CATERPILLAR®

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June 2001

Operation and Maintenance Manual

SR4B Generators And Control Panels

Important Safety Information

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

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

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

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

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

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

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

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

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

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

⚠ WARNING

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

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

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Foreword

Literature Information

This Manual contains operation instructions and maintenance information.

The operation sections is a reference for the new operator and a refresher for the experienced one. Read - study - and keep it handy.

Illustrations guide the operator through the correct procedures of checking, starting, operating and stopping the engine generator.

The maintenance sections is a guide to equipment care and has illustrated step-by-step instructions.

Some photographs in this publication may show details or attachments that may be different from your equipment. Also, guards and covers may have been removed for illustrative purposes.

Continuing improvement and advancement of product design may have caused changes to your engine driven generator which may not be covered in this publication.

Whenever a question arises regarding your engine driven generator or this publication, please consult your Caterpillar dealer for the latest available information.

Generator Identification

Every Caterpillar generator has a serial number stamped on the nameplate and on the frame. The plate is located on the left side of the generator. The number identifies the generator type, capacity, and nominal voltage of the generator.

Ordering Parts

Quality Caterpillar replacement parts are available from Caterpillar dealers throughout the world. Their parts stocks are up to date and include all parts normally required to protect your investment in Caterpillar equipment.

When ordering parts, your order should specify the quantity, part number, part name and serial number, arrangment number and modification number of the equipment for which the parts are needed. If in doubt about the part number, please provide your dealer with a complete description of the needed item.

California Propostion 65 Warning

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

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

Certified Engine Maintenance

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

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

Caterpillar Product Identification Number

Effective First Quarter 2001 the Caterpillar Product Identification Number (PIN) will change from 8 to 17 characters. In an effort to provide uniform equipment identification, Caterpillar and other construction equipment manufacturers are moving to comply with the latest version of the product identification numbering standard. Non-road machine PINs are defined by ISO 10261. The new PIN format will apply to all Caterpillar machines and generator sets. The PIN plates and frame marking will display the 17 character PIN. The new format will look like the following:

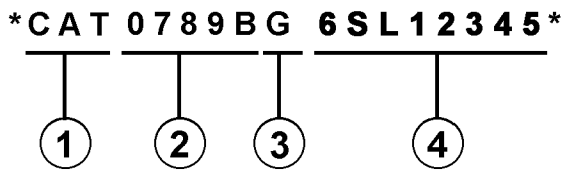

Illustration 1 g00751314

Where:

1. Caterpillar's World Manufacturing Code (characters 1-3)

2. Machine Descriptor (characters 4-8)

3. Check Character (character 9)

4. Machine Indicator Section (MIS) or Product Sequence Number (characters 10-17). These were previously referred to as the Serial Number.

Machines and generator sets produced before First Quarter 2001 will maintain their 8 character PIN format.

Components such as engines, transmissions, axles, etc. and work tools will continue to use an 8 character Serial Number (S/N).

Safety Section

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Safety Signs and Labels

SMCS Code: 4450; 7405

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

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

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

⚠ 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.

The warning labels that may be attached on the generator are illustrated and described below.

Electrical Distribution (Generator)

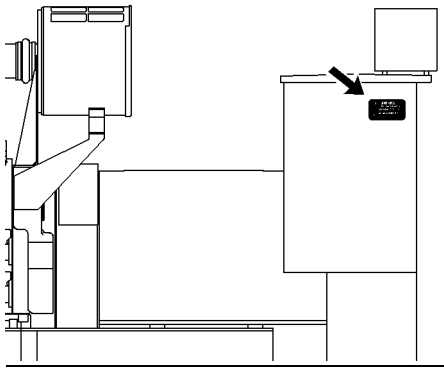
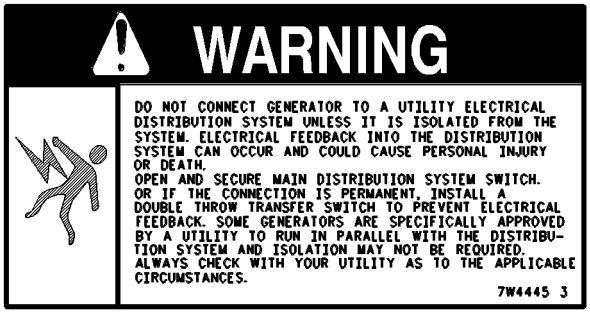


Illustration 2 g00305862

The warning label for electrical distribution (generator) is located on the covers of the generator.



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⚠ WARNING

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

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

Emergency Stop

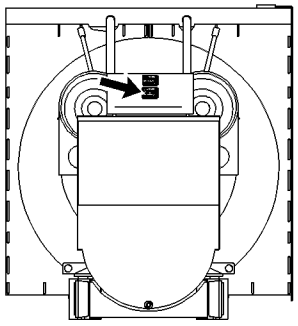
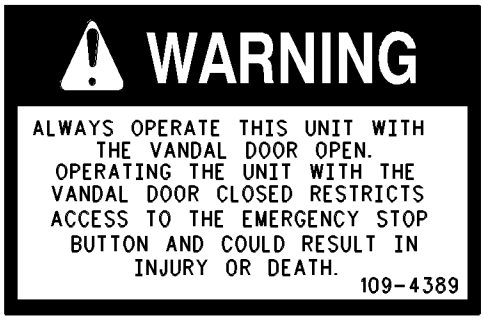


Illustration 3 g00305895

The warning label for emergency stop is located on the outside of the door of the control panel.



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WARNING

Always operate this unit with the vandal door open. Operating the unit with the vandal door closed restricts access to the emergency stop button and could result in injury or death.

Operation

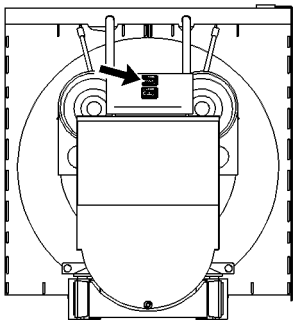
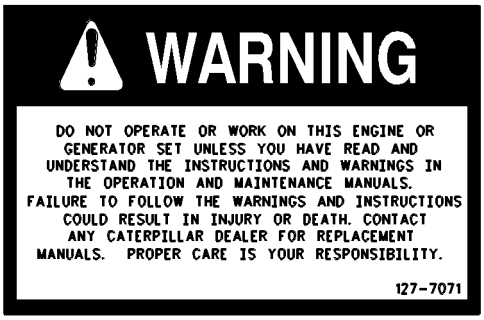


Illustration 4 g00306263

The warning label for operation is located on the outside of the door of the control panel.



g00306265

WARNING

Do not operate or work on this engine or generator set unless you have read and understand the instructions and warnings in the Operation and Maintenance Manuals.

Failure to follow the warnings and instructions could result in injury or death. Contact any Caterpillar dealer for replacement manuals. Proper care is your responsibility.

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General Hazard Information

SMCS Code: 4450

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

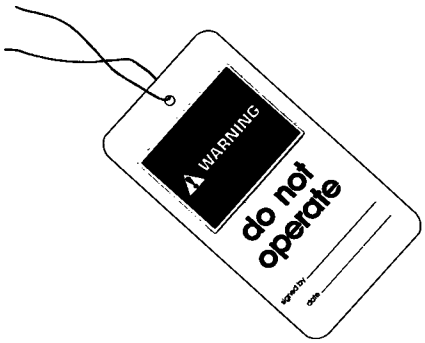

Illustration 5 g00104545

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

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

Engine speeds, temperatures, and load are the best indicators of performance. Rely on instrumentation. Record all readings. Compare these readings with previous readings in order to detect developing abnormalities.

- Wear a hard hat, protective glasses, and other protective equipment, as required.
- When work is performed around a generator set 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 generator set.
- Ensure that all protective guards and all covers are secured in place on the generator set.
- 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 generator set is stopped. Ensure that the generator set cannot be started. Ensure that the remote starting system is inoperative.
- Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads in order to help prevent sparks.
- Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.
- Remove all tools, electrical cords, and any other loose items from the engine before starting the engine.

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Burn Prevention

SMCS Code: 4450

Do not touch any part of an operating generator set. Allow the generator set to cool before any maintenance is performed on the generator set. Before any lines, fittings or related items are disconnected, relieve all pressure in the following systems: lubrication system, fuel system, and cooling system.

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Fire Prevention and Explosion Prevention

SMCS Code: 4450

Make sure that the engine room is ventilated properly.

Keep the engine clean. Keep the floor clean of debris.

Store oily rags and other flammable material in protective containers.

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

Do not smoke in battery charging areas. Batteries give off flammable fumes which can explode. Store batteries in a well ventilated area.

Do not smoke in areas that contain flammable material.

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

Do not allow flammable materials to accumulate on the engine.

Before the engine is operated, tighten all loose electrical wires and 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. Do not use a wire or a cable that is physically smaller than 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. Arcing or sparking could cause a fire. The following practices will help prevent arcing and sparking:

- use only recommended wiring.
- secure all connections.
- properly maintain battery cables.

Fire Extinguisher

Ensure that fire extinguishers are available. Be familiar with the operation of the fire extinguishers. Inspect the fire extinguishers and service the fire extinguishers regularly. Service the fire extinguisher according to the recommendations on the instruction plate.

Do not use carbon tetrachloride fire extinguishers. The fumes are toxic and the liquid has a deteriorating effect on insulation.

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Crushing Prevention and Cutting Prevention

SMCS Code: 4450

When work beneath a component is performed, support the component properly.

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 (if equipped). The fan blades will throw objects and the fan blades will cut objects.

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

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

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Mounting and Dismounting

SMCS Code: 4450

Generator sets in permanent installations may require the use of climbing equipment in order to provide access for normal maintenance. The owner is responsible and/or the user is responsible for providing safe access that conforms to SAE J185 and/or local building codes.

Inspect the steps, the handholds, and the work area before mounting the generator set. Keep these items clean and keep these items in good repair.

Mount the generator set and dismount the generator set only at locations that have steps and/or handholds. Do not climb on the generator set, and do not jump off the generator set.

Face the generator set in order to mount the generator set or dismount the generator set. Maintain a three-point contact with the steps and handholds. Use two feet and one hand or use one foot and two hands. Do not use any controls as handholds.

Do not jump from an elevated platform. Do not jump from a ladder or stairs.

Do not stand on components which cannot support your weight. Use an adequate ladder or use a work platform. Secure the climbing equipment so that the equipment will not move.

Do not carry tools or supplies when you are climbing. Use a hand line or other means for carrying equipment up to the work area.

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Before Starting Engine

SMCS Code: 1000; 4450

Inspect the engine for potential hazards.

Walk around the generator set before the engine is started. Ensure that no one is on the generator set. Also ensure that no one is underneath the generator set, or close to the generator set. Ensure that the area is free of personnel.

Ensure that the generator set is equipped with a lighting system that is suitable for the conditions. Ensure that all lights work properly.

See Service Manual for repairs and for adjustments.

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Engine Starting

SMCS Code: 1000; 4450

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.

Do not start the engine when anyone is working on the generator set. Do not start the engine when anyone is working near the generator set.

All protective guards and all protective covers must be installed if the engine is 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.

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

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Engine Stopping

SMCS Code: 1000; 4450

Stop the engine. In order to avoid overheating and accelerated wear of the engine components, refer to the engine Operation and Maintenance Manual, "Engine Stopping".

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

On the initial start-up of a new engine or an engine that has been serviced, make provisions to stop the engine if an overspeed occurs. This may be accomplished by shutting off the fuel supply to the engine or by shutting off the ignition system.

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Electrical System

SMCS Code: 1000; 4450

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.

Check the electrical wires daily for wires that are loose or frayed. Tighten all loose electrical wires before the engine is operated. Repair all frayed electrical wires before the engine is started.

Always disconnect the engine starter circuit when you are working on the generator.

Do not touch the heat sink on the generator regulator when the generator is running. The heat sink is electrically "hot". Do not work on electrically hot equipment. Always disconnect all electrical power from electrical equipment that is being serviced.

Grounding Practices

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

Uncontrolled electrical circuit paths can cause electrical activity that may degrade the engine electronics and communications.

For the starting motor, do not attach the battery negative terminal to the engine block.

Use a ground strap in order to ground the case of all control panels to the engine block.

Ground the engine block with a ground strap. Connect this ground strap to the ground plane.

Use a separate ground strap in order to ground the battery negative terminal for the control system to the ground plane.

Ensure that all grounds are secure and free of corrosion.

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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.

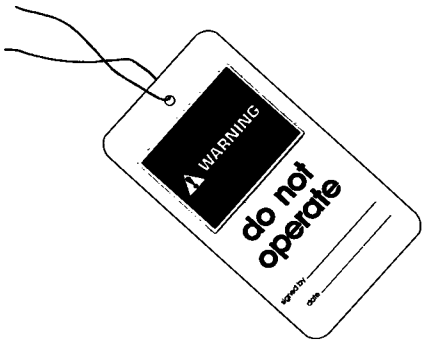

Illustration 6 g00104545

2. Attach a “DO NOT OPERATE” or similar warning tag to the engine prime mover starting circuit. Disconnect the engine starting circuit.

3. Disconnect the generator from the distribution system.

4. Lock out the circuit breaker. Attach a “DO NOT OPERATE” or similar warning tag to the circuit breaker. Refer to the electrical diagram. Verify that all points of possible reverse power flow have been locked out.

5. For the following circuitry, remove the transformer’s fuses:

- power
- sensing
- control

6. Attach a “DO NOT OPERATE” or similar warning tag to the generator excitation controls.

7. Remove the cover of the generator’s terminal box.

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

9. Determine that the generator is in a de-energized condition. Add ground straps to the conductors or terminals. During the entire work period, these ground straps must remain connected to the conductors and to the terminals.

Product Information Section

Model Views

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Model View Illustrations

SMCS Code: 4450

SR4B Generators (Typical Examples)

Large Frame Generators

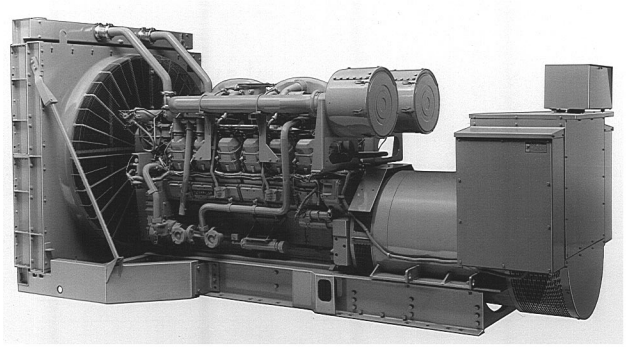

Illustration 7 g00611770
3512B Generator Set

Small Package Generator Sets

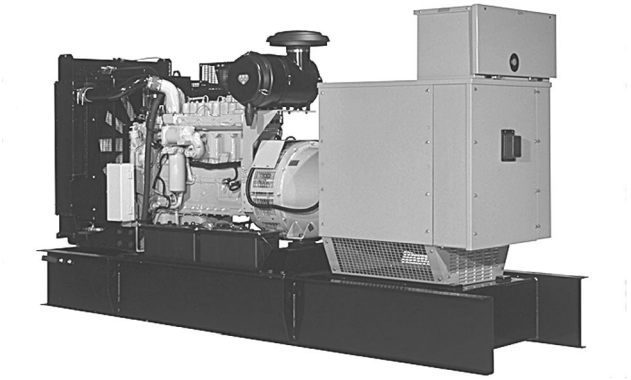

Illustration 8 g00625906
3306B Generator Set

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Generator Description

SMCS Code: 4450

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 brushes in the field circuit provides the following benefits:

- reduced maintenance
- increased reliability
- increased protection in potentially hazardous atmospheres

Generator set packages can be utilized for prime power generation or standby power generation. 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 that are used in 3306B and 3406C generator sets are either four pole or six pole design. 3306B and 3406C generator sets can have the following lead configurations: four lead, six lead, ten lead, and twelve lead. The generators that are used in 3406E, 3412C, and 3500 generator sets are four-pole design and six-pole design. The generator's frame size will determine the lead configuration. 3412C and 3500 generator sets can have a six-lead configuration or a twelve-lead configuration. SR4B generators are capable of producing electrical power in either 50 Hz or 60 Hz applications.

Product Identification Information

i01489989

Generator Identification

SMCS Code: 1000; 4450

Generator Identification

The generator identification and information plate is located on the left side of the generator.

When service is required, the information that is given on this plate should be used. The generator identification and information plate includes the following information: serial number, model number, and the rating of the generator set. The generator set consists of the engine and generator. All pertinent generator data is also included on the plate in order to provide the information that is necessary to order parts.

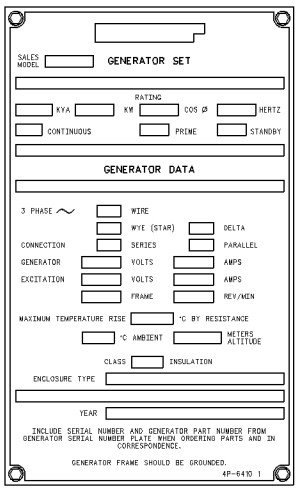

Illustration 9 g00572840

Generator Identification Plate

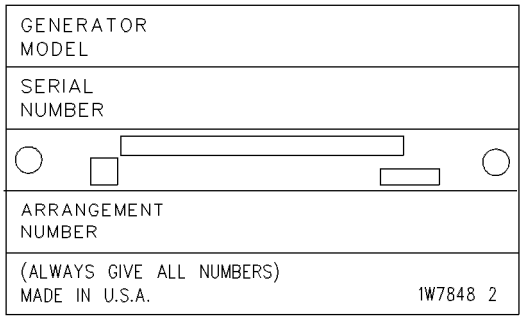

Illustration 10 g00601027

Serial Plate

Output Lead Wiring

All generator lead wiring information can be found on a decal that is located on the side panel of the generator's terminal box. If the generator is equipped with a circuit breaker, the decal may be found on the sheet metal of the circuit breaker panel.

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Reference Numbers

SMCS Code: 1000; 4450

Generator Set Information Sheet

Customer Designation _____

Engine Model Number _____

Engine Arrangement Number _____

Engine Serial Number _____

Generator Arrangement Number _____

Generator Serial Number _____

Generator Frame Size _____

Voltage Rating _____

kW Rating _____

Excitation System:

S.E. _____

P.M. _____

i01490015

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. The diagrams that are contained in the “Wye Configuration Diagrams” section show lead numbering for the four, six, ten and twelve lead generators. The diagrams that are contained in the “Delta Configuration Diagrams” section show lead numbering for the six and twelve lead generators.

Wye Configuration Diagrams

4 Lead

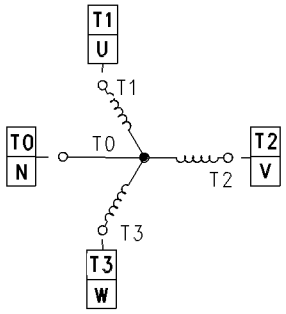


Illustration 11 g00611469

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

Terminal T0 is the neutral lead.

6 Lead

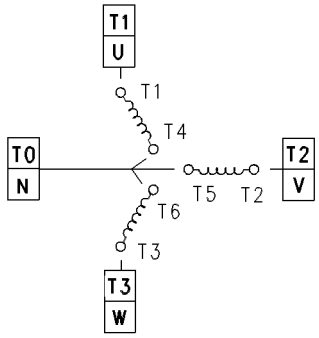


Illustration 12 g00611486

6 Lead Wye Configuration

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

10 Lead

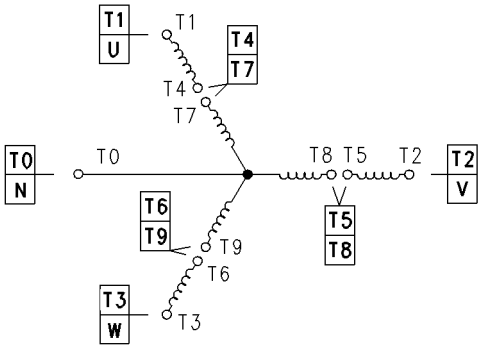
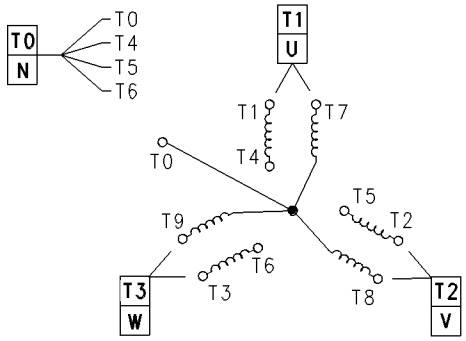


Illustration 13 g00669334

10 Lead Wye Configuration (only used on 3306B generator sets and 3406C generator sets)

High Voltage

Terminal T0 is the neutral lead.



g00611596

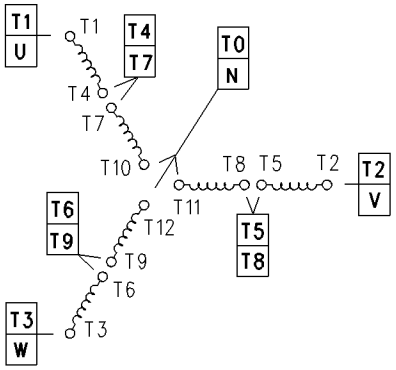
Illustration 14

10 Lead Wye Configuration (only used on 3306B generator sets and 3406C generator sets)

Low Voltage

Terminal T0 is the neutral lead.

12 Lead



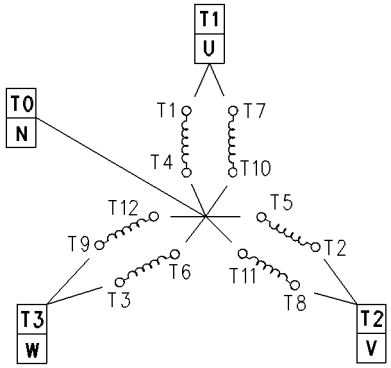
g00661863

Illustration 15

12 Lead Wye Configuration

High Voltage

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



g00611608

Illustration 16

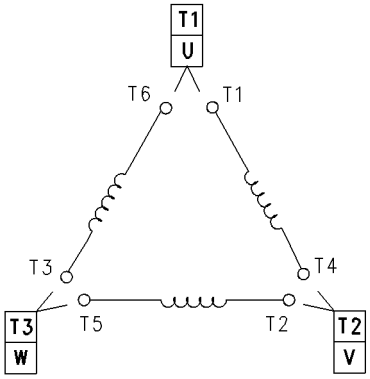
12 Lead Wye Configuration

Low Voltage

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

Delta Configuration Diagrams

6 Lead



g00669319

Illustration 17

6 Lead Delta Configuration

12 Lead

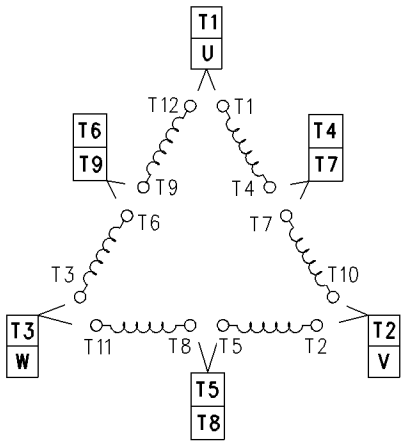


Illustration 18 g00669312

12 Lead Delta Configuration

Terminals T6 and T9 become the neutral connections when the terminals are tied together and when the terminals are 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 the frame of the generator must be positively connected to the hull of a vessel. This connection is the first connection that should be made at the installation. This connection is the last connection that should be removed. If the generator set is on flexible pads or resilient pads, the ground connection must be flexible in order to avoid possible breakage in later operation.

