

Dispose of all fluids according to local regulations and mandates.

5. Remove the fuel filter bowl and wash the fuel filter bowl with clean diesel fuel.

6. Remove the fuel filter.

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

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

NOTICE
In order to maximize fuel system life and prevent premature wear out from abrasive particles in the fuel, use Cat fuel filters.

Consult your Cat dealer for proper part numbers.

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

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

10. Install the clean fuel filter bowl on the new fuel filter.

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

11. Open the fuel tank supply valve.

12. Start the engine and check for leaks. Run the engine for 1 minute. Stop the engine and check the engine for leaks again.

Detection of leaks is very difficult especially if the engine is running. The primary filter/water separator is under suction. A leak will allow air to enter the fuel. The air in the fuel can cause low power due to aeration of the fuel. If air enters the fuel, check the components for overtightening or under tightening.

i06544918

Fuel System Primary Filter/ Water Separator - Drain

SMCS Code: 1260-543; 1263-543

S/N: TGC1–Up

S/N: DJN1–Up

S/N: 9EP1–Up

S/N: TFT1–Up

S/N: BCW1–Up

S/N: RTY1–Up

S/N: 4BZ1–Up

⚠ WARNING

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

NOTICE
The water separator is not a filter. The water separator separates water from the fuel. The engine should never be allowed to run with the water separator more than half full. Engine damage may result.

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

If your engine is equipped with high pressure fuel lines you must wait for 60 seconds after the engine has stopped, 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”.

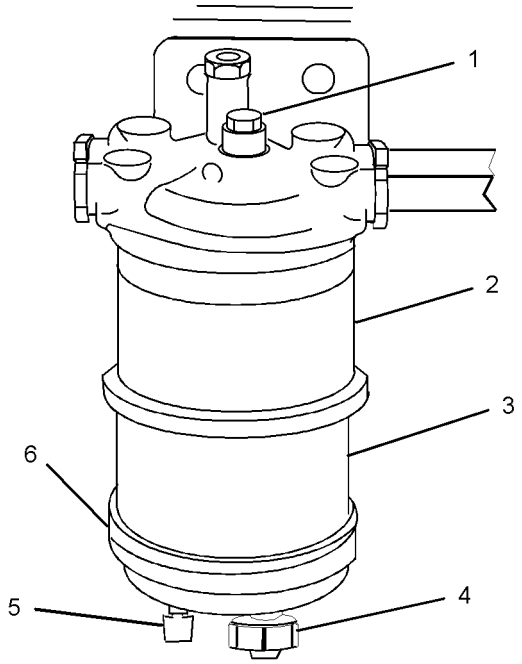

Illustration 111 g01118416

(1) Screw
(2) Element
(3) Glass bowl
(4) Sensor connection
(5) Drain
(6) Bottom cover

1. Place a suitable container below the water separator.

2. Open the drain (5). Allow the fluid to drain into the container.

3. When clean fuel drains from the water separator close the drain (5). Tighten the drain by hand pressure only. Dispose of the drained fluid correctly.

i06548377

Fuel System Primary Filter/ Water Separator - Drain

SMCS Code: 1260-543; 1263-543

S/N: XJ51–Up

⚠ WARNING

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

NOTICE
The water separator is not a filter. The water separator separates water from the fuel. The engine should never be allowed to run with the water separator more than half full. Engine damage may result.

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

If your engine is equipped with high-pressure fuel lines you must wait for 60 seconds after the engine has stopped, 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”.

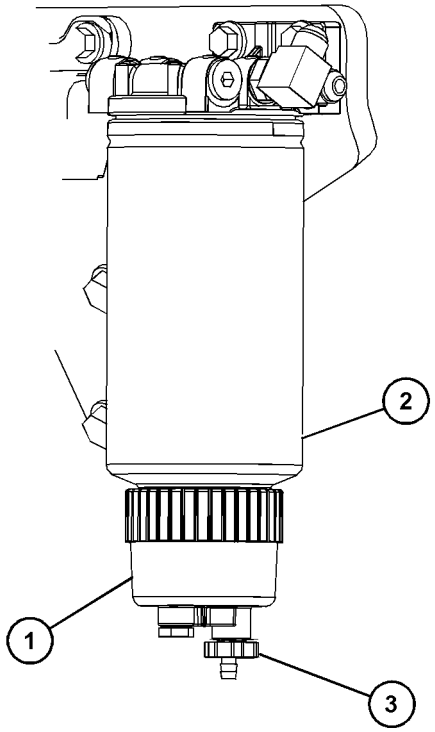

Illustration 112 g06018029

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

1. Place a suitable container below the water separator.

2. Open the drain (5). Allow the fluid to drain into the container.

3. When clean fuel drains from the water separator close the drain (5). Tighten the drain by hand pressure only. Dispose of the drained fluid correctly.

i00703732

Fuel System Secondary Filter - Replace

SMCS Code: 1261-510-SE

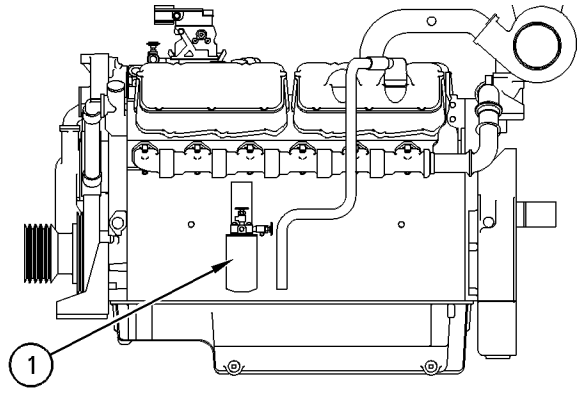

Illustration 113 g00307572

(1) Final fuel filter

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

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

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

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

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

4. Install the new fuel filter. Spin the new fuel filter onto the fuel filter base until the gasket contacts the base. Tighten the fuel filter by hand by one full turn. Do not overtighten the fuel filter. Use the rotation index marks that are on the fuel filter as a guide for proper tightening.

5. Prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime” for information on priming the fuel system.

i06104305

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

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

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

Dispose of all fluids according to local regulations and mandates.

Fuel Tank

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

Drain the Water and the Sediment

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

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

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

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

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

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

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

Fuel Storage Tanks

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

- Weekly
- Refill of the tank

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

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

i04723589

Generator - Dry

SMCS Code: 4450-569

⚠ 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.

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

If the insulation resistance values are less than the recommended values, one of the following drying procedures must be selected. This decision should be based on the following factors:

- the size of the unit
- the location of the unit
- the equipment that is available

- the experience of personnel

Note: For more information on drying methods, refer to Special Instruction, SEHS9124, “Cleaning and Drying of Electric Set Generators”.

Remove the voltage regulator. Cover all of the inlet openings. Cover all of the discharge holes. Provide an opening at the top of the machine. This opening will allow moisture to evaporate. Preferably, this opening will be located at the fan end. Monitor the winding temperatures. DO NOT APPLY HEAT TOO RAPIDLY. Winding temperature should be raised gradually at a rate of 10 °C (50 °F) per hour up to 85 °C (185 °F). Measure insulation resistance in 1 hour intervals. Typically, the insulation resistance will slowly drop while the temperature is rising. The insulation resistance will then start to increase at a slow rate until the insulation resistance reaches a constant level.

The following methods can be used for drying a generator:

- Self-circulating air method
- Oven method
- Controlled current method

Self-Circulating Air Method

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

Oven Method

Place the entire generator inside a forced air drying oven for 4 hours at 65 °C (149 °F).

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

Radiant type ovens can cause localized overheating.

Controlled Current Method

Table 20

Tools Needed		
Part Number	**Description**	**Qty**
225 - 8266	Ammeter Tool Gp	1
	External Power Source	1
	Rheostat	1

Heat can be used in order to dry the generator windings. This heat can be created by allowing a controlled current to flow through the generator. No high voltages are generated during the following procedure. Therefore, insulation breakdown will not occur.

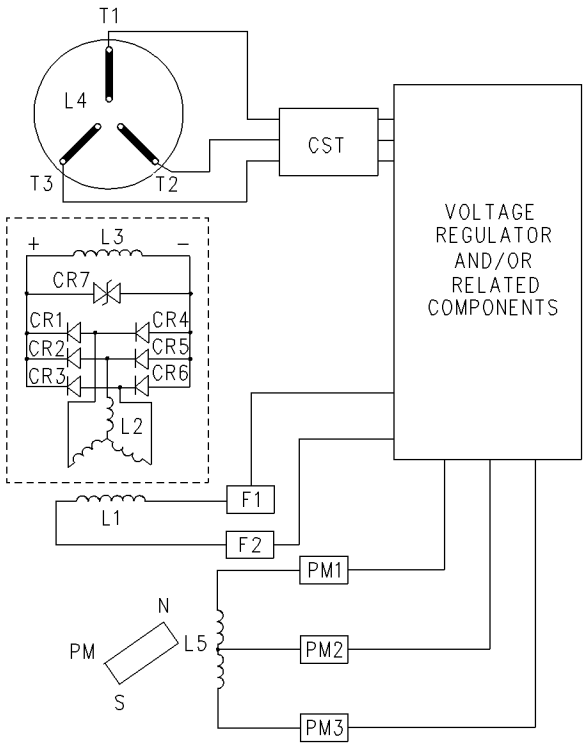

Illustration 114 g00669571

Generator Wiring Diagram

(CR1-CR6) Diodes
(CR7) Varistor
(L1) Exciter field (stator)
(L2) Exciter armature (rotor)
(L3) Main field (rotor)
(L4) Main armature (stator)
(L5) Pilot exciter armature
(PM) Permanent magnet
(RFA) Rotating field assembly
(CST) Customer supplied transformer

1. Make an external power source.
2. Refer to the above diagram. Disconnect “F1+” from the voltage regulator. Disconnect “F2-” from the voltage regulator. Disconnect the generator load. Connect the generator output leads “T0” , “T1” , “T2” , and “T3” . Install the clamp-on ammeter to generator output lead “T1” .

Note: When the line current is measured on multiple-lead units, measure the current in each conductor per phase. The currents can then be added.

3. Refer to the above diagram. Connect the rheostat. Adjust the rheostat to the maximum resistance value. Connect the external power source to wires “F1+” and “F2-” .

4. Start the generator set. Run the generator set at IDLE speed.

5. Monitor the phase current. Gradually increase the engine RPM. Increase the engine RPM until one of the following conditions are met:

- The rated phase current is obtained.
- The full generator set speed is obtained.

6. If more phase current is still necessary, slowly turn the rheostat until the rated phase current is reached.

7. On an hourly basis, stop the drying procedure. Check the insulation resistance. Repeat the above steps until the insulation resistance is acceptable.

i05728320

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.

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

Proper maintenance of electrical equipment requires periodic visual examination of the generator and periodic visual examination of the windings. Proper maintenance of electrical equipment also requires appropriate electrical checks and appropriate thermal checks. Insulation material should be examined for cracks. The insulation material should be examined for accumulations of dirt and dust. If there is an insulation resistance value that is below normal, a conductive path may be present. This conductive path may be made of one of the following materials:

- Carbon
- Salt
- Metal dust
- Dirt that is saturated with moisture

These contaminants will develop a conductive path which may produce shorts. Cleaning is advisable if heavy accumulations of dirt can be seen or if heavy accumulations of dust can be seen. If excess dirt is the cause of a restriction in the ventilation, cleaning is also advisable. Restricted ventilation will cause excessive heating.

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, various cleaning techniques are available. The cleaning procedure that is used may be determined by one of the items on the following list:

- The extent of the cleaning procedure that is being attempted
- The type of enclosure of the generator
- The voltage rating of the generator
- The type of dirt that is being removed

Cleaning (Assembled Generators)

Cleaning may be required at the point of installation. If complete disassembly of the generator is not necessary or feasible, a vacuum cleaner should be used to pick up the following items: dry dirt, dust and carbon. Vacuuming dust and dirt will prevent the spreading of these contaminants.