Ground connection cables 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. These joints are also frequent sources of radio frequency interference (RFI). Joints should be silver soldered and joints should also be bolted. These bolts will be electrically reliable and mechanically reliable.

Neutral Connections

On Wye Configuration Generators, the neutral lead should be attached to ground. This connection should be made at installation. The neutral lead is grounded in order 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. In addition, this excessive current will cause the generator voltage to collapse. The result depends on the following factors: the particular generator's 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 when the neutral wire should not be grounded. An ungrounded generator neutral lead is acceptable when measures have been taken in order to prevent grounds to the phase leads. An example of such measures are ground fault protective circuits. When ground fault protective circuits are used, the entire group of distribution circuits should be studied. The entire group of distribution circuits should then be treated as a system. If a new distribution system is being developed, the owner should confer with a consultant that is certified and registered. If an existing system should be modified for ground fault protection, the owner should also confer with a consultant that is certified and registered.

Single Units

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

When definite measures need to be 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

When multiple generators are operated in parallel, all the neutral connections may be grounded. In this case, there may be 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 a line, a switch should be installed in each generator's neutral ground circuit. 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 a Utility

There will be occasions when a Wye connected generator is paralleled with a utility system (infinite bus). On these occasions, the utility system's step-down transformer may also have a Wye connection. The grounding of both of the Wye neutral connections may result in circulating currents through the neutral connections. The coordination of ground fault protection requires a study of the entire system. This study should be done by a consultant that is familiar with generator systems. This consultant should be registered and certified. This study will determine the grounding method that should be used.

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Voltage Connections

SMCS Code: 4450

Three-Phase Voltage Connections

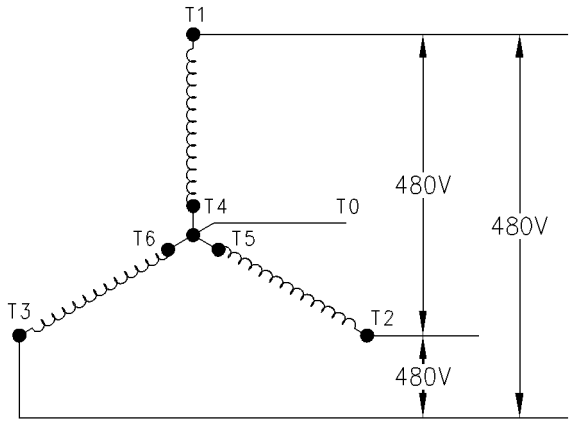
The Wye Configuration and the Delta Configuration are given in the following diagrams.

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

If a Delta Configuration is being used, the generator winding pitch must be two-thirds. If the generator winding pitch is not two-thirds, there will be circulating current within the Delta. This circulating current will cause additional heat in the generator stator. In such cases, the generator must be derated.

Wye Configuration Diagrams

6 Lead Generators

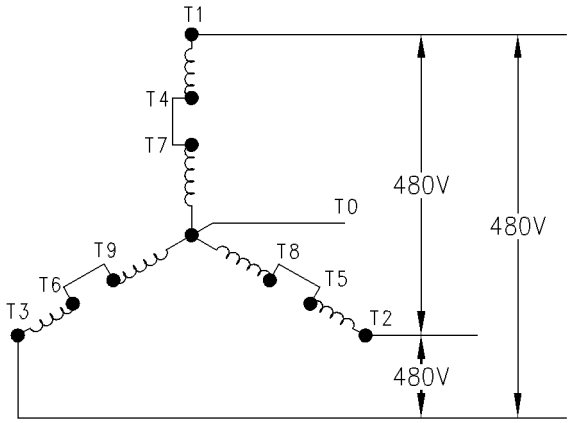


g00626053

Illustration 19

Typical Wye Configuration (60 Hz Six Lead)

10 Lead Generators



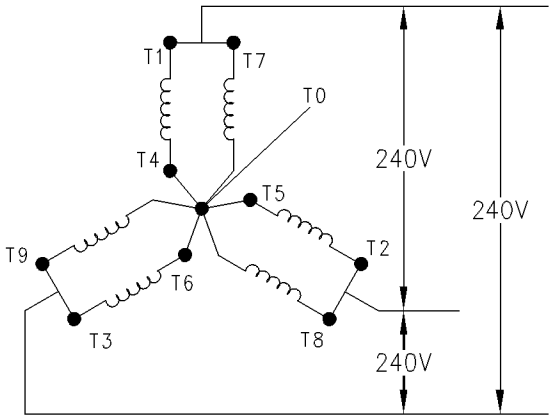
g00626051

Illustration 20

Typical Series Wye Configuration (60 Hz Ten Lead)

Only for 3306B generator sets and 3406C generator sets

This is a typical high voltage connection.



g00626054

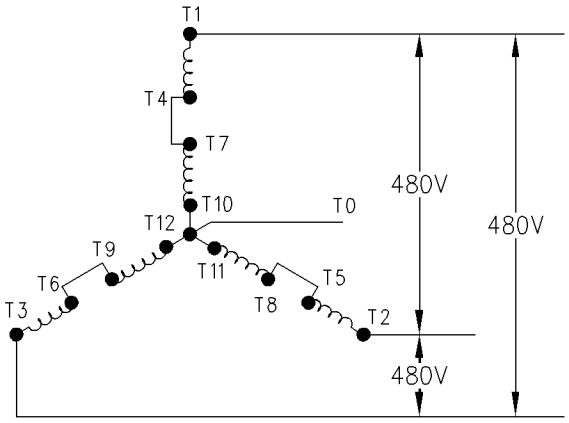
Illustration 21

Typical Parallel Wye Configuration (60 Hz Ten Lead)

Only for 3306B and 3406C generator sets

This is a typical low voltage connection.

12 Lead Generators



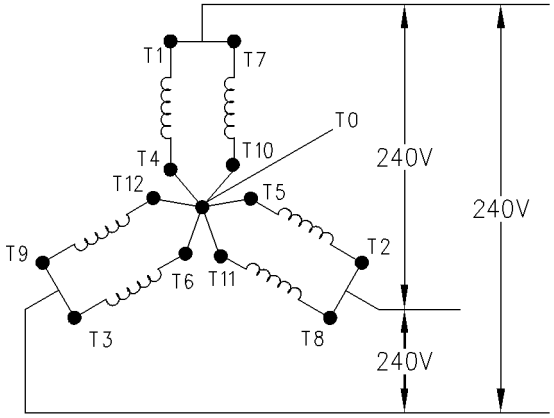
g00637319

Illustration 22

Typical Series Wye Configuration (60 Hz Twelve Lead)

Only for 3406E, 3412C, and 3500 series generator sets

This is a typical high voltage connection.



g00637320

Illustration 23

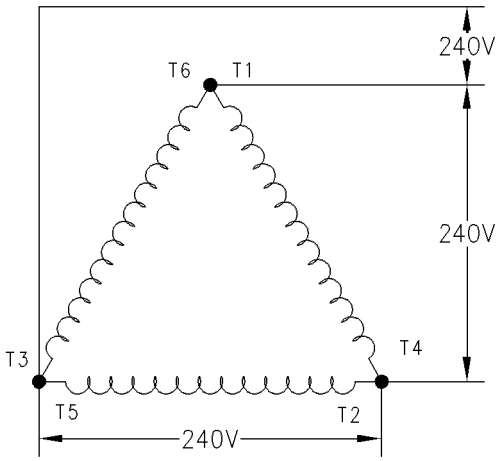
Typical Parallel Wye Configuration (60 Hz Twelve Lead)

Only for 3406E, 3412C, and 3500 series generator sets

This is a typical low voltage connection.

Delta Configuration Diagrams

6 Lead Generators

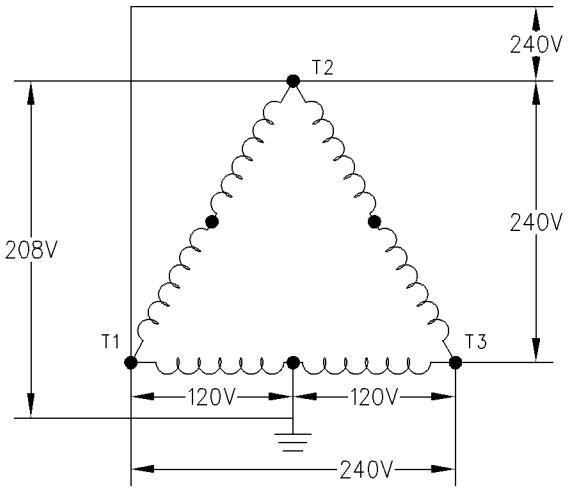


g00626129

Illustration 24

Typical Delta Configuration (60 Hz Six Lead)

12 Lead Generators



g00626130

Illustration 25

Typical Delta Configuration (60 Hz Twelve 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 a Delta Configuration (240 Volts, 60 Hz, and three-phase power), the following voltages will be present: 208 Volts between the high phase and neutral and 240 Volts between either of the low phases and neutral.

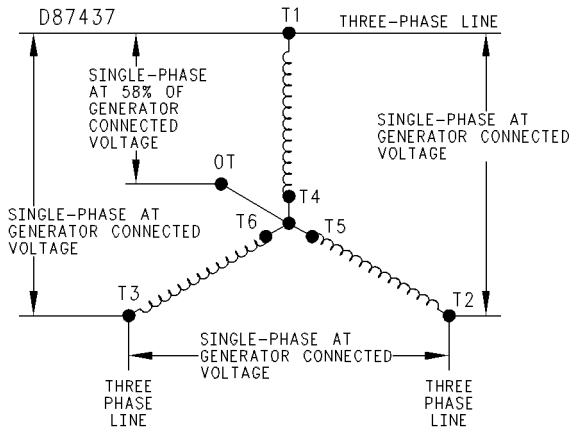
Refer to Operation Section, “Generator Operation” for allowable single-phase loading unbalance.

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

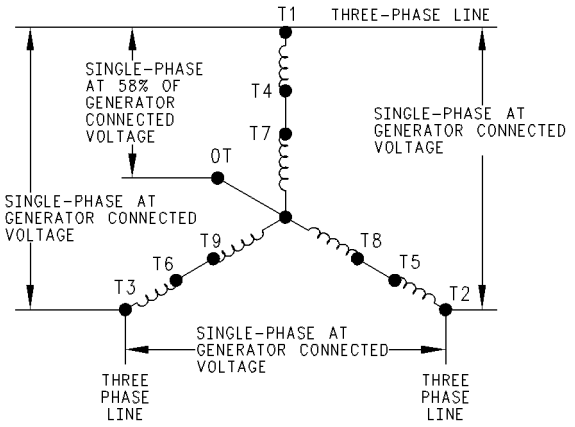


g00626132

Illustration 26

Single-Phase Voltage Diagram with Six-Lead Wye Configuration

10 Lead Generators



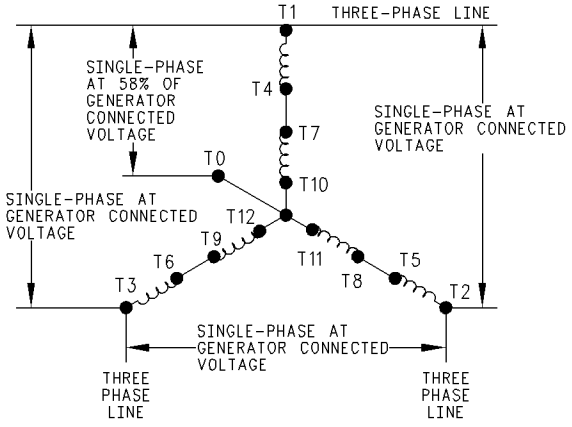
g00626133

Illustration 27

Single-Phase Voltage Diagram with Ten-Lead Wye Configuration

Only for 3306B and 3406C generator sets

12 Lead Generators



g00637321

Illustration 28

Single-Phase Voltage Diagram with Twelve-Lead Wye Configuration

Only for 3406E, 3412C, and 3500 series generator sets

12 Lead Generators

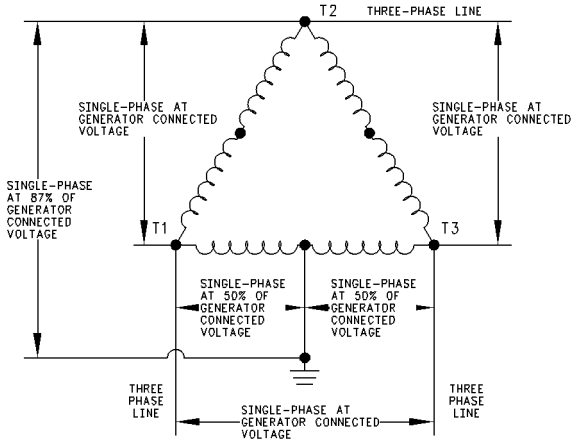


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Illustration 30

Single-Phase Voltage Diagram with Twelve-Lead Delta Configuration

Delta Configuration Diagrams

6 Lead Generators

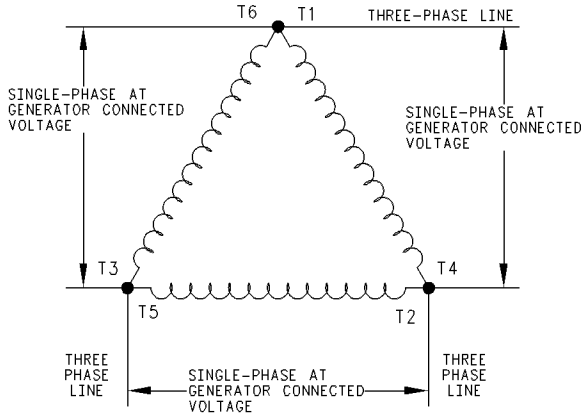

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Illustration 29

Single-Phase Voltage Diagram with Six-Lead Delta Configuration

Operation Section

Operation

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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. An electrical unbalance can result in an electrical overload and overheating if one phase current exceeds the nameplate amperage.

Allowable combinations of unbalanced loads are shown in Illustration 31. 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.

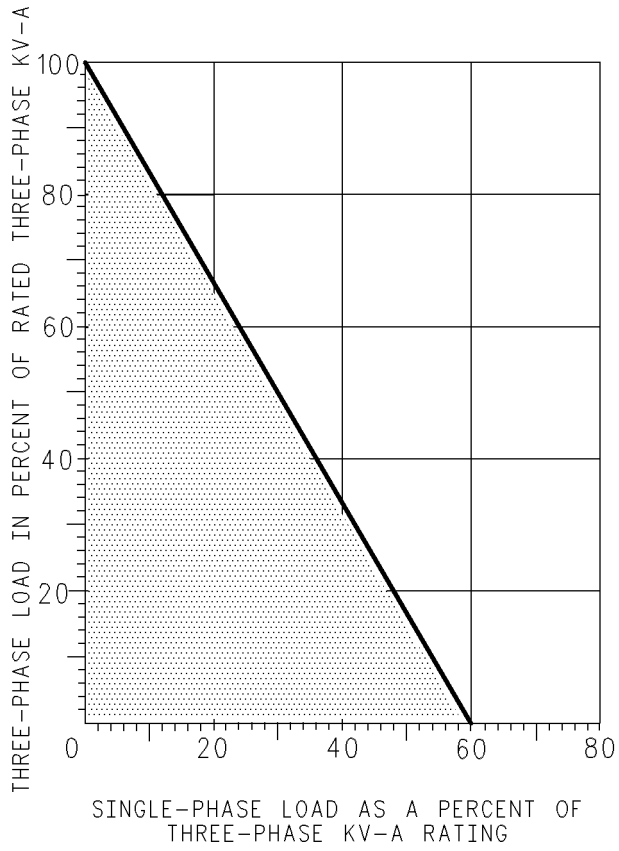

Illustration 31 g00627416

Allowable Combinations of Unbalanced Loads

Block Loading

When an electrical load is applied to a generator set, block loading occurs. 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
- the amount of load that is already present

If a block load derating 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”.

Power Factor

The power factor represents the efficiency of the load. The power factor is the ratio of apparent power to total power. This ratio is expressed as a decimal. The power factor represents the 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. This current is called the reactive load. Engine power is not required to maintain the reactive load.

In most applications, electric motors and transformers determine the power factor of the system. Induction motors usually have a power factor that is no larger than 0.8. 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 that is supplied to a constant power demand will decrease. With equal loads, a lower power factor will draw more current. A high power factor will result in full engine load that is less than the generator’s rated amperage. A lower power factor increases the possibility of overloading the generator.

Note: Normally, Caterpillar generators are designed for a power factor of 0.8.

Excitation Systems

Self-Excited Generators

Self-excited generators receive excitation power and regulator-voltage sensing from the generator’s main armature output. The voltage regulator senses the generator output voltage. A regulated output is provided to the generator exciter. This regulated output is provided by the voltage regulator. 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 stator. The main rotating field is also called 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 the generator’s 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.

Low Idle Adjustment

Electric sets normally have a higher low idle setting than industrial engines. On 60 Hz units, low idle will be approximately 66% of the full load speed. On 50 Hz units, low idle will be approximately 80% of full load speed.

There is no low idle stop on electric sets with electronic governors. On electric sets with mechanical governors and natural gas electric 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 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. Then, the electric set must be restarted. This will allow the voltage regulator to again produce an output.

Standby Electric Sets

Most standby units are automatic. Without an operator in attendance, standby units will perform the following functions: start, pick up the load, run, and stop.

Standby units will not change the governor speed control or voltage level settings automatically. The governor speed and voltage level must be preset for the proper operation of that unit. Whenever the set is operated manually, ensure that the governor speed and the voltage level settings are set correctly for automatic operation. Check all switches for the proper setting. The Start Selector 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 on large-frame generators. Bearing temperature detectors measure the main bearing temperature. 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. Bearing temperature detectors are used with customer provided equipment. Contact your Caterpillar dealer for more information.

Oilfield Generators

Oilfield generators are available for 3306B and 3406C 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 drill rig’s manufacturer on the following questions that pertain to generator control: voltage regulation, paralleling, and load sharing.

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Parallel Operation

SMCS Code: 4450

Initial Startup Requirements

Preparing a generator for parallel operation requires special attention. Before attempting to parallel units for the first time, all units must be checked. The following three conditions must be met:

1. Same phase rotation
2. Same alternating current frequency
3. Same voltage adjustment

Phase Rotation

The phase sequence of the generator must be equal to the phase sequence of the system in order for the systems to operate in parallel. The phase sequence can be checked by a phase rotation meter. Check the phase sequence at the generator and check the phase sequence at the lines that come from the system bus. Synchronizing lamps can also be used in order to determine the relative phase sequence. The correct phase sequence is indicated when the brilliance of the two lamps changes together.

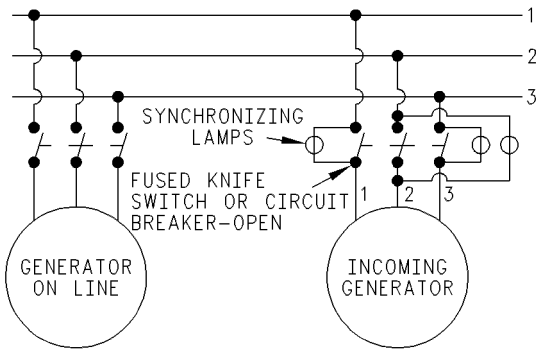


Illustration 32 g00630590

Phase Rotation Meter (Using Three Light Bulbs)

⚠ 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.

1. Connect the light bulbs between the generator leads and the corresponding line phase. Ensure that the light bulbs are the correct rated voltage. Refer to Illustration 32.
2. Start the parallel units. Bring these units up to speed. As the units approach the same speed the lights will start to blink.
   a. If the lights blink in sequence, one of the units is connected backward. If one of the units is connected backward, remove generator leads “1” and “3” at the circuit breaker. Exchange generator leads “1” and “3”. This reverses the direction of the phase rotation. Line “2” should always be connected to line “2”.
   b. If lights blink in unison, the phase rotation of both generators is equal.

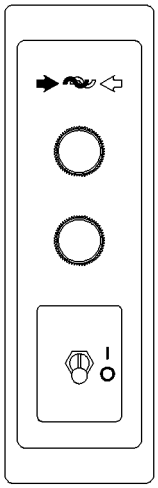


Illustration 33 g00633434
Synchronizing Lights Module

The Synchronizing Lights Module is equipped with a reverse power relay. This will provide additional protection to the system. If the engine should lose power, the other parallel units will attempt to motorize the engine and the generator. Power will flow to the failing generator. This power will cause the failing generator to act as a motor. When this occurs, the reverse power relay will activate. The failing engine and the generator will be shutdown.

For additional information, refer to the appropriate EMCP II Service Manual Module.

Frequency Adjustment

The speed of the paralleled units must be equal. Speed is proportional to the alternating current frequency.

1. Allow each electric set to run under load (about 30 minutes).
2. Adjust the governor control in order to give rated frequency at full load.
3. Remove the load and check the high idle speed. For governors that are equipped with droop, the high idle speed should be approximately 2% to 5% above full load speed. If these speeds cannot be obtained, contact your Caterpillar dealer.
4. For the most consistent results, repeat Step 2 and Step 3. Repeat these steps until all units have the same alternating current frequency.

Voltage Adjustment

Note: The following voltage adjustment is for individual compensation. This adjustment is also known as reactive droop correction. There is another method that is called differential compensation (cross current compensation). In cross current compensation, the regulator is forward biased by the difference in the parallel generator's reactive current outputs. For the adjustment procedure, Refer to Engine Data Sheet, LEKX8142, "Zero Droop Voltage For Parallel Operation".

The voltage level and the voltage droop adjustments determine the amount of circulating currents between generators. Carefully matched voltage regulator adjustments will reduce the circulating currents. Loads with a power factor of 0.8 require a generator voltage droop of approximately 5%. This will occur primarily in motors. Voltage droop is expressed as the percentage of voltage change from no load to full load. Use the same voltmeter to make adjustments on each paralleled unit.