If necessary, connect a small nonconductive tube to the vacuum cleaner. A nonconductive tube 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 firmer dirt.

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 Cat dealer.

Cleaning (Disassembled Generators)

An initial insulation resistance check should be made on the generator in order to confirm electrical integrity. A minimum reading of 1 megohm would be expected with severely contaminated generators. A zero megohm reading may indicate an insulation breakdown. An insulation breakdown requires more than cleaning. An insulation breakdown requires repair.

A high-pressure wash is normally an effective way to clean windings. Windings that have been exposed to flooding, or windings that have been contaminated by salt can be high-pressure washed as well. A solution of hot water and detergent is used for this method of cleaning.

A high-pressure wash sprays a high velocity fluid stream of this solution over the generator that is being cleaned. This detergent washing is followed by multiple sprays of clean water. The clean water is used in order to remove the detergent or the clean water is used in order to dilute the detergent.

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. Use of solvents may be necessary if the generator is contaminated with oil or if the generator is contaminated with grease.

Note: For more information on drying methods, refer to Special Instructions, SEHS9124, “Cleaning and Drying of Electric Set Generators”.

i03569354

Generator Bearing Temperature - Measure/Record

SMCS Code: 4471-082-TA

Bearing temperature detectors are optional on generators. Bearing temperature detectors are used with equipment that has been provided by the customer in order to measure the bearing temperature. Bearing temperature detectors may help to prevent premature bearing failure.

A bearing temperature that is 50 °C (122 °F) above the ambient temperature may require a change in operation. The unit should be shut down in order to prevent damage if the bearing temperature is 50 °C (122 °F) above the ambient temperature.

i04066149

Generator Lead (Flat Braided Cable) - Check
(If Equipped)

SMCS Code: 4450-535

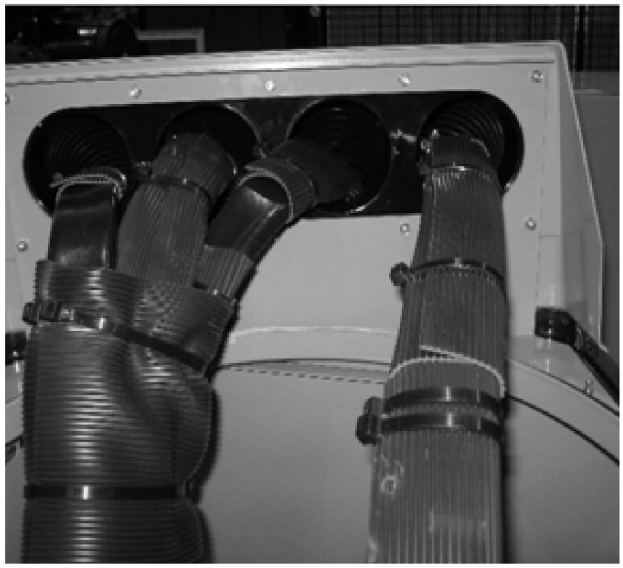

Illustration 115 g02146533

Typical flat braided conductor

The generator set may have braided square conductors or multiple round cables between the generator and the breaker.

Check braided conductors for signs of wear. Pay particular attention to the conductor protective sleeve insulation at the housing for the breaker and in the generator terminal box. Replace the mat immediately if the mat shows signs of wear at a point of contact. Replace the cable immediately if the insulation shows signs of wear at points of contact. If your generator set does not have rubber mats in place, contact your Cat dealer.

i04066150

Generator Lead (Round Cable) - Check
(If Equipped)

SMCS Code: 4450-535

The generator set may have braided square conductors or multiple round cables between the generator and the breaker.

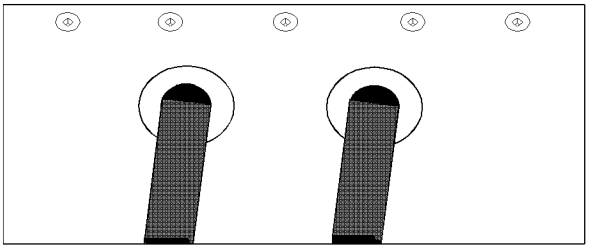

Illustration 116 g02223453
Round generator lead cables

Ensure that the generator output leads are routed out of the generator in a manner that prevents the leads from rubbing against metal objects. Visually inspect the following areas for cracking and physical damage:

- Stator output leads
- Protective sleeving
- Insulation

i01228480

Generator Load - Check

SMCS Code: 4450-535-LA

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

When a generator is installed or when a 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 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 .

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.

Electric sets normally have a low idle setting that is higher than industrial engines. Low idle will be approximately 66% of the full speed that is achieved by 60 Hz units. This would be equal to 80% of the full speed that is achieved by 50 Hz units.

Some electric sets are equipped with Woodward governors and some electric sets are equipped with Caterpillar electronic governors. These electric sets have no low idle stop. On electric sets with mechanical governors and natural gas electric sets, the low idle is set at the factory. Adjustment of the low idle on these machines should only be done by a Caterpillar dealer.

Note: Operating the electric set at low idle speed for an extended time will cause some voltage regulators to shut off. The electric set must be completely shut down and the electric set must be restarted. This will allow the voltage regulator to again produce an output.

i01228520

Generator Set - Test

SMCS Code: 4450-081

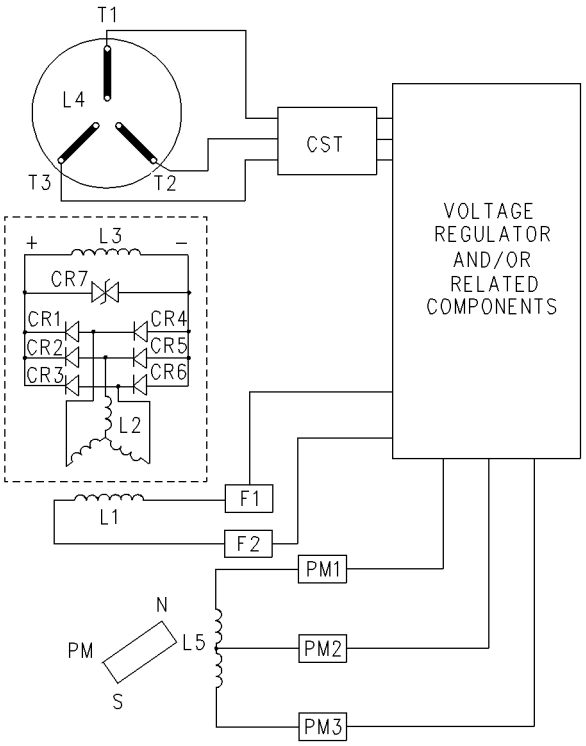

Illustration 117 g00669571

Generator Wiring Diagram

(CR1-CR6) Diodes
(CR7) Varistor
(L1) Exciter field (stator)
(L2) Exciter armature (rotor)
(L3) Main field (rotor)
(L4) Main armature (stator)
(L5) Pilot exciter armature
(PM) Permanent magnet
(RFA) Rotating field assembly
(CST) Customer supplied transformer

⚠ DANGER

Dangerous voltages are present at both the generator and the system bus.

Under no circumstances should any attempt be made to connect instrumentation to these points until you are certain all power is off.

All instruments must be connected to the generator and the system bus through potential transformers, which provide a maximum of 600 volts to the instruments.

Failure to follow instructions will result in death or serious injury.

Dangerous voltages are present at the generator's output terminals. Until the power is verified to be OFF, there should not be any device that is connected to the following terminals: (T1), (T2) and (T3). The voltmeter must be connected to the generator through potential transformers. Potential transformers provide a maximum of 600 volts to the voltmeter.

Table 21

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 “F1+” and “F2-” from the voltage regulator. Disconnect the generator from the load.
3. Connect a 12 VDC automotive battery to wires “F1 +” and “F2-” .

NOTICE
Do not operate the generator set at a speed that is higher than one-half of the rated speed.

Higher speeds under these test conditions can cause damage to the system.

4. Operate the generator set at half the rated speed.

5. 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.
6. Monitor the voltage between any two of the locations in step 5. Decrease the generator set speed by 10%. Increase the generator set speed by 10%.
7. The voltages that were measured in Step 5 should be nearly equal. These voltages should measure a minimum of 85 VAC.
8. When the generator set speed is decreased by 10%, the voltages that were measured in Step 6 should decrease by 10%. When the generator set speed is increased by 10%, the voltages that were measured in Step 6 should increase by 10% .

i01228545

Generator Set Vibration - Inspect

SMCS Code: 4450-040-VI

Check for vibration damage. Vibration may cause the following problems:

- loose fittings
- loose bolts
- excessive noise
- cracked insulation

The following areas are susceptible to vibration damage:

- stator output leads
- protective sleeving
- insulation
- exposed electrical connections
- transformers
- fuses
- capacitors
- lightning arrestors

Check the generator set's vibration level by using a broad spectrum analyzer.

i06104329

Hoses and Clamps - Inspect/ Replace

SMCS Code: 7554-040; 7554-510

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

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

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

Inspect the Hoses and the Clamps

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

- Hoses which are cracked
- Hoses which are soft
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering
- Hoses which exhibit signs of leakage which are not the result of loose couplings or clamps

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

- Cracking
- Looseness
- Damage

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

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

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

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

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

Replace the Hoses and the Clamps

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

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

Dispose of all fluids according to local regulations and mandates.

Cooling System

⚠ WARNING

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

⚠ WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

1. Stop the engine.
2. Allow the engine to cool.
3. Before servicing a coolant hose, slowly loosen the filler cap for the cooling system in order to relieve any pressure.
4. Remove the filler cap for the cooling system.
5. Drain the coolant from the cooling system to a level that is below the hose that is being replaced. Drain the coolant into a suitable clean container. The coolant can be reused.
6. Remove the hose clamps.
7. Disconnect the old hose.
8. Replace the old hose with a new hose.
9. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications” “Hose Clamps” for information about selecting and installing the proper hose clamps.
10. Refill the cooling system.
11. Clean the coolant filler cap. Inspect the gaskets on the filler cap. Inspect the gasket seat. Inspect the vacuum valve and seat for debris or damage. Replace the filler cap if the gaskets are damaged. Install the filler cap.
12. Start the engine. Inspect the cooling system for leaks.

Fuel System

⚠ WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

⚠ WARNING

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

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

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

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

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

2. Remove the hose clamps.

3. Disconnect the old hose.

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

4. Replace the old hose with a new hose.

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

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

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

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

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

Lubrication System

⚠ WARNING

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

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

2. Remove the hose clamps.

3. Disconnect the old hose.

4. Replace the old hose with a new hose.

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

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

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

Air System

1. Remove the hose clamps.

2. Disconnect the old hose.

3. Replace the old hose with a new hose.

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

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

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

i01917577

Instrument Panel - Inspect

SMCS Code: 7451-040

Inspect the instrument panel for good condition. Perform the self test. All of the warning lamps should illuminate. If a warning lamp does not illuminate, replace the bulb immediately. If the alarm does not sound, investigate the problem and correct the problem.

Check the condition of all of the gauges. If a gauge is broken, repair the gauge or replace the gauge immediately.

Frequently monitor the gauges during normal operation.

Record the data in a log. Compare the new data to the data that was previously recorded. Comparing the new data to the recorded data will help to establish the trends of engine performance. A gauge reading that is abnormal may indicate a problem with operation or a problem with the gauge.

i01189694

Insulation - Test

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

Recommended Periodic Insulation Tests

⚠ 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.