1. To adjust the voltage, refer to Operation Section, "Single Unit Operation".

2. While the engine is running at the rated speed, turn the voltage droop clockwise. Turn the voltage droop until one half of the full range is reached. For unity power factor, set the voltage droop control on all generators to one half of the full range. Proceed to Step 7. A normal driven load has a power factor of approximately 0.8. If the driven load is normal, proceed to Step 3.

3. Readjust the voltage level control until the voltage is about 5% above desired voltage.

4. Apply full load.

Note: If a generator is paralleled with other generators, each generator's voltage droop must be equal in order to satisfactorily divide the reactive load.

5. With full load at 0.8 power factor, readjust the voltage droop control in order to obtain the desired voltage.

6. For each parallel generator, repeat Steps 3, 4, and 5. Continue until the line voltage is equal to the desired level (full load). The no-load voltage should be approximately 5% above the rated voltage.

NOTICE

Damage to the generator is possible. Do NOT exceed the rated ampere load on any single generator.

7. Parallel the generators and apply the driven load. Check the output current of the generator. Add the amperes of the individual generators. If this sum exceeds the rated full load current that is going to the load by 10%, adjust the voltage droop controls in order to share the current proportionally between generators. Some circulating current is permitted at light load.

8. After the paralleled generators have been running at full load for at least one hour, make the final adjustments. Tighten the locknuts on all controls and install the access cover. The third condition of the Initial Startup Requirements has been met.

Note: When generators are cold, a small amount of circulating current is normal.

Starting Multiple Units

The starting procedure for multiple units is identical to the starting procedure for single units.

Paralleling Multiple Units

Units may be paralleled at no load or units may be paralleled under load. To parallel two or more units, the following conditions must be met:

1. Same phase rotation

2. Same voltage level

3. Same voltage droop

4. Same frequency

5. Voltages in phase

The first three conditions have been met in the initial start-up for parallel operation.

1. Start the parallel unit. Refer to the Engine Operation Section.

2. Turn on the synchronizer lights.

3. Run the engine for a few minutes. Bring the engine up to synchronous speed (the same frequency as the unit on the line). The synchronizing lights will begin to blink.

4. Use the governor control to adjust the engine speed until the lights blink very slowly.

Note: The frequency of the incoming unit should be slightly greater than the line frequency. This will allow the incoming unit to assume some of the load instead of adding to the system load.

5. When the voltages of the two units are in-phase, the lights are off. At this point, very quickly close the breaker while the lights are out.

6. Use governor controls to share kilowatt load between engines.

7. After the generator's temperature has stabilized for one hour, adjust each generator's voltage droop control. This will share the reactive load and this will limit the circulating currents. There will be less droop when the voltage droop control is turned counterclockwise. When the droop control is turned counterclockwise, the reactive current that is carried by the generator increases.

Load Division

Once two units have been paralleled, the sharing of the kilowatt load is determined by the governor control setting. If two units of the same capacity and the same governor characteristics have the same governor control settings, the load will be shared equally.

In order to transfer one engine's load to another engine, follow this procedure: The total load must not exceed the capacity of the one engine.

1. To increase the load, increase the governor speed control of one unit.

2. In order to decrease the load on a unit, reduce the unit's governor speed control.

3. To change system frequency, raise or lower the governor speed control of both units.

Circulating Currents

When two units are paralleled, there will be circulating currents. These currents are not doing useful work. Circulating currents flow between the generators. By determining the total generator amperage that is going to the load, the amount of circulating current can be determined.

Circulating currents are caused by voltage differences between two units.

With generator sets that are cold, circulating currents may be as high as 25% of the ampere rating without being considered harmful. Circulating current is part of the total generator current. This total must not exceed the amperage rating.

As the generators warm, the circulating currents will decrease. The ammeter readings should decrease slightly. The voltmeter readings should remain constant.

Governors That Are Operating In Parallel

This section is a general description of the function of the engine governor in relation to the load division between parallel electric sets. For detailed information on governor controls and adjustments, see the Operation and Maintenance Manual and Service Manual for the engine.

There are two basic facts that must be understood concerning the load division between generator sets that are operating in parallel. First, the power that is supplied to the generator and the power that is supplied to the load is a function of the engine. The engine governor settings and the positions of the governor controls determine the amount of power that is delivered by the engine. The engine governor settings and the positions of the governor controls also determine the kilowatt load that is carried by each generator.

If the governor control setting is advanced, the engine and the generator will assume more kilowatt load. Decreasing the governor control setting will result in a reduction of load on the unit. At the same time, the other units on the line will gain load or the other units on the line will reduce load. This is assuming that no change in the total load or no change in the governor settings of the other units has taken place.

Regarding the second point, the division of power is not determined by the generator excitation and the division of power is not determined by terminal voltage. When a generator is operating in parallel with other generators, that generator will operate at a certain power factor. This power factor is determined by excitation.

Governors that are furnished with Caterpillar Generator Sets can be two different types: governors with fixed speed droop and governors with adjustable speed droop. The speed droop values that are used are 3% and 0%. For similar characteristics, governors with adjustable speed droop can be adjusted in order to match fixed speed droop governors. If a governor is adjusted for a 0% speed droop operation, the same speed can be obtained from no load to full load.

The preceding discussion of governor operation is summarized in the following paragraphs:

1. With parallel electric sets, the simplest governor combination is a 3% speed droop characteristic. If a constant frequency is required, one governor can be adjusted for isochronous operation. An isochronous operation is also known as a 0% speed droop operation. This constant frequency must exist at a no-load condition. This constant frequency must also exist with a full load. This is called a lead unit.

2. In order for all paralleled units to accept a full share of the load, the following governor adjustments are required:

- All units must have the same speed at full load.
- Maintain the same high idle speed at no load. This would occur on governors that have been adjusted for speed droop operation.
- Set the governor controls to high idle. Full range must be available.
- Special techniques are required for parallel operation of isochronous governors and speed droop governors.
- Any number of electric sets can be operated in parallel. However, only one governor of the group can be adjusted for isochronous operation. Electric governors (automatic load sharing) are exceptions.

Electric Governors

The different governors that can be used on SR4B generator sets are shown below.

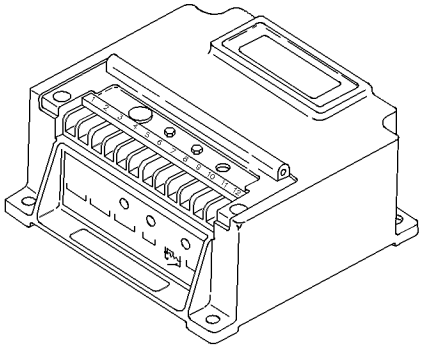


Illustration 34 g00630882

Electric Governor (Typical Example)

The 1724/8290 and 524/8290 electric governors are used with 3306B and 3406C generator sets. The 1724/8290 and 524/8290 electric governor systems provide precision engine speed control. No mechanical drive or hydraulic supply is required for this system. Each system consists of three components: a magnetic pickup, an 8290 speed control, and a 524 actuator or a 1724 actuator. More information is available in the General Service Information, SENR6430, “524 and 1724 Electrically Powered Governor Systems for Generator Set Engines”.

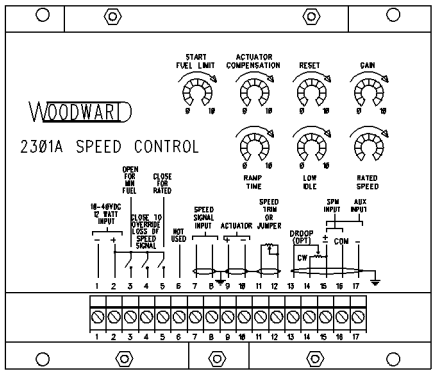


Illustration 35 g00637393

2301A electric speed governor (Typical Example)

The 2301A electric speed governor is used with the following generator sets: 3406E, 3412C, and 3500 series. The 2301A electric speed governor control system consists of a 2301A electric governor control, an actuator, and a magnetic pickup. The 2301A electric speed governor control system provides precision engine speed control. More information is available in the Service Manual, SENR4676, “2301A Speed Control”.

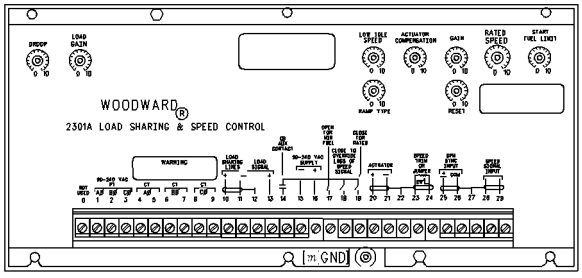
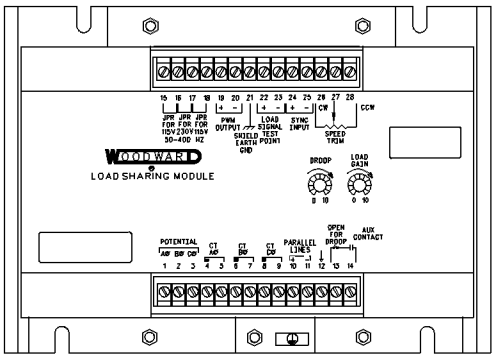


Illustration 36 g00637396

2301A Electric Load Sharing and Speed Control Governor(Typical Example)

The 2301A electric load sharing and speed control governor is used with the following generator sets: 3406E, 3412C, and 3500 series. The 2301A electric load sharing and speed control governor is used for the following functions: exact engine speed control and kilowatt load sharing. The system constantly measures engine speed. The system then makes the necessary corrections to the engine fuel setting. These corrections are made through an actuator which is connected to the fuel system. On parallel generator sets, the system provides isochronous load sharing. For more detailed information, refer to the Service Manual, SENR3585, “2301A Electric Load Sharing and Speed Control”.

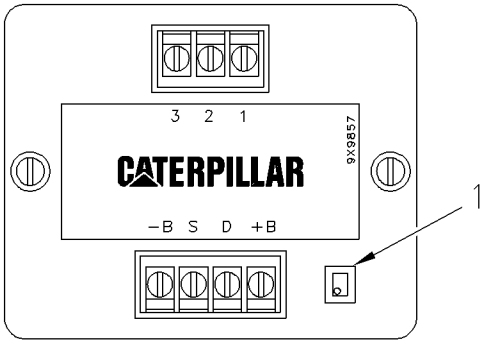


g00630841

Illustration 37

Load Sharing Module (Typical Example)

For parallel generator applications, the generator set load sharing module provides two types of load sharing: droop load sharing and isochronous load sharing. The load sharing module has a synchronizing parallel module input (SPM-A). The module provides proportional load sharing. More information is available in the System Operation, Testing and Adjusting, SENR6565, “Generator Set Load Sensor and Generator Load Sharing Module”.



g00637397

Illustration 38

(1) Droop potentiometer

A Speed brick converter is used with the following generator sets: 3406E, 3412C, and 3500 series. A Speed brick converter changes the analog signal of the speed potentiometer (SP). The analog signal is changed into a pulse width modulated signal (PWM). The engine’s electronic control can recognize a pulse width modulated signal. The converter is mounted on the subpanel which is located within the control panel.

Function of The Engine Governor

This section describes the function of the engine governor in relation to load division between parallel electric sets. For more information, refer to the Operation and Maintenance Manual and the Service Manual for the appropriate engine.

It is very important to understand two basic facts about load division between generator sets which are operating in parallel.

1. The power which is supplied to the generator and to the load is a function of the engine. The engine governor settings and the positions of the governor controls determine the amount of power that is delivered by the engine. Therefore, the engine governor settings and the positions of the governor controls determine the kW load which is carried by the generator. If the governor control setting is advanced, the engine and the generator will assume more kW load. Likewise, decreasing the governor control setting will result in a reduction of load on the unit. Simultaneously, other units will reduce load. These other units will assume that no change in total load or no change in the governor settings of the other units has taken place.

2. The division of power is not determined by generator excitation or terminal voltage. When a generator is paralleled with other generators, the excitation will determine the power factor.

Governors that are used with Caterpillar powered electric sets can be of two types: governors with fixed speed droop or governors with adjustable speed droop. The values of speed droop which are commonly used are 3% and 0%. Adjustable speed droop governors can be adjusted in order to match fixed speed droop governors. If the governor is adjusted for isochronous speed droop (0%), the same speed can be obtained. This speed can be obtained from no load to full load.

Summary on Governor Operation

The preceding discussion of governor operation can be summarized below.

- For parallel electric sets, each governor should have a speed droop characteristic of approximately 3%. If a constant frequency from no load to full load is required, one governor can be adjusted for isochronous operation. This isochronous unit will be called a “lead unit”.
- In order for all paralleled units to accept a full share of the load, the following governor adjustments are required. The governors should have the same full load speed. In the case of governors that are adjusted for speed droop operation, the governors should have the same high idle speed (no load). To ensure that the full governor range is available, governor controls should be set to the high idle position.
- An isochronous governor can be operated in parallel with a speed droop governor. This requires special techniques.
- Any number of electric sets can be operated in parallel. However, only one governor of the group can be adjusted for isochronous operation. The exception will be some special cases of electronic governors with automatic load sharing.

Stopping

In order to remove a generator from the line, perform the following procedure.

1. Check the load. The load must be less than the rated capacity of the remaining units.
2. Be sure that the neutral of one of the remaining units is grounded.
3. Remove the load from the outgoing unit. See the Parallel Operation, “Load Division - Speed Droop”. The amperage may never go to zero due to circulating currents.
4. Open the circuit breaker.
5. Allow the engine to cool for five minutes.
6. Stop the engine.

i01490164

Single Unit Operation

SMCS Code: 4450

Initial Start-Up

Before the initial start-up, perform the megohmmeter test on the main stator winding. Refer to the Special Instruction, SEHS9124, “Cleaning and Drying of Electric Set Generators” for the procedure.

Starting

1. Make all preliminary engine starting checks.
2. Be sure that the main circuit breaker or the line circuit breaker is open.
3. Start the engine. Allow the engine to warm up.
4. Adjust to the full load engine speed.
5. Close the main circuit breaker.
6. Apply the load. Do not try to apply the full load. Apply the load in increments in order to maintain system frequency at a constant level.
7. Readjust the governor for rated frequency.

Stopping

1. Remove the load in increments.
2. Open the circuit breaker.
3. Allow the engine to run for five minutes in order to cool.
4. Stop the engine.

Generator Set Control Panels

i01490168

Manual Start/Stop Control Panel

SMCS Code: 7451

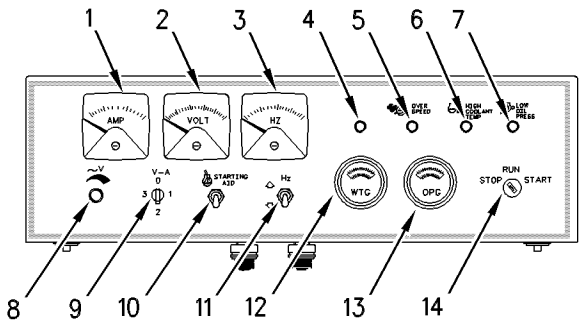


Illustration 39 g00601296

130-3786 Control Panel

(1) AC Ammeter(AM)
(2) AC Voltmeter (VM)
(3) Frequency meter
(4) Spare fault indicator
(5) Engine overspeed fault indicator
(6) High coolant temperature fault indicator
(7) Low oil pressure fault indicator
(8) Voltage adjust rheostat
(9) Ammeter/Voltmeter phase selector switch (AVS)
(10) Starting aid switch
(11) Governor switch
(12) Water temperature gauge (WTG)
(13) Oil pressure gauge (OPG)
(14) Keyswitch

The 130-3786 Control Panel is used to perform the following functions: manually starting a generator set and manually stopping a generator set. The control panel can be used in either a standby or prime power operation. The control panel is modified on the generator's terminal box.

Gauges And Meters

AC Ammeter (1) – The AC ammeter (AM) shows the amperes of the current in phase 1, phase 2, or phase 3. The ammeter/voltmeter phase selector switch (AVS) is used to select the phase that is shown on the AC ammeter. Each selected phase that is shown on the AC ammeter is connected to a current transformer. This relationship is shown in Table 1.

Table 1

Phase	Current Transformer
T1	CT1
T2	CT2
T3	CT3

The current transformers transform the actual line current of each respective phase lead. This line current is transformed to a level within the alternating current ammeter's input range (approximately 0 to 5 amperes).

AC Voltmeter (2) – The AC voltmeter (VM) shows the voltages between the following phases: T1 and T2, T2 and T3, and T3 and T1. The ammeter/voltmeter phase selector switch (AVS) is used to select the phase which is shown on the AC voltmeter.

Frequency Meter (3) – The frequency meter shows the frequency of the electricity that is being made by the generator set. This frequency is displayed in hertz (Hz). There is a direct relationship between the frequency of the electricity and the RPM of the engine.

To find the frequency of a four-pole generator, divide the RPM by 30.

To find the frequency of a six pole generator, divide the RPM by 20.

Water Temperature Gauge (12) – The water temperature gauge (WTG) displays the engine water temperature. The engine should operate within the range of 88 °C (190.4 °F) to 100 °C (212.0 °F). The water temperature may vary according to the load. The water temperature must never exceed the boiling temperature for the pressurized system that is being used. Thermostats that are in the system regulate the water temperature. The thermostats must be installed when the engine is being operated.

While the engine is running, check the water temperature. If high water temperature is observed, take the following actions:

- Reduce the load and reduce the engine speed.
- Check for coolant leaks.
- Determine if reducing the load will cool the engine or if the engine must be shut down immediately.

The WTG is powered whenever the keyswitch is in the RUN position. The value that is shown on the WTG is proportional to the flow of current through the WTG. The current flow is controlled by the resistance of the water temperature sending unit (WTSU). As the water temperature changes there is a corresponding change in the resistance of the WTSU. Therefore, there will be a corresponding change that is shown on the WTG.

Note: The water temperature sending unit must be fully submerged. If the water temperature sending unit is not fully submerged, the temperature reading will be false.

Oil Pressure Gauge (13) – The oil pressure gauge (OPG) shows engine oil pressure. The oil pressure will be highest after a cold engine is started. While the engine idles, oil pressure will decrease as the engine temperature increases. As the engine speed is increased to full load speed, the oil pressure will increase and the oil pressure will stabilize.

NOTICE

If no oil pressure is indicated, STOP the engine. The engine will be damaged from operating without oil pressure.

Normal operating engine oil pressure should be 275 kPa (39.9 psi) to 600 kPa (87.0 psi) when the following conditions are met:

- The engine is running at rated engine speed.
- SAE 10W30 oil is being used.
- The operating oil temperature is 104 °C (219.2°F).
- The operating temperature of the engine water is normal.

At low idle speed, a lower pressure of 186 kPa (27.0 psi) to 344 kPa (50.0 psi) is normal.

Ensure that the load is stable. The gauge reading should not fluctuate after the load is stable. If the gauge reading fluctuates, take the following actions:

- Remove the load.
- Reduce the engine speed to low idle.
- Check and maintain oil level.

The oil pressure gauge (OPG) is powered whenever the keyswitch is in the RUN position. The value that is shown on the OPG is proportional to the flow of current through the OPG. The current flow is controlled by the resistance of the Oil Pressure Sending Unit (OPSU). As the oil pressure changes, there is a corresponding change in the resistance of the OPSU. Therefore, a corresponding change will be seen in the value that is shown on the OPG.

Fault Indicators

The control panel will shut down the engine if certain conditions exist. At the same time, the control will illuminate the corresponding fault indicator. To reset the shutdown, turn the keyswitch to the STOP position. To turn off the fault indicators, also turn the keyswitch to the STOP position. Find the cause of the fault (shutdown) before attempting to restart the engine. The lamp of each fault indicator can be tested by pushing in on the fault indicator.

The conditions which can cause shutdown are shown for the following fault indicators:

Spare Fault Indicator (4) – This shutdown is determined by the particular application. The spare fault indicator and the spare fault shutdown may be used or the spare fault indicator and the spare fault shutdown may not be used. A normally open contact must be connected to the spare fault circuit.

Engine Overspeed Fault Indicator (5) – The speed of the engine exceeds the limit of the Electronic Speed Switch (ESS).

High Coolant Temperature Fault Indicator (6) – The temperature of the engine coolant exceeds the limit of the Water Temperature switch.

Low Oil Pressure Fault Indicator (7) – The pressure of the engine oil is less than the setpoint of the Oil Pressure switch.

Operator Controls

Voltage Adjust Rheostat (8) – The voltage adjust rheostat connects to the voltage regulator. The voltage adjust rheostat is used to adjust the voltage output of the generator.

Ammeter/Voltmeter Phase Selector Switch (9) – The ammeter/voltmeter phase selector switch (AVS) allows the operator to select the phase that will be shown on the AC ammeter (AM) and the AC voltmeter (VM). The four positions of the AVS are shown in the following table.

Table 2

FOUR POSITIONS OF THE AMMETER/VOLTMETER PHASE SELECTOR SWITCH (9)				
	Position 1	**Position 2**	**Position 3**	**Position 0**
AM (1)	T1 Phase Current	T2 Phase Current	T3 Phase Current	0
VM (2)	T1 - T2 Phase Voltage	T2-T3 Phase Voltage	T3-T1 Phase Voltage	0

Starting Aid Switch (10) – The optional starting aid switch will inject ether into the engine for starting in cold weather conditions when the following steps are followed:

1. Turn the keyswitch to the START position.

2. Press the starting aid switch.

3. Hold the starting aid switch in the ON position.

The Start Aid Solenoid Valve (SASV) will be energized following step 3. The SASV will meter a specific amount of ether into the holding chamber. When the SAS is released, the SASV de-energizes and the ether is released to the engine.

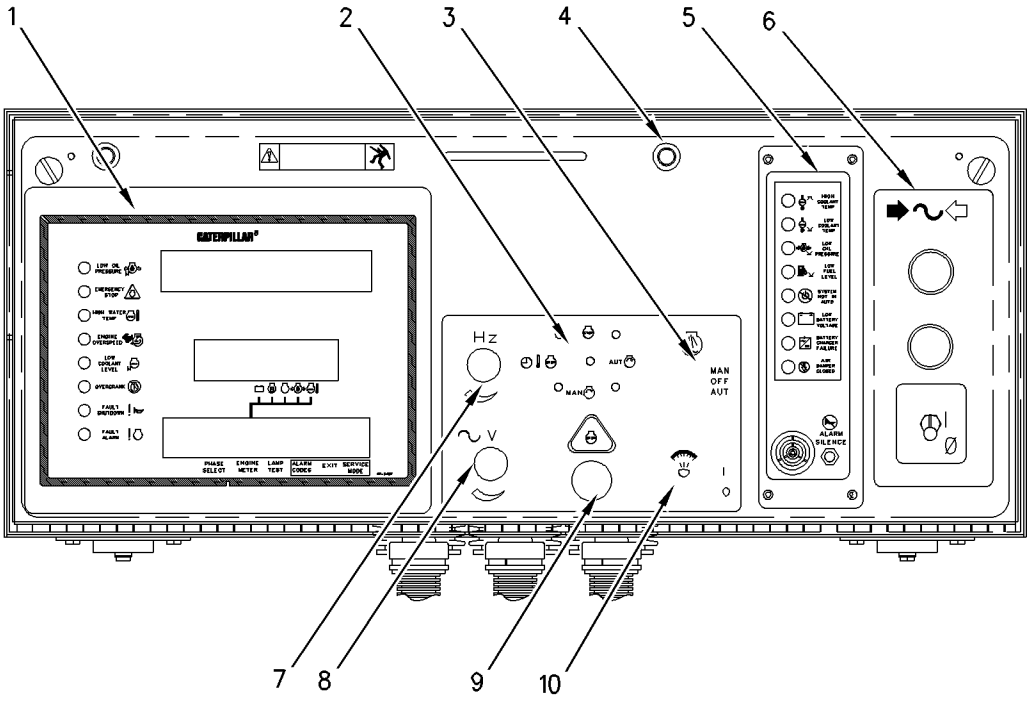
Governor Switch (11) – The optional governor switch is used to adjust the engine speed when the governor is equipped with a speed adjusting motor. The engine speed may be raised or lowered.

Keyswitch (14) – The keyswitch is used to start the engine and the keyswitch is used to stop the engine. The START position is spring loaded in order to return to the RUN position. When the keyswitch is in the RUN position, do not turn the keyswitch to the START position. The keyswitch must be turned to the STOP position prior to being turned again to the START position. When the keyswitch is in the STOP position, the fuel solenoid is de-energized and the engine shuts down. All fault indicators are reset when the keyswitch is turned to STOP.

i01490234

Electronic Modular Control Panel II (EMCP II)

SMCS Code: 4490



g00789627

Illustration 40

Electric Modular Control Panel II (EMCPII)

(1) Generator set control (GSC)
(2) Engine control switch (ECS)
(3) Start aid switch (SAS)
(4) Panel lights
(5) Alarm module - optional
(6) Synchronizing lights module - optional
(7) Speed potentiometer
(8) Voltage adjust rheostat
(9) Emergency stop push button (ESPB)
(10) Panel lights switch

The Electronic Modular Control Panel II (EMCP II) is located on top of the generator regulator housing. The control panel consists of a main panel with indicators, meters, and control switches. This control panel either has one empty slot or two empty slots. Control panels with one empty slot may be configured in one of the following ways:

- no module
- contain an alarm module.
- contain a synchronizing lights module.

Control panels with two empty slots may be configured in one of the following ways:

- no modules (two blank slots)
- one alarm module (one blank slot)
- one synchronizing lights module (one blank slot)
- one alarm module and one synchronizing lights module (zero blank slots)

The left side of the control panel contains the Generator Set Control (GSC). This is the main component of the system. The GSC (1) also displays generator output, fault conditions, and key engine parameters.

Main Control Panel

The main control panel may not contain all of the components that are shown below. Some components are optional. These components may not be required for your particular application.

Panel Lights (4) – The panel lights are controlled by the Panel Light Switch (10).

Voltage Adjust Rheostat (8) – The voltage adjust rheostat is used to adjust the generator output voltage to the desired level.

Optional Governor Switch or Speed Potentiometer (7) – If the governor is equipped with a speed adjusting motor, the governor switch is used to adjust the engine speed. If the engine is equipped with an electric governor, a speed potentiometer is mounted in this location.

Starting Aid Switch (3) – The starting aid switch is used to inject ether into the engine for starting in cold weather conditions. After being turned to the ON position, the starting aid switch meters a specific amount of ether into a holding chamber. When the switch is released, the solenoid releases the ether into the engine.

Emergency Stop Push Button (9) – The emergency stop push button is used to shut down the engine during an emergency situation. In order to shut down the engine, the emergency stop push button shuts off the fuel. The emergency stop push button also activates the optional air shutoff (if equipped).

Engine Control Switch (2) – The engine control switch determines the status of the control panel. In the Automatic position (3 o'clock), the engine will start automatically whenever a remote start/stop initiate contact is closed. The engine will stop after the initiate contact opens and after an adjustable cooldown period has elapsed. A cooldown period can be programmed. This cooldown period (0 to 30 minutes) will allow the engine to dissipate heat before the engine shuts down.

In the Manual Run position (6 o'clock), the engine will start and the engine will run. In order for the engine to continue to run, the ECS must remain in the Manual Run position.

In the Stop position (9 o'clock), the fuel solenoid stops the engine. This shutdown occurs after a programmable cooldown period.

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

Generator Set Control (GSC)

The left side of the control panel contains the Generator Set Control (GSC). This is the main component of the system. The GSC also displays the following information:

- generator output
- generator set functions
- fault conditions
- key engine parameters

The GSC accepts information from the following sources: operator, engine speed sensor, 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.

Under 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's starter. When the engine speed reaches the crank termination speed, the starter is disengaged. When the GSC receives an engine stop signal, the GSC shuts off the fuel.

GSC Features and Functions

The GSC has the following features and functions:

- The GSC controls the starting and the stopping of the engine (normal conditions).
- The GSC shows the 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 to describe the fault.
- The GSC contains programmable features for certain applications or customers' requirements.

Cycle Crank – The GSC can be programmed to alternate between cranking and resting for adjustable time periods. Refer to the appropriate Service Manual Module for programming instructions.

2301A Control – When the engine oil pressure is increased beyond the low oil pressure setpoint, the GSC will inform the governor that the engine speed should be increased from IDLE to RATED rpm.

Cool Down – When the GSC receives a signal to perform a shutdown, the GSC hesitates for a period of time. This period of time is preprogrammed. The engine is shut down via the fuel control.

Automatic Operation – While the GSC is in the automatic mode, a remote start signal (contact closure) will start the GSC. Upon loss of the signal (contact opening), the GSC will perform a normal shutdown.

Alarm Module Communication – The GSC can transmit fault conditions and alarm conditions to an alarm module.

Power Down – The Electronic Modular Control Panel II (EMCP II) is designed to remove power from the GSC when the following conditions are met:

- The GSC is in the Off/Reset mode.
- The proper jumper wire is removed.

The GSC will not be powered down until the crank termination relay is OFF and the fuel control relay is OFF. Both relays must be OFF for approximately 70 seconds. The GSC will not be powered down unless the wire is removed.

Note: For the wiring diagram and jumper wire locations, refer to the appropriate Service Manual Module.

Fuel Solenoid Type – The GSC can be programmed for an energized-to-run fuel system or an energized-to-shutdown fuel system.

Fault Indicators

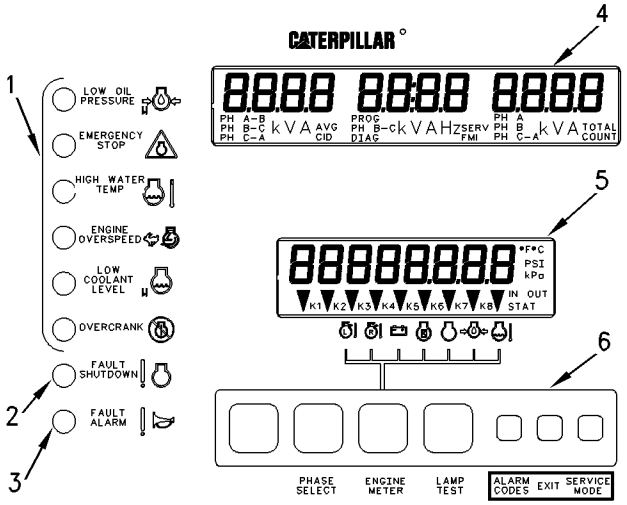


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Illustration 41

Display Area Of Generator Set Control (GSC)

(1) Dedicated shutdown indicators. (2) Fault shutdown indicator. (3) Fault alarm indicator. (4) Upper display. (5) Lower display. (6) Keypad.

The eight fault indicators are used to show that a fault is present. The fault indicators describe the fault. The fault indicators are divided into three groups: fault alarm indicator (3), fault shutdown indicator (2) and dedicated shutdown indicators (1).

The yellow fault alarm indicator (3) FLASHES when the GSC detects an alarm fault. The alarm fault does not cause the engine status to change. The engine will be able to start. Fault alarm indicator (3) is accompanied by a fault code. This fault code is shown on upper display (4) when the alarm codes key is pressed.

The red fault shutdown indicator (2) FLASHES when the GSC detects a fault that is a shutdown fault. When a fault is detected, the engine is shut down. The engine is not allowed to start. Fault shutdown indicator (2) is accompanied by a fault code that is immediately shown on upper display (4).

The red dedicated shutdown indicators (1) 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 corresponding shutdown indicator FLASHES. If the engine is running, the engine is shut down and the engine is not allowed to start. There are no fault codes that are associated with the dedicated shutdown indicators. Each indicator has a descriptive label.

The conditions that are required for each dedicated fault are in the following list. The results of each dedicated fault are also 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: engine at idle speed and engine at rated speed. When this fault occurs, the low oil pressure indicator FLASHES. 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 instrument panel. When this condition occurs, the emergency stop indicator FLASHES. 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 this fault occurs, the high water temperature indicator FLASHES. The engine is shut down. 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 this fault occurs, the engine overspeed indicator FLASHES. The engine is shut down. The engine is not allowed to start until the fault is corrected.

Low Coolant Level – The engine coolant level drops below the coolant loss sensor's probe. This probe is optional. When this fault occurs, the engine coolant level indicator lamp 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 this 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 following shutdowns: low oil pressure, high water temperature, and low coolant level. When the shutdown faults are overridden, the faults are treated as alarm faults. The corresponding dedicated shutdown indicator is ON CONTINUOUSLY. The engine continues to run instead of shutting down. This dedicated shutdown indicator means that the setpoint for shutdown has been exceeded. The GSC is programmed to override the shutdown fault. The GSC will treat the fault as an alarm fault. The factory programs the GSC to treat low oil pressure, high water temperature and low coolant level as shutdowns. The operator must decide if these shutdown faults can be overridden.

Display

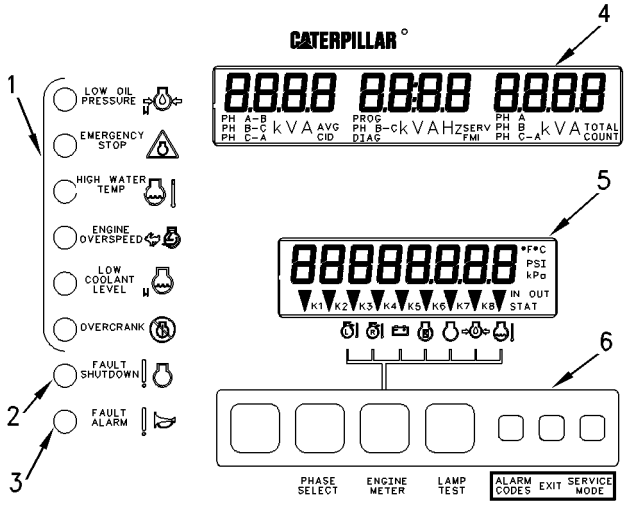


Illustration 42 g00604607

Display Area Of Generator Set Control (GSC)

(1) Dedicated shutdown indicators. (2) Fault shutdown indicator. (3) Fault alarm indicator. (4) Upper display. (5) Lower display. (6) Keypad.

The upper display (4) and lower display (5) of the GSC provide information about the generator set.

Upper display (4) shows AC voltage, current and frequency of one phase of the generator output. Each phase can be viewed one at a time by pushing the phase select key. Upper display (4) is also used to show the various fault codes for system faults. For more information on fault codes, refer to the appropriate service manual module for fault descriptions.

Lower display (5) shows left exhaust temperature, right exhaust temperature, system battery voltage, engine hours, engine speed, engine oil pressure, and engine coolant temperature. The value for one of these conditions is shown for two seconds. The display 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 is pressed, lower display (5) stops scrolling. The lower display continuously shows one particular value. The pointer flashes above the condition with the value that is showing.

The relay status indicator is on the lower display. When a GSC relay is activated, the corresponding indicator (K1, K2, etc) is shown on lower display (5). When a relay is not activated, the corresponding indicator (K1, K2, etc) is not shown.

In the service mode, both displays are used for programming functions. For more information, refer to the appropriate service manual module for service modes.

Keypad

Keypad (6) is used to control the information that is shown on upper display (4) and lower display (5). The seven keys have two sets of functions, normal functions and service functions. For a description of the service functions of the keys, refer to the appropriate Service Manual Module. The normal functions of the keys are in the following list.

Leftmost Key – This key only functions when the GSC is in service mode.

Phase Select Key – This key selects the phase of the generator output that is shown on the GSC. Pressing this key allows the operator to check the voltage, current, and frequency of each phase one at a time.

Engine Meter Key – This key stops the scrolling of engine conditions on lower display (5). The display continuously shows the value for one particular engine condition. The pointer flashes in order to indicate that scrolling is stopped. Pressing the key again resumes the scrolling of engine conditions.

Lamp Test Key – This key performs a lamp test on the GSC and the optional alarm module. The eight fault indicators are ON CONTINUOUSLY. Every segment of upper display (4) and lower display (5) is ON. On the optional alarm module, all of the indicators are ON and the horn will sound.

Alarm Codes Key – If fault alarm indicator (3) is FLASHING, pressing this key causes upper display (4) to show the corresponding fault code. Pressing this key again resumes the showing of generator output information on upper display (4). If fault alarm indicator (3) is OFF, this key has no function. See Systems Operation, “Fault Description” for more information on fault codes.

Exit Key – This key only functions when the GSC is in service mode. See Systems Operation, “Service Mode” for more information.

Service Mode Key – Pressing this key causes the GSC to enter service mode. See Systems Operation, “Service Mode” for more information.

Synchronizing Lights Module (If Equipped)

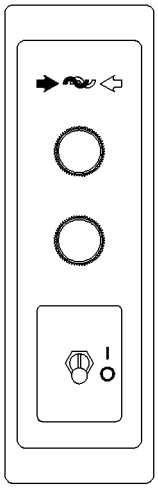


Illustration 43 g00633434
Synchronizing Lights Module

The optional synchronizing lights module is mounted on the right side of the control panel. This module is not used when the control panel is equipped with the 2301A governor.

Synchronizing lights are used as an aid in paralleling units at no load and under load. Two lights are in the module. Each light is connected to the side with the load of the generator output circuit breaker. The lights are used to indicate when the voltages are in-phase. Close the circuit breaker in order to connect the generator with the load.

Note: Refer to Operation Section, “Parallel Operation” for information regarding the paralleling of two generators.

Refer to the appropriate Service Manual Module for all wiring and installation information.

Synchronizing Lights Module With Reverse Power Relay (If Equipped)

When a reverse power relay is added to a synchronizing lights module, the original synchronizing lights module will change in the following ways:

- The reverse power relay is mounted on the control panel interior.
- A reverse power fault is indicated by the Fault Shutdown Indicator on the front of the GSC.

The reverse power relay is a single phase protective relay. This relay is energized by power in only one direction. In a reverse power fault, the relay contacts close and the engine shuts down. This will take the generator off the line. The reverse power relay is equipped with a test switch and adjustments.

For additional information, refer to the appropriate Service Manual Module.

Alarm Module (If Equipped)

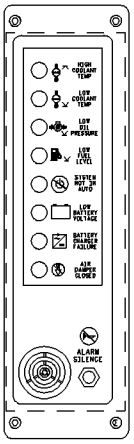


Illustration 44 g00604696

Alarm Module

The optional alarm module is located on the right side of the control panel. The alarm module provides a warning of engine conditions. This warning is given before conditions become so severe that the engine shuts down or conditions become severe enough to prevent the engine from starting.

One basic alarm module is used to satisfy the following requirements:

- Standby NFPA 99 alarm module
- Standby NFPA 110 alarm module
- NFPA 99 remote annunciator panel
- Prime power alarm

Several signals can be input to the module. Different decals on the front of the module indicate alarms or shutdown conditions.

Refer to the appropriate Service Manual Module for the following information:

- Wiring information
- Installation information
- Indicators that meet the requirements of NFPA
- Alarm functions that meet the requirements of NFPA

The front of the alarm module consists of four AMBER Light Emitting Diodes (LED). Relative to the configuration, these light emitting diodes can indicate various warnings:

- High Coolant Temperature
- Low Coolant Temperature
- Low Coolant Level
- Low Oil Pressure
- Generator On Load
- Charger Malfunction
- Low Oil Level
- Low Fuel Level

There are four RED light emitting diodes that can indicate the following conditions:

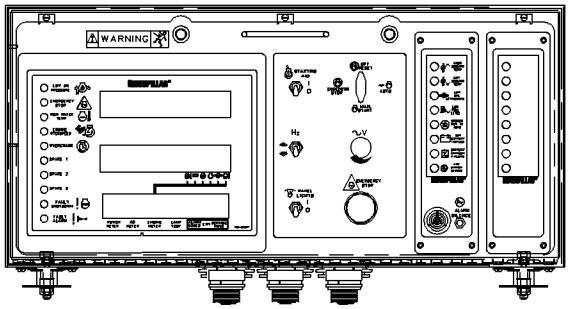
- Not-in AUTO condition
- Low DC Voltage
- Closed Air Damper
- Low Oil Pressure Shutdown
- Overcrank Shutdown
- High Coolant Temperature Shutdown
- Overspeed Shutdown

The front of the alarm module consists of an alarm horn and an Acknowledge/Silence Switch. For more information, refer to the appropriate Service Manual Module.

i01490278

Electronic Modular Control Panel II+ (EMCP II+)

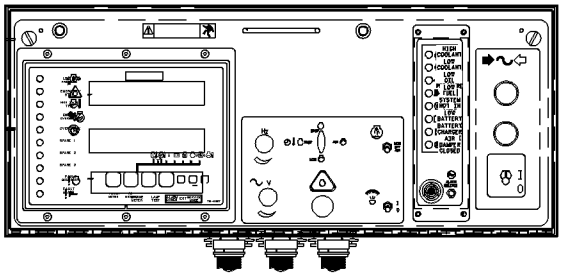
SMCS Code: 4490



g00606789

Illustration 45

Control Panel for MUI Engines or PEEC Engines



g00606800

Illustration 46

Control Panel for EUI Engines

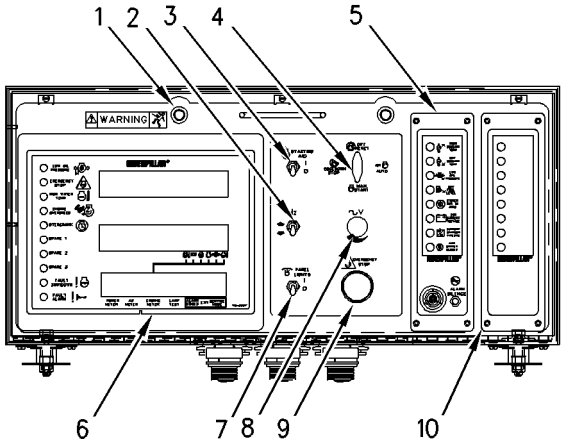
The Electronic Modular Control Panel II+ (EMCP II+) is located on top of the generator's regulator housing. The control panel consists of a main panel with indicators, meters, and control switches. This control panel has two empty slots that can be configured in the following ways:

- no module
- contain one or two alarm modules.
- contain a synchronizing lights module.

The left side of the control panel contains the Generator Set Control + (GSC+). This is the main component of the system. The GSC+ also displays generator output, fault conditions, and key engine parameters.

Main Control Panel

The main control panel may not contain all of the components that are shown below. Some components are optional. These components may not be required for your particular application. The control panel for MUI engines and PEEC engines is shown. The EUI control panel is similar.



g00798081

Illustration 47

Main Control Panel

(1) Optional Panel Lights (two)
(2) Governor Switch or Optional Speed Potentiometer
(3) Starting Aid Switch
(4) Engine Control Switch
(5) Optional Alarm Module
(6) Generator Set Control + (GSC+)
(7) Optional Panel Light Switch
(8) Voltage Adjust Rheostat
(9) Emergency Stop Push Button
(10) Optional Custom Alarm Module or Optional Synchronizing Lights Module

Panel Lights (1) – The panel lights are controlled by the Panel Light Switch (7).

Optional Governor Switch or Speed Potentiometer (2) – If the governor is equipped with a speed adjusting motor, the governor switch is used to adjust the engine speed. If the engine is equipped with an electric governor, a speed potentiometer is installed in this location.

Starting Aid Switch (3) – The optional starting aid switch is used to inject ether into the engine for starting in cold weather conditions. After being turned to the ON position, the starting aid switch meters a specific amount of ether into a holding chamber. When the switch is released, the solenoid releases the ether into the engine.

Engine Control Switch (4) – The engine control switch determines the status of the control panel. In the Automatic position (3 o'clock), the engine will start automatically whenever a remote start/stop initiate contact is closed. The engine will stop after the initiate contact opens and after an adjustable cooldown period has elapsed. A cooldown period can be programmed. This cooldown period (0 to 30 minutes) will allow the engine to dissipate heat before the engine shuts down.

In the Manual Start position (6 o'clock), the engine will start and the engine will run. In order for the engine to continue to run, the ECS must remain in the Manual Start position.

In the Stop position (9 o'clock), the fuel solenoid stops the engine. This shutdown occurs after a programmable cooldown period.

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

Alarm Module (5) – The optional alarm module provides two types of warnings: a visual warning of the engine's conditions and an audible warning of the engine's conditions. These warnings are given before the conditions become severe enough to shut down the engine. These warnings are also given before the conditions prevent the engine from starting.

Generator Set Control + (6) – See the topic Generator Set Control + in this section.

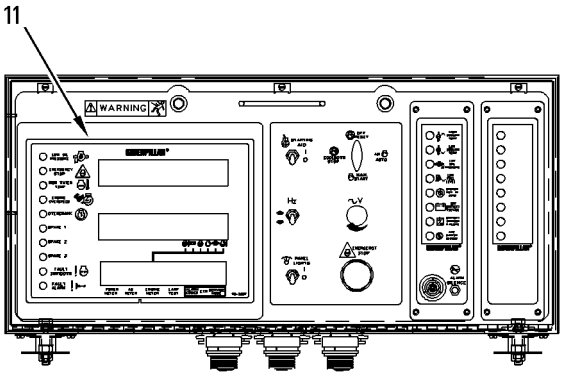
Panel Light Switch (7) – The panel light switch turns ON the panel lights (1). The panel light switch also turns OFF the panel lights (1).

Voltage Adjust Rheostat (8) – The voltage adjust rheostat is used to adjust the generator output voltage to the desired level.