Periodically, use a megohmmeter to check the insulation resistance of the generator's main stator winding. The frequency of this test is determined by the generator's environment. Previous megohmmeter readings will also determine the frequency of this test.

Test the main stator windings with a megohmmeter in the following situations:

- The generator set is started for the first time.
- The generator set is removed from storage.
- The generator set is operating in a humid environment. Test every three months.
- The generator set is not protected from the elements in an enclosed area. Test every three months.
- The generator set is installed in an enclosed area. This area needs to be low in humidity and this area needs to have steady temperatures. Test every six months.
- The generator set has not been run under load for three months. Test the generator set weekly. Use space heaters around the generator set if the generator is exposed to a sea water environment or if the humidity is above 75%. Also use space heaters if a test result was below 3 megohms.

Space heaters must be used whenever the generator set is not under load. Space heaters must also be used whenever salt is present or whenever high humidity is present. Using a space heater in this fashion is the only way to maintain megohmmeter readings above one megohm. Use space heaters only when the generator is not running.

Recommended Periodic Insulation Test Procedure

⚠ 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.

1. Take the generator out of service.

2. Visually inspect the generator for moisture. If moisture exists, do not megger. Dry the unit first. Refer to Special Instruction, SEHS9124, “Cleaning and Drying of Electric Set Generators”.

3. Inspect the installation. Determine the equipment that will be tested by the 9U-6003 Megohmmeter.

4. Discharge the capacitance of the windings.

5. Disconnect “T0” from ground.

6. Disconnect the regulator sensing lead wires: “20” , “22” and “24” .

7. Disconnect the voltage transformer leads of the control panel (T1, T2 and T3).

8. Disconnect any sensing leads from the switchgear. Disconnect any sensing leads from other devices.

9. Connect the megohmmeter's RED lead to ground.

10. Connect the megohmmeter's BLACK lead to “T0” .

11. For units that are 600 volts or less, set the voltage to 500 Volts. For units that are more than 600 volts, set the voltage to 1000 Volts.

12. Use the 30/60 Time Resistance Method:

a. Apply voltage.

b. Observe the readings at 30 seconds. Observe the readings at 60 seconds.

c. Record the 60 second reading. This reading must be corrected for temperature.

d. Record temperature.

e. Record humidity.

f. Remove voltage.

13. Evaluate the readings. The actual value of the resistance may vary greatly between generators. For this reason, the insulation's condition must be evaluated. Base this evaluation on the comparison between the 60 second resistance readings and the readings that were taken on previous dates. These two readings must be taken under similar conditions. If a 60 second resistance reading has a 50% reduction from the previous reading, the insulation may have absorbed too much moisture.

14. Switch the megohmmeter to the “OFF” position. This will discharge the megohmmeter leads. Disconnect the megohmmeter leads.

Note: The results from the insulation resistance checks indicate when cleaning and/or repairing is becoming critical. Generally, insulation resistance will vary greatly with temperature. Therefore, always test at the same temperature and humidity. Refer to Illustration 118 .

Engine Serial Number_____

Generator Serial Number_____

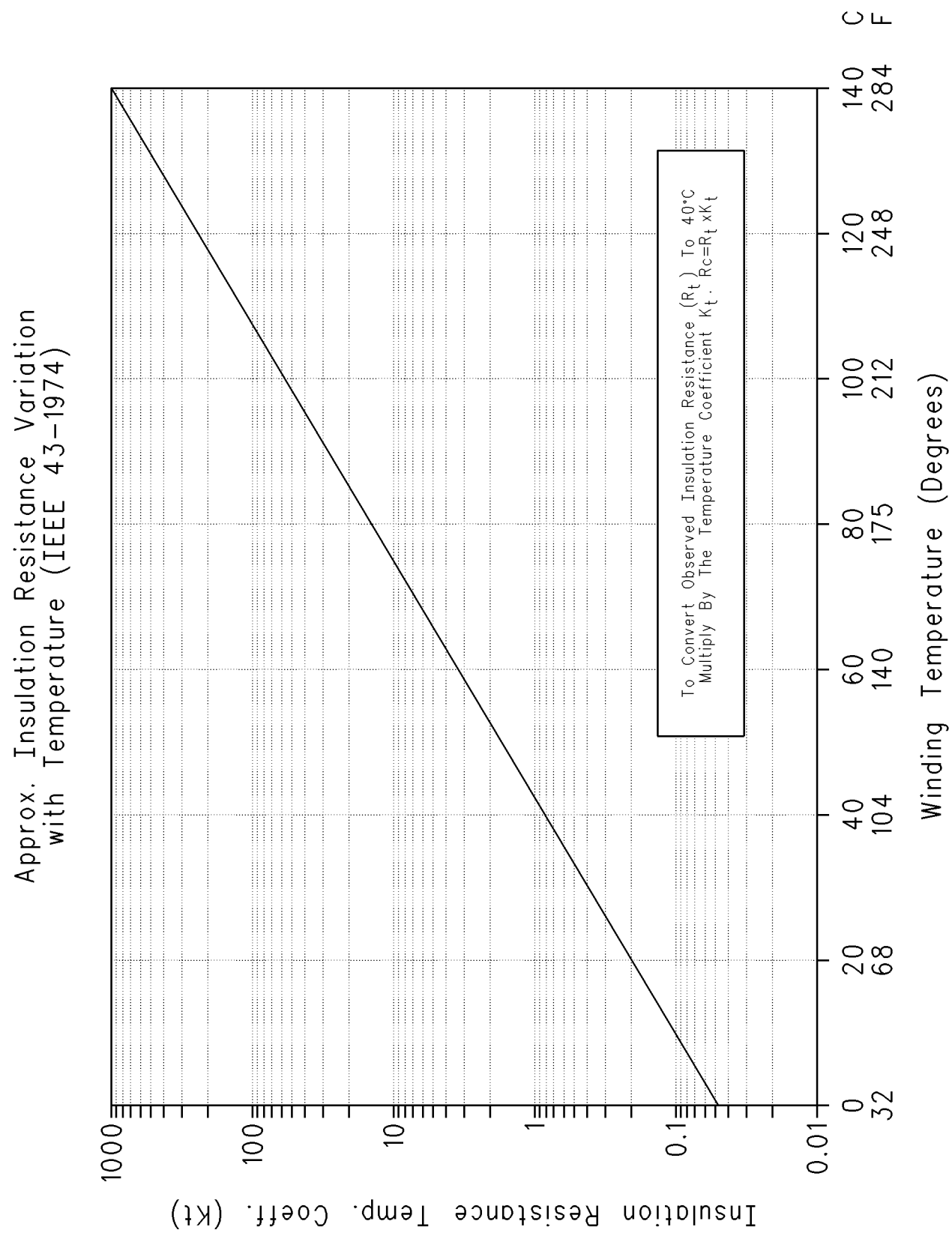
Approx. Insulation Resistance Variation
with Temperature (IEEE 43-1974)
Insulation Resistance Temp. Coeff. (Kt)
1000
100
10
1
0.1
0.01
0
32
20
68
40
104
60
140
80
175
100
212
120
248
140
284
C
F
Winding Temperature (Degrees)
To Convert Observed Insulation Resistance (Rt) To 40°C
Multiply By The Temperature Coefficient Kt. Rc=Rt xKt