Emergency Stop Push Button (9) – The emergency stop push button is used to shut down the engine during an emergency situation. The engine is shut down by shutting off the fuel and activating the optional air shutoff (if equipped).

Custom Alarm Module or Synchronizing Lights Module (10) – The custom alarm module provides a visual warning and the custom alarm module provides an audible warning. These warnings are given when faults, alarms, or other conditions are present in customer supplied inputs. The purpose of the synchronizing lights module is as an aid when units are paralleled at no load and under load.

Generator Set Control +



g00798119

Illustration 48

Generator Set Control +

(11) Generator Set Control +

The left side of the control panel contains the Generator Set Control + (GSC+). This is the main component of the system. The GSC+ displays the following information:

- generator output
- generator set functions
- fault conditions
- key engine parameters

The GSC+ accepts information from the operator, engine speed sensor, oil pressure sensors, water temperature sensors, and optional remote sources. This information is used to determine the on/off state of the engine's air, fuel, and starter.

Under 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's starter. When the engine speed reaches the crank termination speed, the starter is disengaged. When the GSC+ receives an engine stop signal, the GSC+ shuts off the fuel.

GSC+ Features and Functions

The GSC+ has the following features and functions:

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

- The GSC+ shows the engine conditions and generator output information (on two displays). These 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 to describe the fault.

- The GSC+ contains programmable features for certain applications or customers' requirements.

Cycle Crank – The GSC+ can be programmed to alternate between cranking and resting for adjustable time periods. Refer to the appropriate Service Manual Module for programming instructions.

Governor Control – When the engine oil pressure is increased beyond the low oil pressure setpoint, the GSC+ will inform the governor that the engine speed should be increased from IDLE to RATED rpm.

Cool Down – When the GSC+ receives a signal to perform a normal shutdown, the GSC+ hesitates for a period of time. This period of time is preprogrammed. After this period of time, the engine is shut down via the fuel control.

Automatic Operation – While the GSC+ is in the automatic mode, a remote start signal (contact closure) will start the GSC+. Upon loss of the signal (contact opening), the GSC+ will perform a normal shutdown.

Alarm Module Communication – The GSC+ can transmit fault conditions and alarm conditions to an alarm module.

Power Down – The Electronic Modular Control Panel II+ (EMCP II+) is designed to remove power from the GSC+ when the following conditions are met:

- The GSC+ is in the Off/Reset mode.

- The proper jumper wire is removed.

The GSC+ will not be powered down until the crank termination relay is OFF and the fuel control relay is OFF. Both relays must be OFF for approximately 70 seconds. The GSC+ will not be powered down unless the wire is removed.

Note: For the wiring diagram and jumper wire locations, refer to the appropriate Service Manual Module.

Fuel Solenoid Type – The GSC+ can be programmed for an energized-to-run fuel system or an energized-to-shutdown fuel system.

Fault Indicators

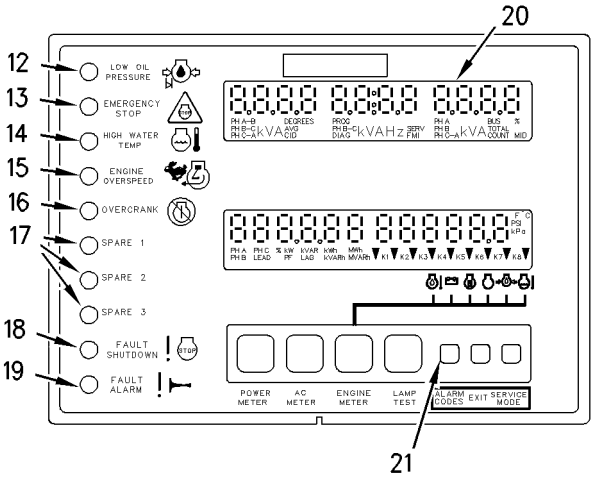


Illustration 49 g00798132

Generator Set Control + (GSC+)

(12) Low Oil Pressure Fault Indicator
(13) Emergency Stop Fault Indicator
(14) High Water Temperature Fault Indicator
(15) Engine Overspeed Fault Indicator
(16) Overcrank Fault Indicator
(17) Three Spare Fault Indicators
(18) Fault Shutdown Indicator
(19) Fault Alarm Indicator
(20) Upper Display
(21) Alarm Codes Key

The ten fault indicators are located on the front of the GSC+. These fault indicators are used to display present faults. These fault indicators are also used to describe present faults.

The yellow fault alarm indicator (19) FLASHES when the GSC+ detects a fault that is an alarm condition. The engine continues to run and the engine continues to start. The fault alarm indicator is accompanied by an alarm fault code. This alarm fault code is displayed on the upper display (20) when the alarm codes key (21) is pressed. Refer to the appropriate Service Manual Module for fault code descriptions.

The red Fault Shutdown Indicator (18) FLASHES when the GSC+ detects a fault that is a shutdown condition. When a fault is detected, the engine is shutdown. If the engine is not running, the engine is prevented from starting. The fault shutdown indicator is accompanied by a diagnostic fault code. This fault code is shown immediately on the upper display. Refer to the appropriate Service Manual Module for fault code descriptions.

The five dedicated shutdown indicators represent the following shutdown conditions:

- low oil pressure
- emergency stop
- high water temperature
- engine overspeed
- engine overcrank

When the GSC+ detects a fault in one of these conditions, the corresponding dedicated shutdown indicator FLASHES. When a fault is detected, the engine is shutdown. If the engine is not running, the engine is prevented from starting. Because each indicator has a label, there are no fault codes that are associated with the dedicated shutdown indicators. The conditions that are required for each dedicated fault are shown below and the results of each dedicated fault are shown below:

Low Oil Pressure (12) – 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 operating at idle speed. The second setpoint is used when the engine is at rated speed. The low oil pressure indicator FLASHES. When a fault is detected, the engine is shutdown. If the engine is not running, the engine is prevented from starting.

Emergency Stop (13) – The operator presses the Emergency Stop Push Button on the instrument panel. The emergency stop indicator FLASHES. If the engine is running, the engine is shutdown. If the engine is not running, the engine is prevented from starting.

Engine Overspeed (15) – The engine speed exceeds the setpoint that is programmed into the GSC+. The Engine Overspeed Indicator FLASHES. If the engine is running, the engine is shutdown. If the engine is not running, the engine is prevented from starting.

Overcrank (16) – The engine does not start within the setpoint for total cycle crank time that is programmed into the GSC+. The overcrank indicator FLASHES and the engine is not allowed to start.

Note: The GSC+ can be programmed to override the shutdown for low oil pressure and high water temperature faults. When the shutdowns are overridden, these faults are treated as alarm conditions. The corresponding dedicated shutdown indicator will remain CONTINUOUSLY ON. The engine will continue to run. The engine will continue to start instead of shutting down. When a dedicated shutdown indicator is ON continuously, the setpoint for shutdown has been exceeded. The GSC+ is programmed to override the shutdown condition. The GSC+ will treat the fault as an alarm condition. At the factory, the GSC+ is programmed to treat low oil pressure and high water temperature as shutdowns. Refer to the appropriate Service Manual Module for programming procedures.

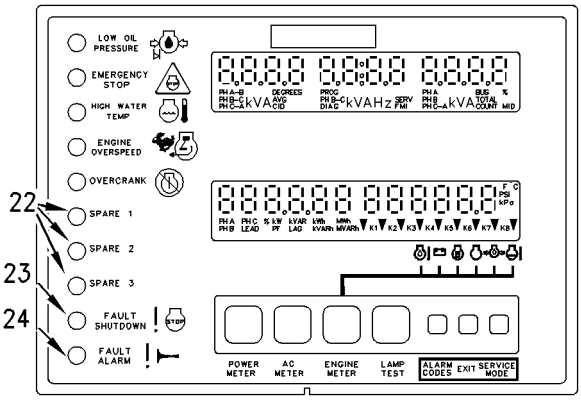
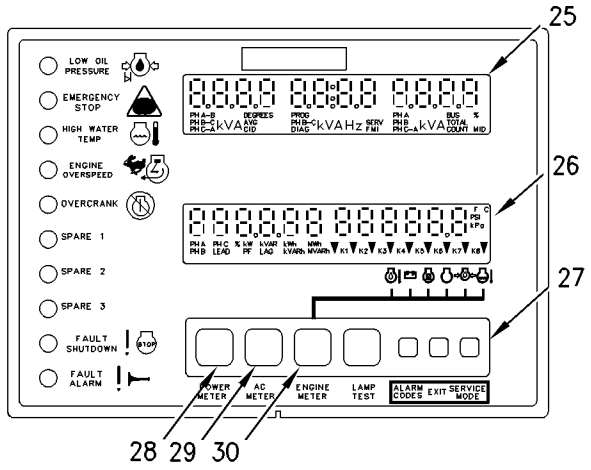


Illustration 50 g00798142

(22) Spare fault indicators
(23) Fault shutdown indicator
(24) Fault alarm indicator

When the conditions that are associated with each spare fault are active, the yellow spare fault indicators (22) FLASH. The three spare faults are programmable. The spare fault indicators (22) can be programmed to indicate an alarm condition or the spare fault indicators can be programmed to indicate a shutdown condition. The spare fault indicators can be programmed to flash when the following conditions are met: coolant loss, high oil temperature, and customer generated switched input. When the spare fault indicators flash, either the red fault shutdown indicator (23) will flash or the yellow fault alarm indicator (24) will flash. This will depend on the programming of the spare fault indicators. For more information on programming procedures, refer to the appropriate Service Manual Module.

Display



g00798155

Illustration 51

(25) Upper Display
(26) Lower Display
(27) Keypad
(28) Power meter key
(29) AC meter key
(30) Engine meter key

The display consists of the upper display and the lower display. When the display is in the service mode, both displays are used for programming functions. For more information, see Systems Operation, Testing and Adjusting, RENR1249, “Electronic Modular Control Panel II+ (EMCP II+) for MUI Engines”.

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
- Simultaneous line to line voltage for all three phases
- Simultaneous line current for all three phases

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

- Simultaneous line to neutral voltage for all three phases

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

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, RENR1249, “Electronic Modular Control Panel II+ (EMCP II+) for MUI Engines”.

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 (26) shows values for power metering, engine parameters and the relay status.

The left side of the lower display (26) 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 (kVAR/Hr)

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

Note: When setpoint P032 is set to 1 for delta generator sets, the following phases are NOT shown:

- real power “phase A”
- real power “phase B”
- real power “phase C”
- power factor “phase A”
- power factor “phase B”
- power factor “phase C”

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). This will be followed by .001 MW/h (second step).

The right side of lower display (26) shows the value of certain engine parameters. The parameters are listed below.

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

The value for one of these conditions is shown on the lower display (26) 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 (26) 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 (26). When a GSC+ relay is activated, the corresponding indicator (K1, K2, etc) is shown on lower display (26). When a relay is not activated, the corresponding indicator (K1, K2, etc) is not shown. For a description of the relay functions, refer to Systems Operation, Testing and Adjusting, RENR1249, “Electronic Modular Control Panel II+ (EMCP II+) for MUI Engines”.

Keypad

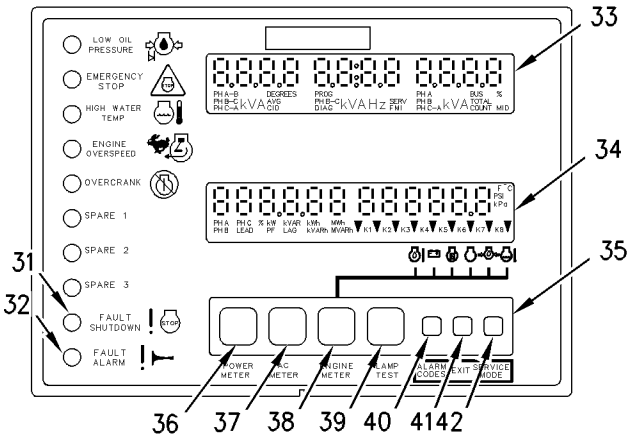


Illustration 52 g00798161

Keypad Area of the GSC+

(31) Fault shutdown indicator
(32) Fault alarm indicator
(33) Upper display
(34) Lower display
(35) Keypad
(36) Power meter key
(37) AC meter key
(38) Engine meter key
(39) Lamp test key
(40) Alarm codes key
(41) Exit key
(42) Service mode key

Keypad (35) is used to control the information that is shown on upper display (33) and lower display (34). The seven keys have two sets of functions: normal functions and service functions. See the Systems Operation, Testing and Adjusting, RENR1249, “Electronic Modular Control Panel II+ (EMCP II+) for MUI Engines” for a description of the service functions of the keys. The normal functions of the keys are described in the following paragraphs.

Power Meter Key (36) – 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. When the key is pressed again, the power meter functions will continue to scroll.

AC Meter Key (37) – 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 (38) – 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 (39) – 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 (33) and lower display (34) are ON. On the optional alarm module, all of the indicators are ON and the horn sounds. If an operator presses the key, the lamp test function automatically turns off.

Alarm Codes Key (40) – If fault alarm indicator (32) is FLASHING, pressing this key causes upper display (33) to show the corresponding alarm fault code. If this key is pressed again, the generator AC output information will show on the upper display (33). If fault alarm indicator (32) is OFF, this key has no function.

Exit Key (41) – This key only functions when the GSC+ is in Service Mode. See the Systems Operation, Testing and Adjusting, RENR1249, “Electronic Modular Control Panel II+ (EMCP II+) for MUI Engines” for more information.

Service Mode Key (42) – Pressing this key causes the GSC+ to enter service mode. See the Systems Operation, Testing and Adjusting, RENR1249, “Electronic Modular Control Panel II+ (EMCP II+) for MUI Engines” for more information.

Alarm Module

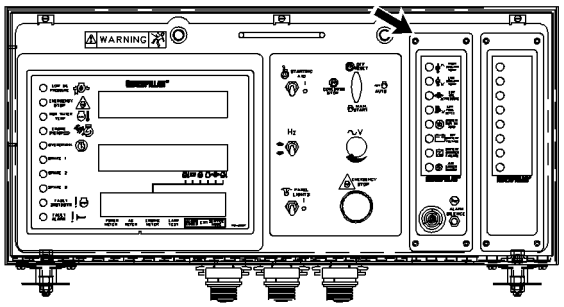


Illustration 53 g00642052

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

One basic alarm module is used to satisfy the requirements of standby NFPA 99 alarm module, standby NFPA 110 alarm module, NFPA 99 remote annunciator panel, and prime power alarm. Different module inputs are used to meet these requirements. On the front of the module, different decals are used in order to indicate alarms or shutdown conditions. Refer to the Systems Operation, Testing and Adjusting, RENR1249, “Electronic Modular Control Panel II+ (EMCP II+) for MUI Engines” for all wiring and installation information. For a listing of indicator functions and a listing of alarm functions, refer to Systems Operation, Testing and Adjusting, RENR1249, “Electronic Modular Control Panel II+ (EMCP II+) for MUI Engines”.

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

- There are four amber indicators. These indicators will light under the following conditions (depending on the module configuration): High Coolant Temperature, Low Coolant Temperature, Low Coolant Level, Low Oil Pressure, Generator On Load, Charger Malfunction, Low Oil Level, and Low Fuel Level.

- There are four red indicators. These indicators will light under the following conditions (depending on the module configuration): Out of “AUTO”, Low DC Voltage, Closed Air Damper, 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, RENR1249, “Electronic Modular Control Panel II+ (EMCP II+) for MUI Engines”.

Custom Alarm Module (If Equipped)

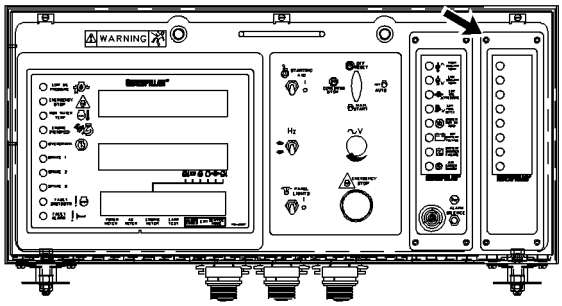


Illustration 54 g00642053

The custom alarm module (CAM) is optional. The CAM is located in the right side of the control panel. The custom alarm module provides a visual warning of engine conditions and an audible warning of customer supplied inputs. These warnings are provided before conditions become severe enough that the engine will shut down or the engine will be unable to start. The custom alarm module is equipped with the following devices: horn, an alarm silence switch, a lamp test switch, and eight switched inputs. Refer to the Systems Operation, Testing and Adjusting, RENR1249, “Electronic Modular Control Panel II+ (EMCP II+) for MUI Engines” for all wiring and installation information. Refer to the Systems Operation, Testing and Adjusting, RENR1249, “Electronic Modular Control Panel II+ (EMCP II+) for MUI Engines” for the names of input signals.

Note: A basic version of the CAM also exists. The basic version does not have a horn, an alarm/silence switch, or a lamp test switch. The basic CAM should be used with an existing fully equipped CAM or an existing alarm module (ALM).

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

Synchronizing Lights Module (If Equipped)

The optional synchronizing lights module is mounted on the right side of the control panel.

Synchronizing lights are used as an aid in paralleling units that are at no load and units that are under load. Each of the two lights are connected across the generator. These lights will connect to the circuit breaker's load side. Together, these lights will indicate when the voltages are in-phase. When the voltages are in-phase, the circuit breaker can be closed. When the circuit breaker is closed, the generator will be in line with the load.

For a complete explanation of the proper procedure to parallel two generators, refer to "Parallel Operation" in the Operation Section of this book. For information regarding wiring and installation, refer to the appropriate EMCPII+ Service Manual Module.

Voltage Regulators

i01490317

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. Different types of voltage regulators that are available with SR4B generators are listed in table 3.

Table 3

VOLTAGE REGULATORS THAT ARE AVAILABLE WITH SR4B GENERATORS					
Voltage Regulator	**Genset**				
	3306B	**3406B**	**3406E**	**3412C**	**3500**
VR3	Standard	Standard	N/A	N/A	N/A
VR3F	Standard	Standard	Standard	Standard	Option
VR4	Standard	Standard	N/A	N/A	N/A
DVR	Standard	Standard	Option	Option	Standard

Illustrations 55 through 58 show the different types of voltage regulator adjustment controls.

The VR3 regulators and the VR3F regulators have voltage droop capability (1). The VR4 regulator does not have a voltage droop capability. The VR4 regulator is not designed for parallel applications.

The VR3 regulators, VR3F regulators, and VR4 regulators have the voltage level control (2).

The VR3 regulators and VR4 regulators have a voltage gain capability (3). The VR3F regulator does not have voltage gain capability.

Voltage droop, voltage level and voltage gain are controlled by multiturn potentiometers. The adjusting 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 adjusting screw can be turned past the potentiometer stop (ratchet action) without further changing the potentiometer setting.

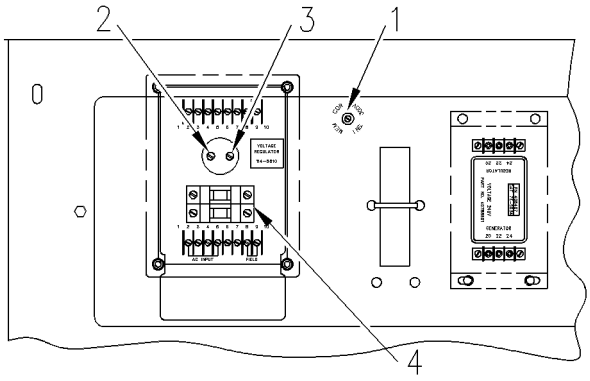


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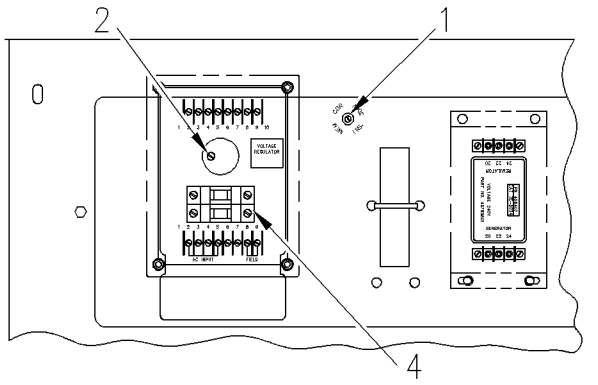
Illustration 55

Adjustment Controls of the VR3 Regulator

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

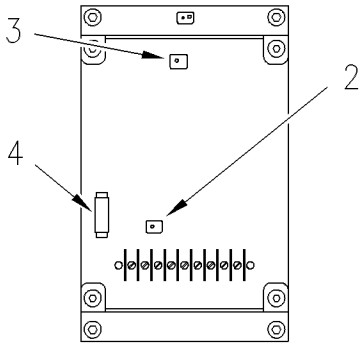


g00626331

Illustration 56

Adjustment Controls of the VR3F Regulator

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

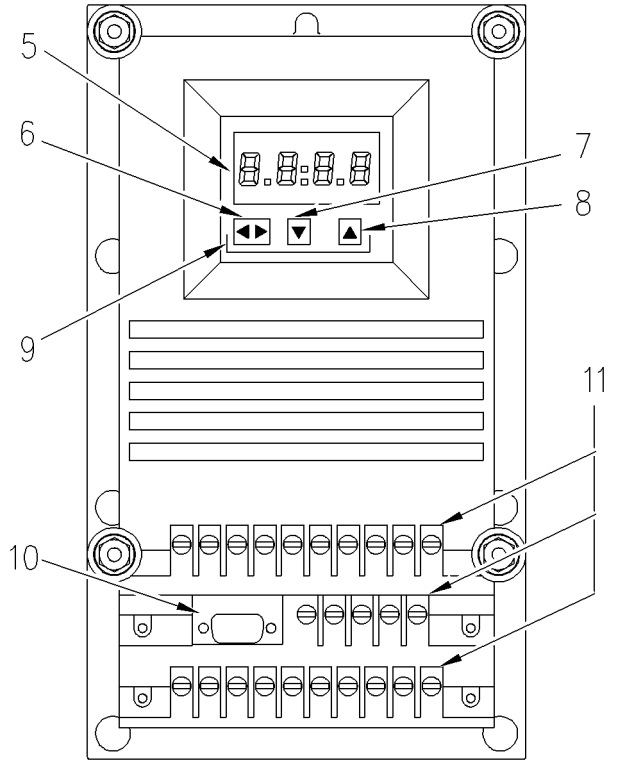


g00626398

Illustration 57

Adjustment Controls of the VR4 Regulator

(2) Voltage level potentiometer
(3) Voltage gain potentiometer
(4) Fuse(s)



g00626333

Illustration 58

Digital Voltage Regulator (DVR)

(5) Display
(6) Function key
(7) Scroll down key
(8) Scroll up key
(9) Keypad
(10) J1 connector
(11) 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 (5) of the DVR. Keypad (9) is used to change the information that is shown on the display (5). J1 connector (10) is used to join the DVR to a personal computer. Screw terminals (11) are used to join the DVR to the generator and various customer options.