Illustration 118 g00633226

i03230758

Jacket Water Heater - Check

SMCS Code: 1383-535

Jacket water heaters help to improve startability in ambient temperatures that are below 21 °C (70 °F). All installations that require automatic starting should have jacket water heaters.

Check the operation of the jacket water heater. Check the operation of the circulation pump, if equipped. For an ambient temperature of 0 °C (32 °F), the heater should maintain the jacket water coolant temperature at approximately 32 °C (90 °F).

i00906366

Magnetic Pickups - Clean/ Inspect

SMCS Code: 1907-040; 7400-070; 7400-040

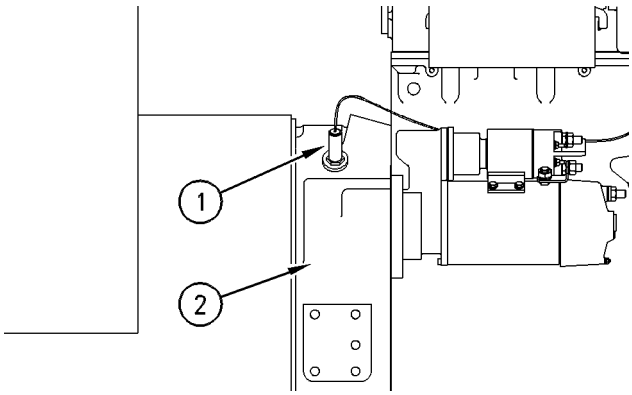

Illustration 119 g00293335

Typical example

(1) Magnetic pickup
(2) Flywheel housing

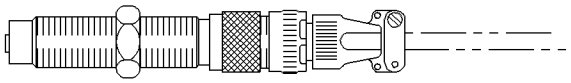

Illustration 120 g00293337

Typical magnetic pickup

1. Remove magnetic pickup (1) from flywheel housing (2). Check the condition of the end of the magnetic pickup. Check for signs of wear and contaminants.
2. Clean the metal shavings and other debris from the face of the magnet.
3. Install the magnetic pickup and adjust the magnetic pickup. Refer to the Service Manual for the installation procedure.

i02378613

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

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

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

This lower cost can be attributed to three aspects:

- Specially designed Caterpillar engine features
- 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

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

These components should be inspected according to the instructions that are found in various 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

Crankshaft Bearings, Valve Rotators, and Crankshaft Seals

The following components may not last until the second overhaul.

- Thrust bearings
- Main bearings
- Rod bearings
- Valve rotators
- Crankshaft seals

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
- Camshaft followers

Caterpillar Inc. recommends replacing the crankshaft vibration damper.

Oil Cooler Core and Aftercooler Core

During an overhaul, Caterpillar Inc. recommends the removal of both the oil cooler core and the aftercooler core. Clean the oil cooler core and the aftercooler core. Then, pressure test both of these cores.

NOTICE
Do not use caustic cleaners to clean the core.

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

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

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

Note: Caterpillar Inc. recommends the use of Hydrosolv Liquid Cleaners. Table 22 lists the Hydrosolv Liquid Cleaners that are available from your Caterpillar dealer.

Table 22

Hydrosolv Liquid Cleaners[1]		
Part Number	**Description**	**Size**
1U-5490	Hydrosolv 4165	19 L (5 US gallon)
174-6854	Hydrosolv 100	19 L (5 US gallon)

(1) Use a two to five percent concentration of the cleaner at temperatures up to 93°C (200°F).

4. Use steam to clean the oil cooler core and the aftercooler core. This removes any remaining residue from the cleaner. Flush the fins of the oil cooler core and the aftercooler core. Remove any other trapped debris.
5. Wash the oil cooler core and the aftercooler core with hot, soapy water. Rinse the oil cooler core and the aftercooler core thoroughly with clean water.

⚠ WARNING

Personal injury can result from air pressure.

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

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

6. Dry the oil cooler core and the aftercooler core with compressed air. Direct the air in the reverse direction of the normal flow.

7. Inspect the components in order to ensure cleanliness. The oil cooler core and the aftercooler core should be pressure tested. Repair the oil cooler core and the aftercooler core, if necessary. Install the oil cooler core and the aftercooler core.

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

Obtain Coolant Analysis

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

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

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

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

S·O·S Coolant Analysis (Level 2)

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

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

S·O·S Coolant Analysis (Level 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.

i01191656

Power Factor - Check

SMCS Code: 4450-535-PWR

The power factor of a system can be determined by a power factor meter or by calculations. The power factor can be calculated by dividing kW by kVA. Power factor is expressed as a decimal.

i04020194

Radiator - Clean

SMCS Code: 1353-070

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

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

⚠ WARNING

Personal injury can result from air pressure.