Adjustment Procedure for the Voltage Regulators

VR3 Regulator

Note: The VR3 regulator is protected by a fuse(s). The VR3 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). Remove the protective screw from the voltage gain potentiometer (3).

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

4. Remove the protective screw from the voltage level potentiometer (2). Remove the protective screw from the voltage gain potentiometer (3).

5. Turn the voltage gain potentiometer (3) counterclockwise to zero. Then, turn voltage gain potentiometer (3) to about 1/4 of full range of clockwise travel.

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

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

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

9. 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.

10. 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.

11. If the voltmeter reading increases above the no-load voltage in Step 10, turn the voltage gain potentiometer counterclockwise. If the voltmeter reading decreases, turn the voltage gain potentiometer (3) clockwise.

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

13. Apply the load. Observe the voltmeter reading. Repeat Steps 10 through 12 until the voltage at no load equals the voltage at full load.

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

VR3F Regulator

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.

VR4 Regulator

Note: The VR4 regulator is protected by a fuse(s). The VR4 regulator also has a solid-state overcurrent protection. If a replaced fuse becomes open, contact a Caterpillar dealer.

1. Remove the access panel of the generator.

2. Turn voltage gain potentiometer (3) counterclockwise to zero. Then, turn voltage gain potentiometer (3) to about 1/4 of the full range of clockwise travel.

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

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

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

6. 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.

7. 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.

8. If the voltmeter reading increases above the no-load voltage in Step 7, turn the voltage gain potentiometer (3) counterclockwise. If the voltmeter reading decreases, turn the gain potentiometer (3) slightly in clockwise direction.

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 7 through 9 until the voltage at no load equals the voltage at full load.

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

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 to be adjusted 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 (5) and keypad (9) are used to select parameter values. Display (5) and keypad (9) are also used to manipulate the parameter values that control the operation of the digital voltage regulator. Display (5) 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 (9) has three keys. The keys are listed below.

- Function key (6)
- Scroll down key (7)
- Scroll up key (8)

Display (5) has two modes. These modes are the parameter code mode and the parameter value mode. Function key (6) is used to toggle back and forth between the two modes. Scroll down key (7) and scroll up key (8) are used to change the display’s value. The scroll down key will decrease the parameter number or the scroll down key will decrease the value number. The scroll up key will increase the parameter number or the scroll up key will increase the value number.

Table 4

Parameter Code	Parameter Value
:01	0480
	0481
	0482
	0483
:02	0001
	0002
	0003
	0004
:03	0004
	0003
	0002
:04	0100
	0099
	0100
	0101

The operation of display (5) and keypad (9) is shown in Table 4. Pressing function key (6) toggles the display between the two columns of the table (parameter code and parameter value). If a colon is present, the display is in parameter code mode. If a colon is not present, the display is in parameter value mode.

When you press scroll up key (8), the number that is displayed will increase to the next higher number within the column. When you press scroll down key (7), 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 (7) or scroll key (8).
2. Access the parameter value by pressing function key (6).
3. Select the desired parameter value by pressing scroll key (7) or (8).
4. In order to enter the selected value into the digital voltage regulator's memory, press function key (6).

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Voltage Regulator Options

SMCS Code: 4467

Electromagnetic Interference/Radio Frequency Interference Module

The Electromagnetic Interference/Radio Frequency Interference Module Option (EMI/RFI) is one of the two voltage regulator options that are available with SR4B generators. EMI/RFI module represents a filter which is connected in series with the sensing leads. This filter meets the following requirements: MIL STD 461B, VDE 875 level N, and 89/336/EEC. The EMI/RFI module is available as an option on 3306B, 3406C, 3406E, and 3412C generator sets. The EMI/RFI module is shown below.

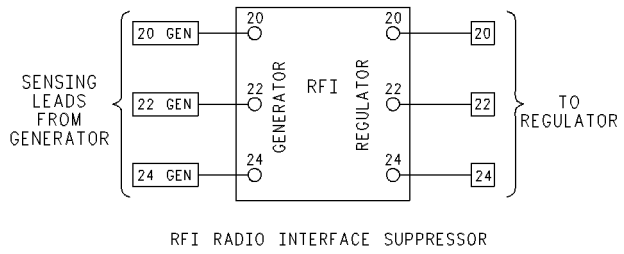
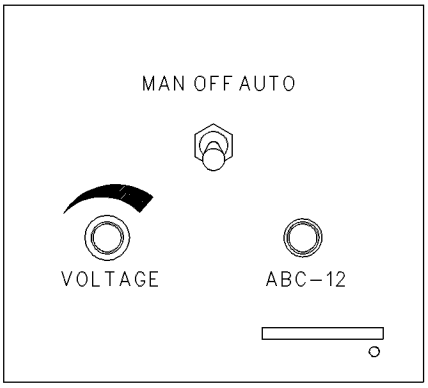


Illustration 59 g00626657

EMI/RFI Module

Manual Voltage Control

A manual voltage control is available as an option on SR4B generator sets. Various specifications and certifications require manual voltage control of the generator if the automatic voltage regulator should fail. The manual voltage controls for the self-excited generators and the manual voltage controls for permanent magnet excited generators are shown below.



g00626634

Illustration 60

Manual Voltage Control for Self-Excited Generators

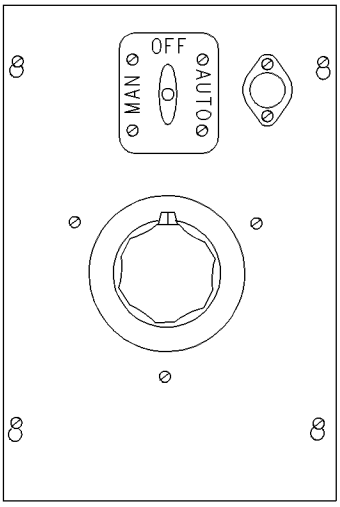


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Illustration 61

The Manual Voltage Control for Permanent Magnet Excited Generators

Installation

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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 and Storage

Moving the Generator

⚠ WARNING

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

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

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

- Attach an overhead crane to the eyebolts that are installed on the generator frame.
- Use a lift truck in order to lift the generator.

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

Storage

Short Time Storage

If the generator is not installed immediately, store the generator in a clean area. This area should also have the following conditions: low humidity, stable humidity, and stable temperature. Space heaters must be energized in order to keep condensation from the windings. All accessory equipment that is supplied with the unit should be stored with the generator. The combined unit should be covered with a durable cover in order to protect against the following contaminants:

- dust
- dirt
- moisture
- other airborne abrasives

Long Time Storage

A storage period in excess of six months should be preceded by the following preparation:

1. Install desiccant bags inside the exciter's cover and install desiccant bags inside the screen of the fan.
2. Seal the unit in a covering of plastic or other material that has been designed for that purpose.
3. Adequately tag the generator. This will ensure that preservative greases and desiccant bags are removed before the unit is placed in operation.

Bearing Inspection

Ball bearing generators use grease. This grease is subject to deterioration. If the generator is stored longer than one year, new ball bearings should be installed. These bearings should be greased to the proper level prior to being put into operation. If inspection indicates that bearings are free of rust or corrosion, and no noise or excessive vibration appear on start-up, replacement is not necessary.

Location

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

- clean

- dry
- well ventilated
- easily accessible for inspection and maintenance

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

Electrical Measurements

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

- rapid changes in temperature
- freezing
- wet climate during shipment
- wet climate during storage

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

Refer to the Generator Maintenance section of this manual in order to measure the following items:

- Exciter Field (Stator)
- Exciter Armature (Rotor)
- Generator Field (Rotor)
- Generator Armature (Stator)

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.

Engine Starting and Engine Stopping

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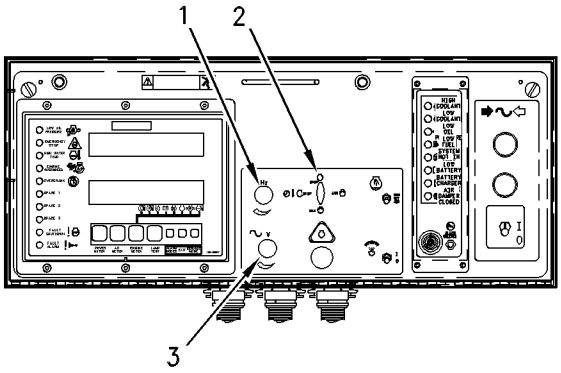
Manual Operation

SMCS Code: 1000; 4450

EMCP II And EMCP II+ Control Panels



g00603350

Illustration 62

EMCP II+ Control Panel

(1) Speed Potentiometer
(2) Engine Control Switch (ECS)
(3) Voltage Adjust Rheostat

Starting the Engine

1. Perform all inspections before starting. Refer to Safety Section, “Before Starting Engine”.
2. Turn the Engine Control Switch (ECS) to the Manual Start position. If the ECS (2) is in this position, the engine will start and the engine will run.
3. When the engine starts, the engine fault circuits are functional. If a fault occurs, the engine will be automatically shut down.

Note: After being shutdown by a fault, follow these steps in order to restart the engine:

- Correct the fault condition.
- Turn the engine control switch to the Off/Reset position.
- Refer to step 2 in order to restart the engine.

4. After the engine starts and the systems have stabilized, apply the load.
5. Regulate the frequency of the generator by using one of the following devices:
   - the optional governor switch
   - the optional Speed Potentiometer (1)
   - the Manual Governor Control Lever on the engine
6. Regulate the voltage level of the generator with the voltage adjust rheostat (3).

Stopping the Engine

1. Remove the load from the engine.
2. In order to cool down the engine at high idle and no load, turn the Engine Control Switch to the STOP position. This will allow the engine to run for the preset cool down time before shutdown. If cooling down the engine at high idle and at no load is not desired, proceed to Step 3.
3. Reduce the engine speed to low idle. On 60 Hz units, low idle is approximately 66% of the full load speed. On 50 Hz units, low idle is approximately 80% of the full load speed. If the governor has an electric motor, push down on the Governor Switch until low idle is achieved. On electronic governors, turn down the Speed Potentiometer until low idle is achieved. For manual governors, move the Governor Control lever to the low idle position.
4. While the engine is at low idle, measure the engine oil level. Oil level must be maintained between the “ADD” and “FULL” marks on the “Engine Running” side of the dipstick.

Note: On 3200 Series engines, the oil level cannot be measured while the engine is running.

5. In order to allow the engine to cool down, run the engine at low idle for approximately five minutes. After the engine cools, turn the Engine Control Switch to the Off/Reset position.

Emergency Stopping

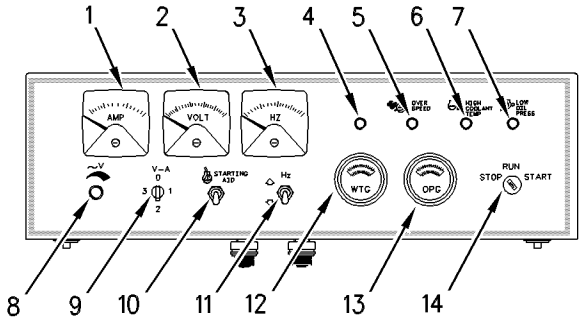
Reset and Check Emergency Stop Switches

If the emergency stop switch was used to shut down the engine, it will be necessary to reset the switch. In order to reset the switch, pull out the switch and rotate the button in a clockwise direction.

Note: Before starting, check the emergency stop buttons that are located on the engine junction box (if equipped). If the emergency stop button was used to stop the engine, reset the air shutoff (if equipped).

Before starting the engine, correct the problem that necessitated the emergency stop.

Manual Start/Stop Control Panel (130-3786)



g00601296

Illustration 63

130-3786 Control Panel

(1) AC Ammeter (AM)
(2) AC Voltmeter (VM)
(3) Frequency meter
(4) Spare fault indicator
(5) Engine overspeed fault indicator
(6) High coolant temperature fault indicator
(7) Low oil pressure fault indicator
(8) Voltage adjust rheostat
(9) Ammeter/Voltmeter phase selector switch (AVS)
(10) Starting aid switch
(11) Governor switch
(12) Water temperature gauge (WTG)
(13) Oil pressure gauge (OPG)
(14) Keyswitch

Starting the Engine

Note: When the keyswitch (14) is in the RUN position, do not turn the keyswitch to the START position. The keyswitch must be turned to the STOP position prior to being turned again to the START position.

1. Prior to starting, perform all inspections. Refer to Safety Section, “Before Starting Engine”.

2. To crank the engine, turn the keyswitch (14) to the START position and hold the keyswitch in the START position.

Note: If the engine does not start, hold the keyswitch (14) in the start position and move the starting aid switch (10) (if equipped) to the ON position. Keep both the switches in these positions until the engine starts. After the engine starts, turn the starting aid switch to the OFF position.

3. After the engine starts, release the keyswitch. When the keyswitch is released, the keyswitch will return to the RUN position.

Note: If the engine does not start after 15 seconds of cranking and the low oil pressure fault indicator (7) turns ON, turn the keyswitch (14) to the STOP position. Attempt to restart the engine.

When the keyswitch is returned to the RUN position, the following fault indicators are armed:

- the engine overspeed fault indicator
- the high coolant temperature fault indicator
- the spare fault indicator

Return the keyswitch to the RUN position. The low oil pressure fault indicator (7) will be armed in ten seconds. If a fault occurs, the control panel will automatically stop the engine. The corresponding fault indicator will turn ON. The fault indicator will remain in the ON position until the keyswitch is moved to the STOP position.

Note: After the engine has been shutdown by a fault, turn the keyswitch to the STOP position in order to restart the engine. Correct the fault. Refer to step 2 in order to restart the engine.

4. After the engine has started and the systems have stabilized, apply the load.

5. To adjust the frequency of the generator, use the optional governor switch (11) or use the manual governor control lever.

6. To adjust the voltage of the generator, use the voltage adjust rheostat (8).

Stopping the Engine

1. Remove the load from the engine.

2. Reduce engine speed. Engine speed can be reduced by either of the following methods:

- press down the optional governor switch (11)
- move the manual governor control lever to the low idle position.

3. While the engine is running at low idle, allow the engine to cool. After the engine cools, turn the keyswitch to the STOP position.

An Engine Shutdown that is Caused by Faults

The control panel is equipped with engine protective devices. The shutdowns are designed to protect the engine from a malfunction that causes the following problems:

- low oil pressure
- high coolant temperature
- engine overspeed
- spare fault condition

When a fault occurs and the engine shuts down, the corresponding fault indicator will turn ON.

Restarting the Engine

To restart the engine after a shutdown that is caused by a fault condition, perform the following steps:

⚠ WARNING

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

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

1. Turn the keyswitch to the STOP position.
2. Correct the fault condition that caused the shutdown.
3. To crank the engine, turn the keyswitch (14) to the START position and hold the keyswitch in the START position.

Note: If the engine does not start, hold the keyswitch (14) in the start position and move the starting aid switch (10) (if equipped) to the ON position. Keep both the switches in these positions until the engine starts. After the engine starts, turn the starting aid switch to the OFF position.

4. After the engine starts, release the keyswitch. When the keyswitch is released, the keyswitch will return to the RUN position.

Note: If the engine does not start after 15 seconds of cranking and the low oil pressure fault indicator (7) is ON, turn the keyswitch (14) to the STOP position. Attempt to restart the engine.

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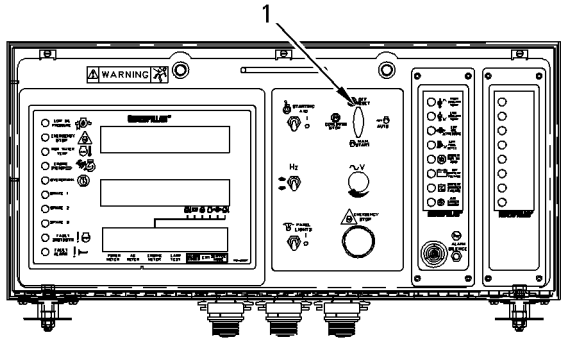
Automatic Operation

SMCS Code: 1000; 4450

An Automatic Start/Stop system is used when an engine must start with no one in attendance. When an Automatic Start/Stop system is used, the generator must perform the following functions:

- Start the engine.
- Pick up the load.
- Operate the load.
- Stop after the load is removed.

Starting the Engine



g00603986

Illustration 64
Engine Control Switch
(1) Engine Control Switch

In order to start an unattended engine, the following conditions must be met:

- the minimum engine room temperature must be 20 °C (68.0 °F).
- the minimum engine jacket water temperature must be 32 °C (89.6 °F).

The Engine Control Switch (1) must be in the Automatic Start position. In this position, the engine will automatically start when a remote starting contact is closed. When the Engine Control Switch is used together with an Automatic Transfer Switch, the engine can be signalled to start and the load will automatically be transferred when commercial power fails. When commercial power is restored, the Automatic Transfer Switch will automatically perform the following functions:

- Transfer the load back to commercial power.
- Provide a cool down time.
- Stop the engine.

In the Automatic Start position, the engine will automatically stop if the engine has a fault. The programmed Cooldown Timer will cause the unloaded engine to run at the rated speed before shutting down.

Standby Sets

If the generator set is used for a standby application with a remote transfer switch, place the Engine Control Switch in the Automatic position. After starting the engine, adjust the speed for proper operation of the generator with load.

Stopping the Engine

The Automatic Start/Stop Control Panel can be used to manually stop the engine. To stop the engine, place the Engine Control Switch in the Stop position. If the Engine Control Switch is left in the Automatic position, the engine will stop automatically when the remote starting contacts open and the programmed cool down cycle is complete.

An Engine Shutdown that is Caused by Faults

The Automatic Start/Stop Module is equipped with engine protective devices. These shutdowns will protect the engine if a malfunction causes one of the following problems:

- low oil pressure
- high coolant temperature
- engine overspeed
- an overcrank condition
- engine coolant loss (optional protective device)
- customer selected parameters

When a fault occurs and the engine shuts down, one of the fault indicators will light.

Restarting the Engine

⚠ WARNING

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

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

To restart the engine after a shutdown that was caused by a fault condition, perform the following steps:

1. Turn the Engine Control Switch to the Stop position.
2. Correct the fault condition that caused the shutdown.
3. Rotate the Engine Control Switch to the Off/Reset position.
4. Make sure that the Emergency Stop buttons are reset. These buttons are located on the control panel or the engine junction box.
5. Make sure that the Air Shutoff Lever is reset. The Air Shutoff Lever is located at the top of the air inlet housing (if equipped).
6. The system will be ready to start when the Engine Control switch is turned to Manual or Automatic.

Note: For additional information, refer to the appropriate Service Manual Module. These modules are contained in the Electric Set Generator Manual, SENR8395.

Maintenance Section

Maintenance Recommendations

i01135057

General Maintenance Information

SMCS Code: 4450

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 insulation systems are very susceptible to damage that is caused by the stresses that are listed above. Exposure to these stresses may shorten the effective life of the insulation system. Therefore, the service life of an electric machine will largely depend on the serviceability of the 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
- operator's experience
- operator's philosophy

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 Caterpillar dealer.

Space Heaters

The SR4B generator is capable of operating in high humidity conditions without problems. However, problems can occur when the generator is idle and the surrounding air is warmer than the generator. Moisture can form on the windings that will result in poor performance from the windings. Moisture can also result in damage to the windings. Whenever the generator is not active, ensure that the space heaters are in operation.

Whenever the generator is operating, ensure that the space heaters are disconnected.

An external source of either 115 VAC or 230 VAC is required to operate the space heaters.

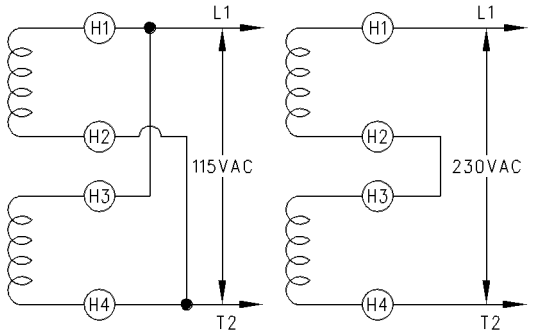


Illustration 65 g00556903

Space heater connection to external source (H1), (H2), (H3), and (H4) terminals.

If a 115 VAC source is available, connect both heaters in parallel across the source. If a 230 VAC source is available, connect both heaters in series across the source. Refer to Illustration 65.

i01494939

Generator Start-up Checklist

SMCS Code: 4450

Table 5

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						
	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					

(continued)

(Table 5, contd)

GENERATOR START-UP CHECKLIST				
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 6

GENERATOR START-UP CHECKLIST (CONT.)								
ELECTRICAL					**Yes**	**No**	**Comments**	
	Unit properly aligned?							
	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 _____			
	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.			

i01492475

Maintenance Interval Schedule (Standard)

SMCS Code: 4450

Before performing any operation or maintenance procedures, ensure that the Safety Information, warnings, and instructions are read and understood.

To determine the maintenance intervals, use service hours or calendar time, which ever comes first.

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

When Required

Generator - Dry 70
Generator Set - Test 73
Varistor - Test 80
Winding - Test 81

Daily

Generator Load - Check 72
Power Factor - Check 78
Stator Winding Temperature - Measure/Record ... 79

Every Week

Air Inlet Filter - Check 66
Bearing Temperature - Measure/Record 70
Electrical Connections - Check 70
Generator - Inspect 72
Rotating Rectifier - Test 78
Space Heater - Check 79
Voltage and Frequency - Check 80
Walk-Around Inspection 81

Every 1000 Service Hours

Bearing (Spherical Roller) - Lubricate 66
Insulation - Test 75

Every 2000 Service Hours

Bearing (Ball) - Lubricate 66

Every 2000 Service Hours or 6 Months

Generator Set Vibration - Inspect 74
Stator Lead - Check 79

Every 7500 Service Hours or 1 Year

Insulation - Test 75
Rotating Rectifier - Check 78

Overhaul

Bearing - Inspect 67

i01492479

Maintenance Interval Schedule (Standby)

SMCS Code: 4450

Before performing any operation or maintenance procedures, ensure that the Safety Information, warnings, and instructions are read and understood.

To determine the maintenance intervals, use service hours or calendar time, which ever comes first.

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

When Required

Generator - Dry 70
Generator Set - Test 73
Varistor - Test 80
Winding - Test 81

Daily

Generator Load - Check 72
Power Factor - Check 78
Stator Winding Temperature - Measure/Record ... 79

Every Week

Air Inlet Filter - Check 66
Bearing Temperature - Measure/Record 70
Electrical Connections - Check 70
Generator - Inspect 72
Rotating Rectifier - Test 78
Space Heater - Check 79
Voltage and Frequency - Check 80
Walk-Around Inspection 81

Every 6 Months

Stator Lead - Check 79

Every Year

Bearing (Ball) - Lubricate 66
Bearing (Spherical Roller) - Lubricate 66
Generator Set Vibration - Inspect 74
Insulation - Test 75

Every 7500 Service Hours or 1 Year

Rotating Rectifier - Check 78

Overhaul

Bearing - Inspect 67

i01491456

Air Inlet Filter - Check

SMCS Code: 1051-535

Monitor the differential pressure switch's connector contacts on the air inlet filter. If the differential pressure rises above 15.2 mm (0.6 inch) of water, clean the filter with a solution of soap and water. Be sure that the filter is thoroughly dry before the start-up. Replace the filter, if necessary.

i01225551

Bearing (Ball) - Lubricate

SMCS Code: 4471-086

The following ball bearings must be lubricated: no shield and single shield. Double shielded ball bearings may not require lubrication. Refer to the grease plate instructions that are located on the machine.

For ball bearings, use Caterpillar 2S-3230 Bearing Lubricant. This grease is an NLGI No. 2 Grade. There is Polyurea (a thickener) in this grease. The temperature range of Caterpillar 2S-3230 Bearing Lubricant is –29 °C (–20.2 °F) to 177 °C (350.6 °F). For extremely low temperatures, use either NLGI No. 1 Grade or NLGI No. 0 Grade.

Lubricating Process

1. Remove either the louver assembly or the rear plate from the rear of the generator housing.
2. Remove the top grease pipe plug and remove the lower grease pipe plug.
3. Install a grease fitting in the grease pipe.
4. Grease the shielded ball bearings with 2S-3230 Bearing Lubricant (53.28 mL (1.8 ounces) to 59.20 mL (2.0 ounces)). Lubricate shielded ball bearings at 2000 hour intervals. Do not mix greases.

Note: Some two-bearing generators have spherical roller bearings in the front bracket and ball bearings in the rear bracket. These units should use a common 108-8611 Grease Cartridge. This grease should be used for the front bearing and the rear bearing.

5. Wipe off the excess grease. Remove the top grease fitting. Install the plug.
6. Operate the generator for one hour. This will allow the grease to expand. The expanding grease will force the excess grease from the cavity. When the excess grease is forced from the cavity, the internal pressure will be reduced. The generator should continue to operate until the grease stops purging.
7. Stop the engine. Install the plug in the bottom grease pipe. Wipe off the excess grease.
8. Install the louver assembly or install the rear plate.

i01181601

Bearing (Spherical Roller) - Lubricate

SMCS Code: 4471-086

Spherical roller bearings must be lubricated. For spherical roller bearings, use a Caterpillar 108-8611 Grease Cartridge. This grease is an NLGI No. 1.5 Grade. There is no molybdenum disulfide in this grease. There is Clay (a thickener) in this grease. At 40 °C (104.0 °F), the viscosity of the grease in a Caterpillar 108-8611 Grease Cartridge is 32 cSt. At 100 °C (212.0 °F), The viscosity is 5 cSt.

Lubricating Process

1. Remove either the louver assembly or the rear plate from the rear of the generator housing.
2. Remove the top grease pipe plug and remove the lower grease pipe plug.
3. Install a grease fitting in the grease pipe.
4. Grease spherical roller bearings with a 108-8611 Grease Cartridge (29.6 mL (1 ounce)). Spherical roller bearings should be lubricated at 1000 hour intervals. Do not mix greases.

Note: Some two-bearing generators have spherical roller bearings in the front bracket and ball bearings in the rear bracket. These units should use common 108-8611 Grease Cartridges. This grease should be used for the front bearing and the rear bearing.

5. Wipe off the excess grease. Remove the top grease fitting. Install the plug.

6. Operate the generator for one hour. This will allow the grease to expand. The expanding grease will force the excess grease from the cavity. When the excess grease is forced from the cavity, the internal pressure will be reduced. The generator should continue to operate until the grease stops purging.

7. Stop the engine. Install the plug in the bottom grease pipe. Wipe off the excess grease.

8. Install the louver assembly or install the rear plate.

i01179003

Bearing - Inspect

SMCS Code: 4471-040

The following maintenance procedure for generator bearings should be followed at every major engine overhaul:

1. Remove the bearing bracket. Inspect the following items: bracket bore, bearing outer race, and rolling elements. On Standby Power Units, the bearing must be inspected and the grease must be replaced at three year intervals. The bearing bracket sleeve should be inspected for out of roundness, excessive wear, and a bracket step that is less than 0.0762 mm (0.0030 inch). If there is no bearing bracket sleeve, inspect the bearing bracket bore. The bearing should be inspected for outer race damage, severe fretting, and smoothness of operation. When possible, the bearing elements should be inspected. Some double-shielded ball bearings prevent visual inspection of the ball bearing elements. Other double shielded ball bearings have a retaining ring. This retaining ring can be removed in order to allow access for a visual inspection of the ball bearing elements.

   On two-bearing generators, the front bearing can only be removed after the hub is removed. In order to remove the hub, cut off the hub. Pulling the hub will damage the shaft.

Note: Bearings that are being removed for failure analysis should not be cut off with a torch.

2. Spherical Roller Bearing should be cleaned and repacked with 108-8611 Grease. Pack the bearing and pack the cavity (one-third to one-half of the cavity volume). The bearing should be filled with 88.8 mL (3 ounces) to 118.4 mL (4 ounces) of grease. The cavity should be filled with 118.4 mL (4 ounces) to 148.0 mL (5 ounces) of grease. Refer to Table 7.

3. All ball bearings should be cleaned. The bracket cavity should be repacked with 2S-3230 Grease. Pack the bearings (one-third to one-half of the cavity volume). Refer to Table 7.

   To reinstall bearings, heat the bearings to 107 °C (224.6 °F) for ten minutes. Mount the bearings on the shaft. To reinstall the hub, heat the hub to 400 °C (752.0 °F) for three hours. Mount the hub to the shaft.

4. Ensure that the grease supply tube to the bearing is filled with grease.

5. Remove the bracket drain plug and operate the generator for one hour. This will allow the grease to expand. The expanding grease will force the excess grease from the cavity. When the excess grease is forced from the cavity, the internal pressure will be reduced. The generator should continue to operate until the grease stops purging.

6. Stop the engine. Install the bracket drain plug. Wipe off the excess grease.

7. For greasing intervals, follow the recommendations on the lubrication plate (if equipped) or refer to Maintenance Schedule, “Bearing - Lubricate”. Whenever the bearings are greased, repeat Step 5. DO NOT MIX GREASES.

Table 7

Bearing Outside Diameter mm (inch)	Bearing Inside Diameter mm (inch)	Part Number	Generator Frame Size	Bearing Bore in Bracket mm (inch)	Bearing Shield (Type)	Bearing Cavity Grease mL (oz.)	Rotor Shaft Diameter mm (inch)
100 mm (3.9370 inch)	45 mm (1.7717 inch)	5P-1977	All 360	100.000 mm (3.9370 inch) to 100.025 mm (3.9380 inch)	Double	29.6 mL (1 oz.)	45.004 mm (1.7718 inch) to 45.019 mm (1.7724 inch)
140 mm (5.5118 inch)	65 mm (2.5591 inch)	3N-1965	440 (round laminated)	140.002 mm (5.5119 inch) to 140.028 mm (5.5129 inch)	Double	53.280 mL (1.8 oz.)(1) 94.720 mL (3.2 oz.) (2)	65.004 mm (2.5592 inch) to 65.021 mm (2.5599 inch)
160 mm (6.2992 inch)	75 mm (2.9527 inch)	5P-2448	580(2) 590(1)	160.002 mm (6.2993 inch) to 160.028 mm (6.3003 inch)	Double	100.64 mL (3.4 oz.) to 168.72 mL (5.7 oz.)	75.004 mm (2.9529 inch) to 75.021 mm (2.9536 inch)
170 mm (6.6929 inch)	80 mm (3.1496 inch)	4L-6677(3)	580(1)	170.002 mm (6.6930 inch) to 170.028 mm (6.6940 inch)	Single	97.68 mL (3.3 oz.) to 162.80 mL (5.5 oz.)	80.002 mm (3.1497 inch) to 80.020 mm (3.1504 inch)
170 mm (6.6929 inch)	80 mm (3.1496 inch)	109-7687(3)	580(1)	170.002 mm (6.6930 inch) to 170.028 mm (6.6940 inch)	Double	97.68 mL (3.3 oz.) to 162.80 mL (5.5 oz.)	80.002 mm (3.1497 inch) to 80.020 mm (3.1504 inch)
180 mm (7.0866 inch)	100 mm (3.9370 inch)	6Y-3955	440 (square laminated)	179.992 mm (7.0863 inch) to 180.017 mm (7.0873 inch)	Double	139.12 mL (4.7 oz.) to 230.88 mL (7.8 oz.)	82.474 mm (3.2470 inch) to 82.486 mm (3.2475 inch)
190 mm (7.4803 inch)	90 mm (3.5433 inch)	6Y-6488	590(1) 589 PM	190.002 mm (7.4804 inch) to 190.028 mm (7.4814 inch)	Double	97.68 mL (3.3 oz.) to 162.80 mL (5.5 oz.)	90.012 mm (3.5438 inch) to 90.028 mm (3.5444 inch)
225 mm (8.8582 inch)	105 mm (4.1338 inch)	6V-0410	680(1)	225.003 mm (8.8584 inch) to 225.034 mm (8.8596 inch)	Single	139.12 mL (4.7 oz.) to 230.88 mL (7.8 oz.)	105.029 mm (4.1350 inch) to 105.034 mm (4.1352 inch)
225 mm (8.8582 inch)	105 mm (4.1338 inch)	108-1760	680(1)	225.003 mm (8.8584 inch) to 225.034 mm (8.8596 inch)	Double	148.00 mL (5.0 oz.) to 236.80 mL (8.0 oz.)	105.029 mm (4.1350 inch) to 105.034 mm (4.1352 inch)
230 mm (9.0551 inch)	130 mm (5.1181 inch)	2L-4444(4)	808 4 pole(1)	229.992 mm (9.0548 inch) to 230.022 mm (9.0560 inch)	Open	177.60 mL (6.0 oz.) to 266.40 mL (9.0 oz.)	130.028 mm (5.1192 inch) to 130.051 mm (5.1201 inch)

(continued)

(Table 7, contd)

Bearing Outside Diameter mm (inch)	Bearing Inside Diameter mm (inch)	Part Number	Generator Frame Size	Bearing Bore in Bracket mm (inch)	Bearing Shield (Type)	Bearing Cavity Grease mL (oz.)	Rotor Shaft Diameter mm (inch)
230 mm (9.0551 inch)	130 mm (5.1181 inch)	2L-4444[4]	820[1]	229.992 mm (9.0548 inch) to 230.022 mm (9.0560 inch)	Open	236.8 mL (8.0 oz.) to 355.20 mL (12.0 oz.)	130.028 mm (5.1192 inch) to 130.051 mm (5.1201 inch)
240 mm (9.4488 inch)	110 mm (4.3307 inch)	108-1761	690[1]	240.002 mm (9.4489 inch) to 240.033 mm (9.4501 inch)	Double	207.20 mL (7.0 oz.) to 296.00 mL (10.0 oz.)[5] 414.40 mL (14.0 oz.) to 621.60 mL (21 oz.)[6]	110.012 mm (4.3312 inch) to 110.028 mm (4.3318 inch)
240 mm (9.4488 inch)	110 mm (4.3307 inch)	6V-3310	800[1]	240.002 mm (9.4489 inch) to 240.033 mm (9.4501 inch)	Single	145.04 mL (4.9 oz.) to 239.76 mL (8.1 oz.)	110.012 mm (4.3312 inch) to 110.028 mm (4.3318 inch)
240 mm (9.4488 inch)	110 mm (4.3307 inch)	6V-6752	800[1]	240.002 mm (9.4489 inch) to 240.033 mm (9.4501 inch)	Single	145.04 mL (4.9 oz.) to 239.76 mL (8.1 oz.)	110.012 mm (4.3312 inch) to 110.028 mm (4.3318 inch)
240 mm (9.4488 inch)	110 mm (4.3307 inch)	108-1761	800[1]	240.002 mm (9.4489 inch) to 240.033 mm (9.4501 inch)	Double	148.00 mL (5.0 oz.) to 236.80 mL (8.0 oz.)	110.012 mm (4.3312 inch) to 110.028 mm (4.3318 inch)
280 mm (11.024 inch)	130 mm (5.1181 inch)	154-3032	820	280.002 mm (11.0237 inch) to 280.032 mm (11.0249 inch)	Double	N/A	130.028 mm (5.1192 inch) to 130.051 mm (5.1201 inch)

(1) Inboard bearing
(2) Outboard bearing
(3) 109-7687 bearing is preferred.
(4) This bearing is a spherical roller bearing. This bearing is greased from the bracket's front side. All of the other bearings are ball bearings.
(5) Bearing on exciter end.
(6) Bearing on drive end.

i01219565

Bearing Temperature - Measure/Record

SMCS Code: 4471-082-TA

Bearing temperature detectors are optional on all SR4B generators. These detectors are 100 ohm resistance temperature detectors. 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.

i01217164

Electrical Connections - Check

SMCS Code: 4459-535

Check all exposed electrical connections for tightness.

Check the following devices for loose mounting or physical damage:

- transformers
- fuses
- capacitors
- lightning arrestors

Check all lead wires and electrical connections for proper clearance.

i01277057

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 fo 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 at one 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. This will help circulate air. Operate the generator space heaters.

Oven Method

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

NOTICE

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

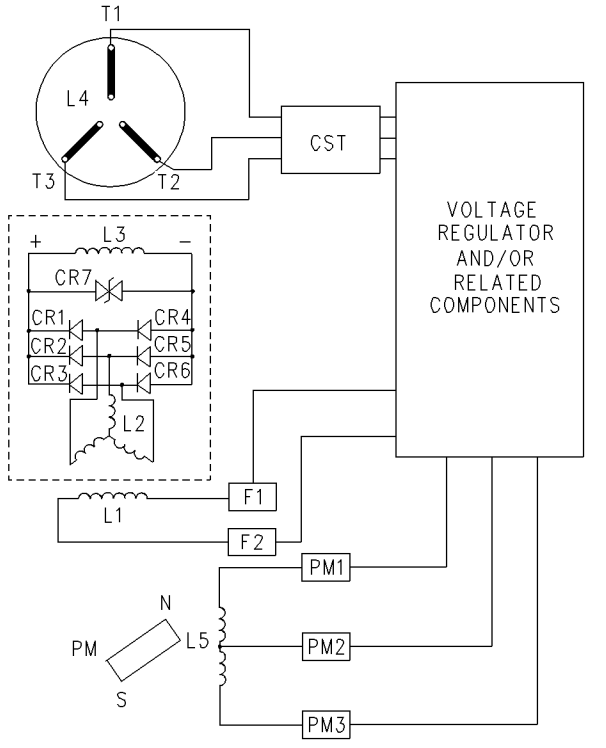
Radiant type ovens can cause localized overheating.

Controlled Current Method

Table 8

Tools Needed		
Part Number	**Description**	**Qty**
8T-0900	Clamp on ammeter (1200 amperes)	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.



g00669571

Illustration 66

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.

i01489486

Generator - Inspect

SMCS Code: 4450-040

⚠ 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

When the engine-generator is operating, voltages up to 600V are present in these areas near or on the regulator:

a. the regulator terminal strip

b. the excitation transformer terminal strip (self-excited generator only)

NOTICE
Electronic components in the regulator can be damaged during generator operation if contact is made between the part and ground.

Periodically, generators should be inspected for cleanliness. The following contaminants should not be allowed to accumulate on the windings:

- dirt
- dust
- grease
- salt
- oil film

If moisture is allowed to remain in contact with an electrical winding, some of the moisture will eventually be retained in voids or cracks of the insulation. This will lower the resistance of the winding insulation. The insulation that is used on Caterpillar generator windings is moisture resistant. However, this insulation is not waterproof. Constant exposure to moisture will gradually lower the insulation's resistance.

Dirt can make the problem worse. Dirt can hold moisture in contact with the insulation. The salt that is present in sea air can compound the problem. When salt and moisture combine, a good electrical conductor is created.

Clean the voltage regulator and clean the generator of dirt and debris. Use a brush to loosen accumulations of dirt. Vacuum clean the system in order to remove residual dirt. The use of compressed air is not recommended. Compressed air contains moisture that is present in the form of condensation.

Carbon tracking on insulators can be caused by dirt or by loose connections. These carbon paths must be cleaned or the insulators must be replaced. A failure to correct a carbon tracking problem will result in an electrical short in the circuit.

Visually check for loose wires or broken wires. Also, visually check for loose connections or broken connections. Check the wires and the connections on the voltage regulator assembly. Check all wires and connections in the generator. Clean heat sinks. Make any necessary repairs to the wiring. Refer to Service Manual, SENR8395 for testing and adjusting or disassembly and assembly procedures.

i01473721

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 percent of the full speed that is achieved by 60 Hz units. This would be equal to 80 percent 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.

i01473730

Generator Set - Test

SMCS Code: 4450-081

⚠ WARNING

Personal injury or death can result from high voltage.

When power generation equipment must be in operation to make tests and/or adjustments, high voltage and current are present.

Improper test equipment can fail and present a high voltage shock hazard to its user.

Make sure the testing equipment is designed for and correctly operated for high voltage and current tests being made.

When servicing or repairing electric power generation equipment:

- **Make sure the unit is off-line (disconnected from utility and/or other generators power service), and either locked out or tagged DO NOT OPERATE.**
- **Make sure the generator engine is stopped.**
- **Make sure all batteries are disconnected.**
- **Make sure all capacitors are discharged.**

Table 9

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 percent. Increase the generator set speed by 10 percent.

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 percent, the voltages that were measured in Step 6 should decrease by 10 percent. When the generator set speed is increased by 10 percent, the voltages that were measured in Step 6 should increase by 10 percent.

i01492190

Generator Set Vibration - Inspect

SMCS Code: 4450-040-VI

Check for vibration damage. Vibration may cause the following problems:

- loose fittings
- loose belts
- 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 vibration analyzer.

i01494696

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.

Table 10

Tools Needed		
Part Number	**Part Name**	**Quantity**
142-5055	Insulation Testing Gp	1
9U-6003	Insulation Testing Gp	1

Periodically, use an insulation tester 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 insulation tester readings will also determine the frequency of this test.

Test the main stator windings with an insulation tester 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 twelve months (minimum).
- 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 percent. 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 insulation tester readings above one megohm. Use space heaters only when the generator is not running.

For additional information, refer to Special Instruction, SEHS9124, "Cleaning and Drying of Electric Set Generators".

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 perform this insulation test. 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 insulation tester.
4. Discharge the capacitance of the windings.
5. Disconnect "T0" from ground.
6. Disconnect the regulator sensing lead wires: "20", "22", and "24".
7. Connect the insulation tester's RED lead to ground.
8. Connect the insulation tester's BLACK lead to "T0".

9. 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.

10. 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.

11. 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 percent reduction from the previous reading, the insulation may have absorbed too much moisture.

Switch the insulation tester to the "OFF" position. This will discharge the insulation tester's leads. Disconnect the insulation tester's 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 67.

Engine Serial Number_____

Generator Serial Number_____

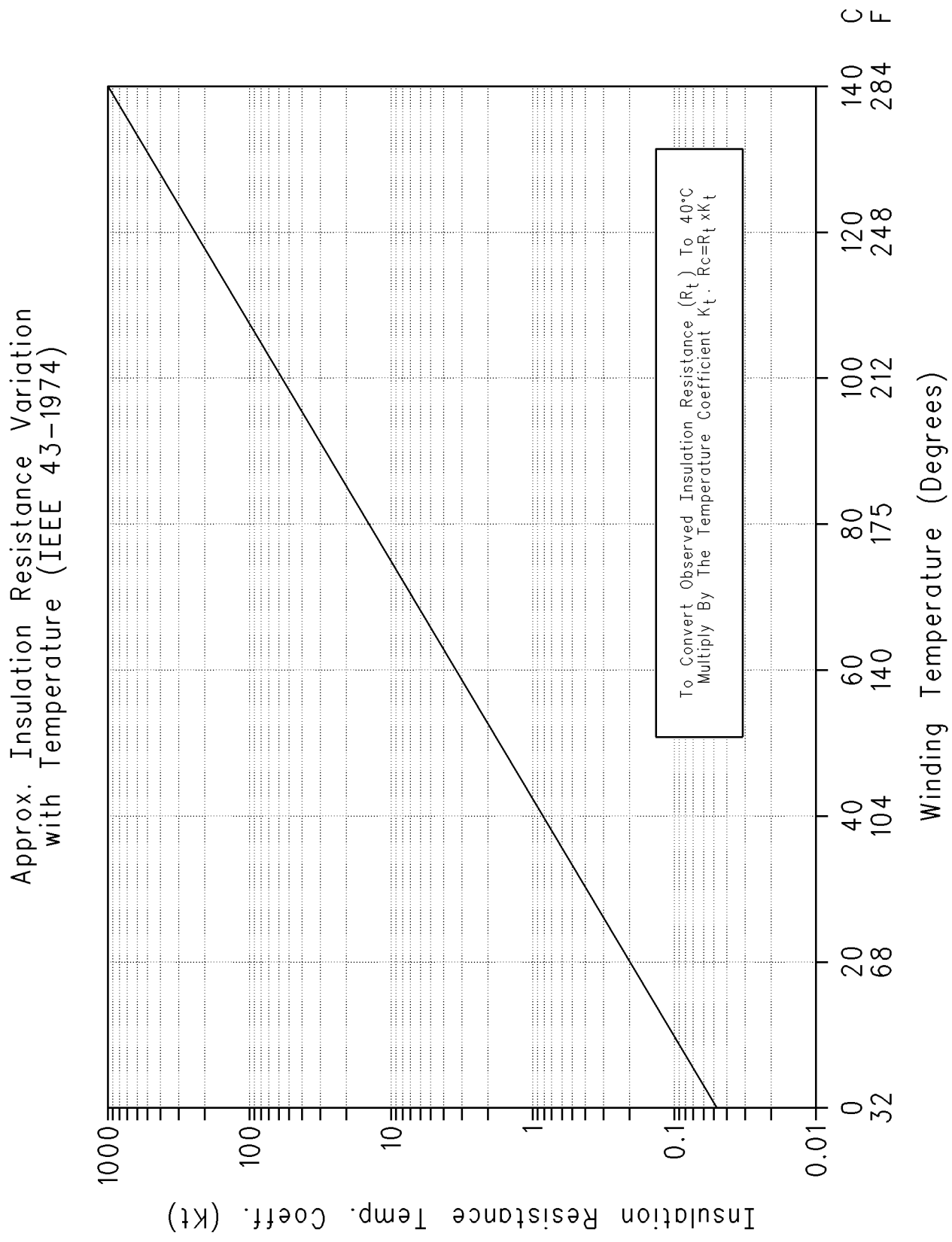


Illustration 67

g00633226

i01216962

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.