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

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

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

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

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

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

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

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”.

i01601961

Rotating Rectifier - Test

SMCS Code: 4465-081

Testing A Brushless Exciter Rotating Rectifier With An Ohmmeter

Table 23

Tools Needed		
Part Number	**Part Name**	**Quantity**
6V-7070	Digital Multimeter	1
9U-7330	Multimeter	1
146-4080	Digital Multimeter (RS-232)	1
7X-1710	Multimeter Probe Group	1

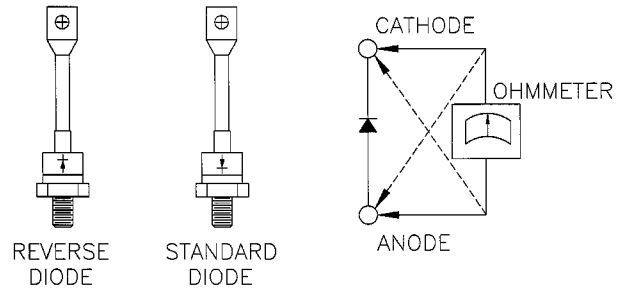

Illustration 121 g00555106

If the failure of a rectifier is suspected, use the following procedure.

1. Remove the cover from the exciter.
2. Remove the nut that secures the rectifier to the heat sink.
3. Remove the diode lead.
4. Lift the rectifier from the heat sink.
5. Refer to Illustration 121 . Connect the ohmmeter's leads across the rectifier. Note the meter reading.
6. Reverse the ohmmeter leads. Note the meter reading.

The ohmmeter should indicate a low resistance when the ohmmeter leads are across the rectifier in one direction. The ohmmeter should indicate a high resistance when the leads are reversed.

If the ohmmeter indicates a low resistance in both directions, the rectifier is shorted. A high resistance in both directions indicates an open rectifier.

Replace any faulty rectifiers with rectifiers that have comparable operating characteristics. Include the following information when a rectifier is being ordered for replacement:

- Part Number of the rectifier
- Model number of the exciter
- Type of the exciter

- Serial number of the generator

Rectifier Block Test

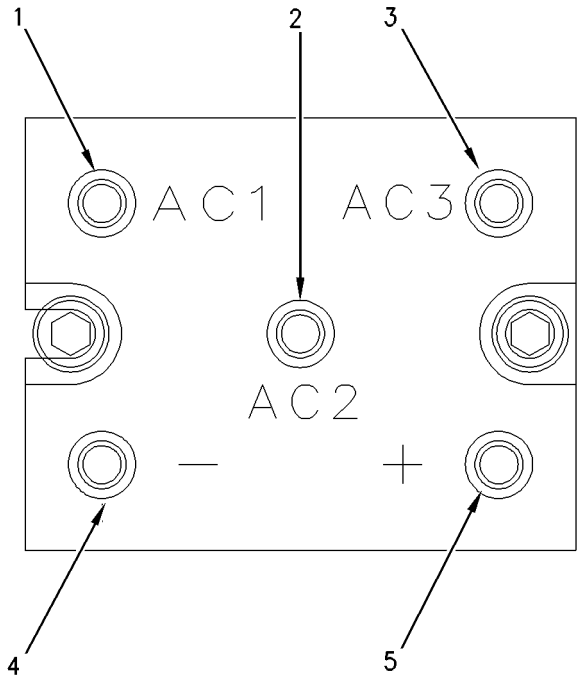

Illustration 122 g00775020

Rectifier Block

(1) “AC1” terminal
(2) “AC2” terminal
(3) “AC3” terminal
(4) Negative terminal
(5) Positive terminal

Perform the following steps in order to test the rectifier block. When possible, use the diode test scale. If there is no diode test scale, use the resistance scale.

1. Touch the red ohmmeter lead to the rectifier terminal that is marked “+” .

2. Touch the black ohmmeter lead to the rectifier terminals that have the following labels: “AC1” , “AC2” and “AC3” . The meter should indicate an open circuit or high resistance for each rectifier terminal. If the meter does not indicate an open circuit or high resistance, the rectifier is bad. Replace the rectifier.

3. Touch the black ohmmeter lead to the rectifier terminal that is marked “+” .

4. Touch the red ohmmeter lead to the rectifier terminals that have the following labels: “AC1” , “AC2” and “AC3” . The meter should indicate a good diode or low resistance. If the meter does not indicate a good diode or low resistance, the rectifier is bad. Replace the rectifier.

5. Touch the black ohmmeter lead to the rectifier terminal that is marked “−” .

6. Touch the red ohmmeter lead to the rectifier terminals that have the following labels: “AC1” , “AC2” and “AC3” . The meter should indicate an open circuit or high resistance for each rectifier terminal. If the meter does not indicate an open circuit or high resistance, the rectifier is bad. Replace the rectifier.

7. Touch the red ohmmeter lead to the rectifier terminal that is marked “−” .

8. Touch the black ohmmeter lead to the rectifier terminals that have the following labels: “AC1” , “AC2” and “AC3” . The meter should indicate a good diode or low resistance. If the meter does not indicate a good diode or low resistance, the rectifier is bad. Replace the rectifier.

Replace any faulty rectifiers with rectifiers that have comparable operating characteristics. Include the following information when a rectifier is being ordered for replacement:

- Part Number of the rectifier
- Model number of the exciter
- Type of the exciter
- Serial number of the generator

i00151038

Severe Service Application - Check

SMCS Code: 1000-535

Severe service is an application of an engine that exceeds current published standards for that engine. Caterpillar maintains standards for the following engine parameters:

- Performance (power range, speed range and fuel consumption)
- Fuel quality
- Altitude range
- Maintenance intervals
- Oil selection and maintenance

- Coolant selection and maintenance
- Environmental qualities
- Installation

Refer to the standards for the engine or consult with your Caterpillar dealer in order to determine if the engine is operating within the defined parameters.

Severe service operation can accelerate component wear. Engines that operate under severe conditions may need more frequent maintenance intervals in order to ensure maximum reliability and retention of full service life.

Due to individual applications, it is not possible to identify all of the factors which can contribute to severe service operation. Consult your Caterpillar dealer for the unique maintenance that is necessary for the engine.

The operating environment, improper operating procedures and improper maintenance procedures can be factors which contribute to severe service conditions.

Environmental Factors

Ambient temperatures – The engine may be exposed to extended operation in extremely cold environments or hot environments. Valve components can be damaged by carbon buildup if the engine is frequently started and stopped in very cold temperatures. Extremely hot inlet air reduces engine performance.

Air Quality – The engine may be exposed to extended operation in an environment that is dirty or dusty, unless the equipment is cleaned regularly. Mud, dirt and dust can encase components. Maintenance can be very difficult. The buildup can contain corrosive chemicals.

Buildup – Compounds, elements, corrosive chemicals and salt can damage some components.

Altitude – Problems can arise when the engine is operated at altitudes that are higher than the intended settings for that application. Necessary adjustments should be made.

Improper Operating Procedures

- Extended operation at low idle
- Frequent hot shutdowns
- Operating at excessive loads
- Operating at excessive speeds
- Operating outside the intended application

Improper Maintenance Procedures

- Extending the maintenance intervals
- Failure to use recommended fuel, lubricants and coolant/antifreeze

i00651416

Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

Caterpillar Inc. recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for proper operation. Check the electrical connections and clean the electrical connections. Refer to the Service Manual for more information on the checking procedure and for specifications or consult your Caterpillar dealer for assistance.

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Turbocharger - Inspect

SMCS Code: 1052; 1052-040

Periodic inspection and cleaning are recommended for the turbocharger compressor housing (inlet side). 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 inlet and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of a turbocharger housing under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is repaired or replaced.

An inspection of the turbocharger can minimize unscheduled downtime. An inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

Note: Turbocharger components require precision clearances. The turbocharger cartridge must be balanced due to high rpm. Severe Service Applications can accelerate component wear. Severe Service Applications require more frequent inspections of the cartridge.

Removal and Installation

For options regarding the removal, installation, repair, and replacement, consult your Cat dealer. Refer to the Service Manual for this engine for the procedure and specifications.

Cleaning and Inspecting

1. Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil. Clean the interior of the pipes in order to prevent dirt from entering during reassembly.

2. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger must be reconditioned.

3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the wheel, there is a possibility of a failed turbocharger oil seal.

The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the inlet air (plugged air filters), which causes the turbocharger to slobber.

4. Inspect the bore of the turbine housing for corrosion.

5. Clean the turbocharger housing with standard shop solvents and a soft bristle brush.

6. Fasten the air inlet piping and the exhaust outlet piping 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 proper place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

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

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

- Ensure that cooling lines are properly clamped and 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 coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

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

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the valve cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.
- Inspect the alternator belt and the accessory drive belts for cracks, breaks or other damage.

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

- Drain the water and the sediment from fuel tanks on a daily basis in order to ensure that only clean fuel enters the fuel system.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Inspect the engine-to-frame 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 which are cracked or 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

A failed water pump might cause severe engine overheating problems. Overheating could result in cracks in the cylinder head, a piston seizure, or other potential damage to the engine.

Visually inspect the water pump for leaks. If leaking of the water pump seals is observed, replace all of the water pump seals. Refer to two articles in the Disassembly and Assembly Manual, “Water Pump - Disassemble and Water Pump - Assemble” for the disassembly and assembly procedure. If necessary to remove the water pump, refer to two articles in the Disassembly and Assembly Manual, “Water Pump - Remove and Water Pump - Install”.

Inspect the water pump for wear, cracks, pin holes, and proper operation. Refer to the Parts Manual for the correct part numbers for your engine or consult your Cat dealer if repair is needed or 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

Ratings for Generator Set Engines

The engine ratings that are listed below have a manufacturing tolerance of plus three percent or minus three percent.

Standby Rating

- Typical load factor of 60 percent or less
- 100 typical operating hours per year
- Typical applications with standby service for building services with an enclosed environment
- 80 percent typical peak demand of the standby rated kW
- 100 percent of the rated kW for the duration of an emergency outage

Prime Rating

- Typical load factor of 60 percent to 70 percent
- No limit to typical operating hours
- Typical peak demand at 100 percent of the continuous rated kW for less than 10 percent of the total operating hours

Some typical applications include the following operations:

- industrial
- pumping
- construction
- peak shaving
- cogeneration

NOTICE
Operating a generator set engine above the rating definitions will result in a shorter engine service life before overhaul.

Customer Service

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Customer Assistance

SMCS Code: 1000

USA and Canada

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

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

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

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

1-800-447-4986

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

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

Caterpillar Inc.
Electric Power North America
Attn: Product Support Manager
AC 6109
Mossville, Illinois 61552

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

Outside of USA and of Canada

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

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

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

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Ordering Replacement Parts

SMCS Code: 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

Additional literature regarding your product may be purchased from your local Cat dealer or by visiting www.cat.com. Use the product name, sales model, and serial number in order to obtain the correct information for your product.

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Decommissioning and Disposal

SMCS Code: 1000

When the generator set is removed from service, local regulations for the generator set decommissioning will vary. Disposal of the generator set will vary with local regulations. Consult the nearest Cat dealer for additional information.

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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 various other business decisions that are related to engine maintenance.

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

Records should be kept for the following items:

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

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

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

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

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

Index

Product and Dealer Information

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

Delivery Date: _____

Product Information

Model: _____

Product Identification Number: _____

Engine Serial Number: _____

Transmission Serial Number: _____

Generator Serial Number: _____

Attachment Serial Numbers: _____

Attachment Information: _____

Customer Equipment Number: _____

Dealer Equipment Number: _____

Dealer Information

Name: _____ Branch: _____

Address: _____

_____

_____

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