i01217130

Rotating Rectifier - Check

SMCS Code: 4465-535

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”.

i01492740

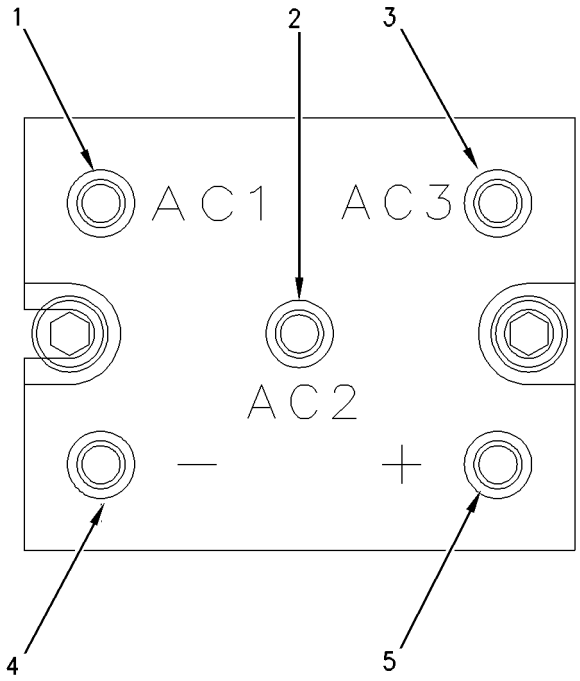
Rotating Rectifier - Test

SMCS Code: 4465-081

Table 11

Tools Needed(1)		
Caterpillar Part Number	**Part Name**	**Quantity**
6V-7070	Digital Multimeter	1
146-4080	Digital Multimeter (RS-232)	1

(1) Only one multimeter is needed for this test.



g00775020

Illustration 68

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.

i01218154

Space Heater - Check

SMCS Code: 4450-535-HTR

An SR4B generator is capable of operating in high humidity conditions without problems. However, problems can occur when the generator is idle and the surrounding air is warmer than the generator. Moisture can form on the windings that will result in poor performance from the windings. Moisture can also result in damage to the windings. Whenever the generator is not active, ensure that the space heaters are in operation.

i01218172

Stator Lead - Check

SMCS Code: 4459-535

Visually inspect the following areas for cracking and physical damage:

- stator output leads
- protective sleeving
- insulation

i01218185

Stator Winding Temperature - Measure/Record

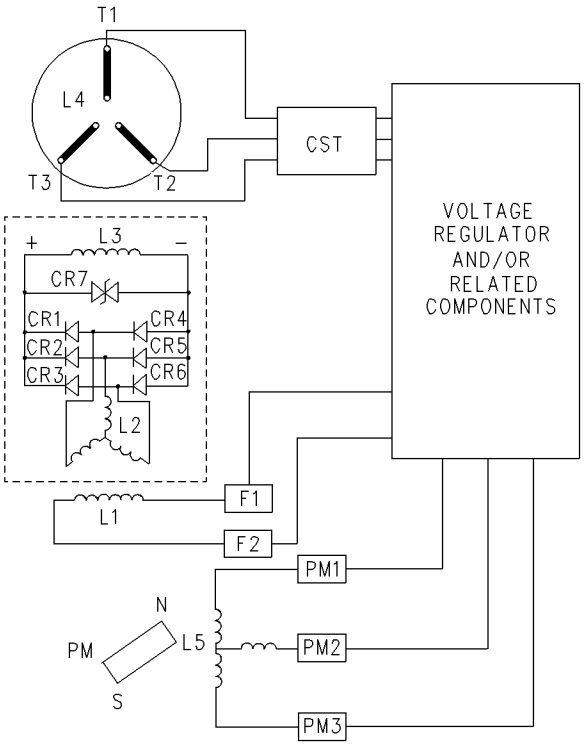
SMCS Code: 4453-082-TA

Some SR4B generators are provided with optional 100 Ohm Resistance Temperature Detectors (RTD). If the generator is furnished with Resistance Temperature Detectors, the detectors are installed in the slots of the main armature (stator). The detectors are used with equipment that is provided by the customer. This equipment is used in order to measure the main armature’s winding temperature. This equipment is also used in order to monitor the main armature’s winding temperature.

i01494879

Varistor - Test

SMCS Code: 4466-081



g00677004

Illustration 69

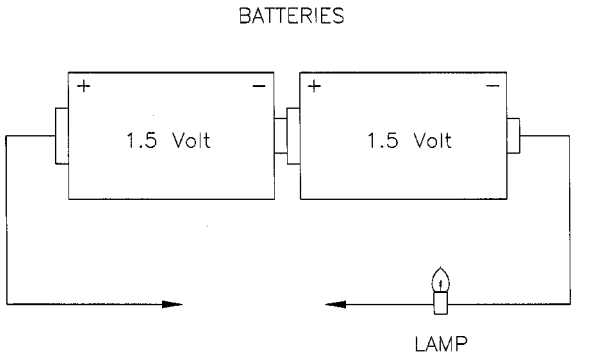
PMPE Generator Wiring Diagram

(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

Ohmmeter

An ohmmeter can be used to check a varistor (CR7). Place an ohmmeter across the varistor. The resistance should be a minimum of 15000 ohms. If the resistance is less than 15000 ohms, the varistor is faulty.

Test Light



g00555113

Illustration 70

Test Light

Refer to the test light that is shown in Illustration 70. Follow these steps in order to test the varistor:

1. Disconnect either lead of the varistor (CR7).

2. Place the test light across the varistor.

3. Observe the results. The lamp should not light.

4. Reverse the test light.

5. Observe the results. The lamp should not light.

If the test light illuminates in either direction, there is a short in the varistor. Replace any faulty varistors with varistors that have comparable operating characteristics. Include the following information when a varistor is being ordered for replacement:

- Part number of the varistor
- Serial number of the generator

After the varistor has been replaced, verify that the strapping of the field winding lead is securely wound on the shaft. Also, verify that the strapping of the field winding lead is securely tied.

i01491868

Voltage and Frequency - Check

SMCS Code: 4450-535-EL

Check for the proper voltage setting and check for the proper frequency setting. Check for stability.

For the correct voltage and frequency, refer to the generator set's Serial Plate.

i01218210

Walk-Around Inspection

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 safely isolate the generator.

A visual inspection should be initially directed at the areas that are most prone to damage and deterioration. The most prone areas to damage and deterioration are listed below:

- Ground Insulation. Ground insulation is insulation that is intended to isolate components that are carrying current from components that are not carrying current.
- Support Insulation. Support insulation is usually made from one of the following items: a compressed lamination of fibrous materials, polyester, or felt pads that have been impregnated with various types of bonding agents.

There are many different types of damage that can occur in these areas. Several of the different types of damage are listed below:

Thermal Aging – Thermal aging can cause the degradation of insulation or the deterioration of insulation. An examination of the coils may reveal that the insulation has expanded into the ventilation ducts. This is the result of a loss of bond which will cause the insulation material to separate. The insulation material could also separate from the conductors on the windings.

Abrasion – The surfaces of coils and the surfaces of connectors may be damaged by abrasion. These surfaces may also be damaged by contamination from other sources. An example of these sources would be chemicals or abrasive substances.

Cracking – Cracking of insulation may result from mechanical stress. The structure that is used to brace the stator winding will become loose if the problem is not corrected. Further mechanical damage or electrical damage may also result.

Erosion – Erosion can be caused when foreign substances rub against the surfaces of coil insulation.

i01492564

Winding - Test

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

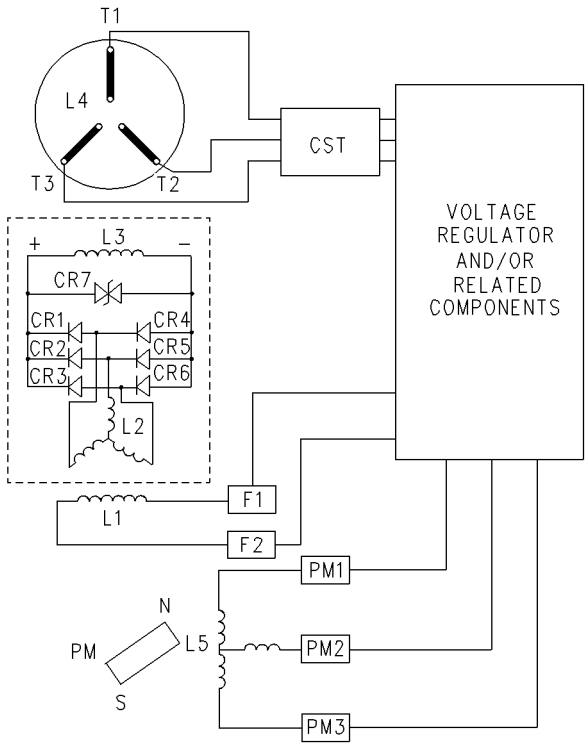


Illustration 71 g00677004

PMPE 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

Table 12

Tools Needed		
Part Number	**Part**[1]	**Quantity**
6V-7070	Digital Multimeter	1
146-4080	Digital Multimeter (RS232)	1

(1) Only one multimeter is necessary for this test. Either of the multimeters that are shown will work.

Measure the resistance of the following windings: (L1), (L2), (L3), (L4), and (L5). The winding that is being tested must be disconnected from the other components before the resistance can be measured. The following resistance measurements are approximations. If the measured value is not near the listed approximation, the winding is probably damaged. For a more precise resistance value, consult the Technical Marketing Information (TMI). Refer to the generator arrangement that is in question.

Note: The winding temperature affects the resistance. When the winding temperature increases, the winding resistance also increases. When the winding temperature decreases, the winding resistance also decreases. Therefore, a correct measurement can be performed only when the winding is at room temperature.

The following armature windings have very little resistance: (L2), (L4), and (L5). The resistance of these windings will measure near 0 ohms. Use a milliohmmeter to measure the resistance of the armature windings.

Exciter Armature (Rotor) (L2) – less than 0.1 ohm

Main armature (Stator) (L4) – less than 0.1 ohm

Pilot Exciter Armature (L5) – less than 0.1 ohm

Use a multimeter in order to measure the resistance of field windings (L1) and (L3).

Exciter Field (Stator) (L1) – approximately 3.0 ohms to 6.0 ohms

Main Field (Rotor) (L3) – approximately 0.75 ohms to 2.0 ohms

Note: There should be no continuity between any winding and ground. There should be no continuity between any winding and another winding.

Reference Information Section

Reference Materials

i01536695

Reference Material

SMCS Code: 1000; 4450

The following literature can be obtained through any Caterpillar dealer.

Operation and Maintenance Manuals

Operation and Maintenance Manual, SEBU6123, “3114, 3116, and 3126 Industrial and EPG Diesel Engines”.

Operation and Maintenance Manual, SEBU5851, “3204 Industrial Engine”.

Operation and Maintenance Manual, SEBU6367, “3208 Industrial and Generator Set Engines”.

Operation and Maintenance Manual, SEBU5559, “3304 and 3306 Marine Engines”.

Operation and Maintenance Manual, SEBU5779, “3304, 3306, 3304B, and 3306B Industrial Engines”.

Operation and Maintenance Manual, SEBU6328, “3304B and 3306B Industrial and EPG Generator Set Diesel Engines”.

Operation and Maintenance Manual, SEBU5791, “3406 and 3406B Industrial and Generator Set Engines”.

Operation and Maintenance Manual, SEBU5415, “3408 and 3412 Industrial and EPG Diesel Engines”.

Operation and Maintenance Manual, SEBU6336, “3406B and 3406C Industrial and Generator Set Engines”.

Operation and Maintenance Manual, SEBU6767, “3412 EPG Generator Set Diesel Engine”.

Operation and Maintenance Manual, SEBU6916, “3500B Generator Set Engines and 3500 Generator Set Engines with Prime Power, Standby”.

Operation and Maintenance Manual, SEBU6917, “3500B Marine Propulsion Engines and 3500 Marine Propulsion Engines”.

Operation and Maintenance Manual, SEBU6701, “3508, 3512, and 3516 Industrial and EPG Generator Engines”.

Operation and Maintenance Manual, SEBU6618, “Supplement for XQ125 Rental Generator Set, Dual and Single Voltage”.

Operation and Maintenance Manual, SEBU6499, “XQ225 Rental Generator Set Dual and Single Voltage”.

Operation and Maintenance Manual, SEBU6455, “XQ350 Rental Generator Set Dual and Single Voltage”.

Owner’s Manuals

Owner’s Manual, SEBU6369, “3304B and 3306B Marine Engines”.

Owner’s Manual, SEBU5881, “3406B Marine Engine”.

Owner’s Manual, SEBU6100, “3508, 3512, and 3516 Diesel Marine Engines”.

Owner’s Manual, SEBU6874, “Customer Communication Module”.

Service Manual Modules

The modules that follow are included in the Service Manual, SENR8395.

Service Manual Module, SENR5833, “Digital Voltage Regulator (DVR)”.

Service Manual Module, SENR5809, “Electronic Modular Control Panel II (EMCPII) for MUI Engine”.

Service Manual Module, SENR5827, “Electronic Modular Control Panel II (EMCPII) for Electronically Controlled Engines”.

Service Manual Module, SENR5398, “Electronic Modular Control Panel II (EMCPII) for EUI Engines”.

Service Manual Module, RENR1200, “Electronic Modular Control Panel II+ (EMCPII+) for EUI Engines”.

Service Manual Module, SENR3905, “VR3 Voltage Regulator Permanent Magnet Excited SR4 Generator”.

Service Manual Module, SENR3904, “VR3 Voltage Regulator (4/6 Lead), Self-Excited SR4 Generator”.

Service Manual Module, SENR3473, “VR3 Voltage Regulator (10/12 Lead), Self-Excited SR4 Generator”.

Service Manual Module, SENR5205, “VR3F Flat Top Voltage Regulator”.

Service Manual Module, SENR5829, “VR3F Voltage Regulator Permanent Magnet Excited SR4 Generator”.

Service Manual Module, SENR3906, “VR4 Voltage Regulator”.

Service Manuals

Service Manual, SENR8395, “SR4B Electric Set Generator”.

Service Manual, SENR6430, “524 and 1724 Electrically Powered Governor Systems for Generator Set Engines”.

Service Manual, SENR4676, “2301A Speed Control”.

Service Manual, SENR3585, “2301A Electric Governors (Load Sharing)”.

Service Manual, SENR6565, “ Generator Set Load Sensor and Load Sharing Module”.

Note: Specific generator set service manuals will include the necessary service information for the generator and for the control panel.

Special Instructions

Special Instruction, SEHS9124, “Cleaning and Drying of Electric Set Generators”.

Additional literature may have become available. This literature may not be included above. Before ordering any literature, contact a Caterpillar dealer. Ask the Caterpillar dealer to check on the following items: availability of the literature, form number of the literature, and price of the literature.

i01194897

Tools

SMCS Code: 0785; 4450

Table 13

Part Number	Tool	Description
		TEST EQUIPMENT
8T-0900	Clamp-on Ammeter	Clamp-on, 0 to 500 Amp range, AC and DC
155-5175	Clamp-on Ammeter	AC current probe, 0 to 1000 Amp with 146-4080 multimeter
146-4080	Multimeter	Digital, RS-232 output, true RMS, used for measuring voltage, current, and resistance
9U-7330	Multimeter	Digital, for measuring voltage, current, and resistance
6V-7070	Multimeter	Digital, heavy-duty, used for measuring voltage, current, and resistance
7X-1710	Probe Group	Used with Digital Multimeter
4C-6500	Digital Thermometer	For measuring temperature in degrees Celsius
142-5055	Megohmmeter	For measuring insulation resistance
1H-3110	Exciter/Bearing Puller	For changing the bearings and exciter armature
1H-3107	Exciter/Bearing Puller	For changing the bearings and exciter armature
		SPECIAL TOOLS
N/A	Resistive Bridge	For measuring resistance of windings
N/A	Protective Gloves	Electrical, rubber, 13,800 V
		STANDARD TOOLS
6V-3001	Crimping Tool	For crimping Sure Seal connectors
8S-1075	Crimping Tool	Heavy duty crimping and stripping
1U-5804	Crimping Tool	For crimping Deutsch connectors
1U-7322	Flashlight	As required
8F-9866	Grease gun	For lubricating bearings
1S-0258	Hammer	Soft-faced
4C-6477	Lamp, fluorescent	Safety light
1U-7230	Screwdrivers	Both phillips and standard; sized as required
1U-7248	Wrench	Adjustable, 12 inch
8T-9293	Wrench	Torque, 40 to 250 ft-lb, 1/2 inch drive
1U-7460	Wrench set	Allen, 1/8 to 1/2 inch
1U-7160	Socket set	Nine piece, 3/8 to 7/8 inch with 3/8 inch drive
1U-8030	Socket set	Twelve piece, 7/16 to 1 1/8 inch with 1/2 inch drive
1U-7830	Socket set	Twelve piece, 8 to 19 mm with 3/8 inch drive
1U-7880	Socket set	Ten piece, 16 to 26 mm with 1/2 inch drive
1U-7050	Wrench set	Thirteen piece, open-end combination sized 1/4 to 1 inch (standard)
N/A	Vacuum	Electric with nonmetallic nozzle

(continued)

(Table 13, contd)

Part Number	Tool	Description
		MATERIALS
1U-8809	Corrosion inhibitor	Rust preventative
1U-8803	Detergent	As required for cleaning, Hydrosolv 67
4C-5522	Gloves	For chemical protection
N/A	Plastic	Protection for long-term storage
N/A	Rags	As required
N/A	Water	For cleaning
N/A	Air	Compressed, dry
N/A	Covering material	Waterproof desiccant bags, for protection from moisure during long-term equipment storage
SEHS7332	"DO NOT OPERATE" Tags	For providing visual warnings and cautions

i01144034

Symbols

SMCS Code: 4450

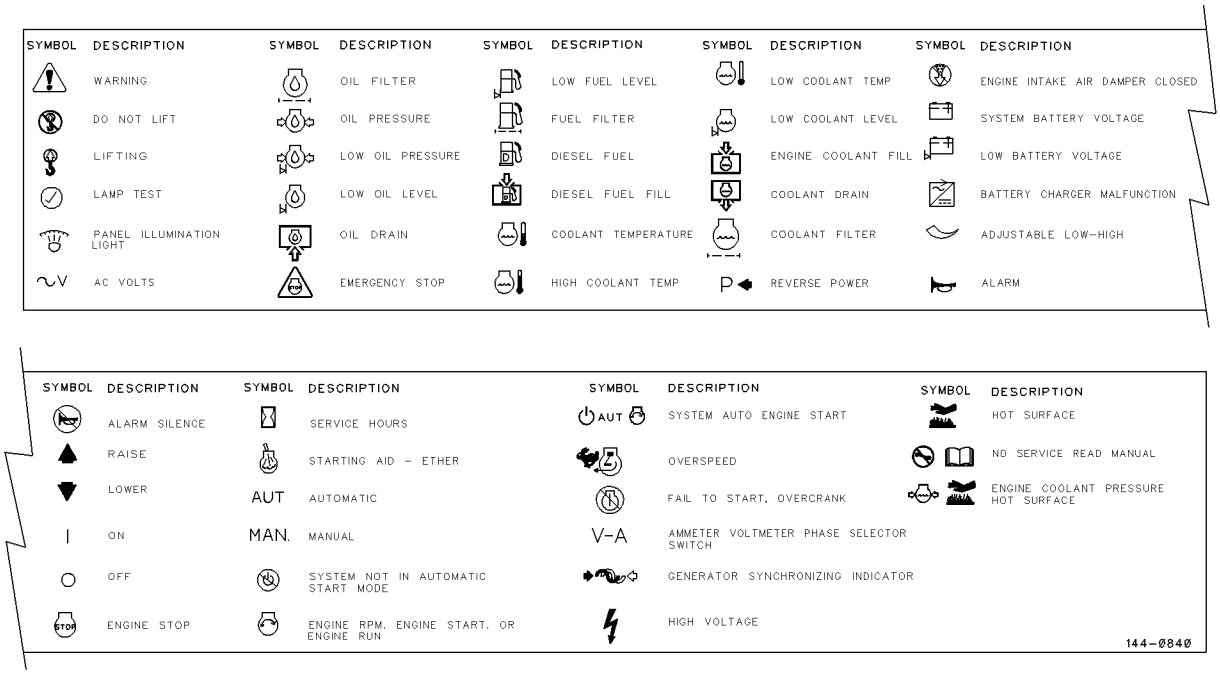


Illustration 72 g00606648

The control panel and modules utilize International Graphic Symbols to identify functions.

A typical list of the symbols that are used is shown above.

i01207219

Glossary

SMCS Code: 4450

Actuate – Actuation relates to putting something in motion.

Alternating Current (AC) – Alternating Current is an electric current that reverses direction at regular intervals (50 times per second in 50 Hz or 60 times per second in 60 Hz).

Anode – An anode is the positive end of a diode or an anode is the positive end of a rectifier.

Blocking Rectifier – A blocking rectifier permits direct current flow in only one direction.

Bolted – A bolted device uses a bolt to hold two or more parts together.

Bridge – A bridge is a circuit that is used to measure small quantities of current, voltage, or resistance.

Bridge Rectifier – A bridge rectifier is a circuit that is used to change alternating current (AC) to direct current (DC).

Buildup – A buildup is a gradual increase in voltage.

Cathode – A cathode is the negative end of a diode or a cathode is the negative end of a rectifier.

Capacitance – Capacitance is the ability to store an electrical charge.

Capacitor – A capacitor is a device that will store an electrical charge.

Circuit Breaker – A circuit breaker is an automatic switch that is used to open a circuit.

Circulating Current – Circulating current is the flow of current between two or more generators that are working in parallel. Circulating current is also the flow of current between two or more generators that are parallel with a utility line.

Conduct – Conducting relates to allowing the flow of current.

Constant Voltage Regulation – Constant Voltage Regulation is one of the two methods of voltage regulation. In order to maintain the line voltage, Constant voltage regulators allow the field to be forced to the saturation point. This allows the engine to be overloaded. On large block load applications, the engine may not recover.

Continuity – Continuity provides a path for current flow.

Control – A control is a device that controls another device. A control is also a circuit that controls a device.

Cross Current Compensation – Cross current compensation is a method that is used for reactive power equalization.

Current Transformer (CT) – A current transformer is used to step down higher line current.

Direct Current (DC) – Direct current is current flow that moves in only one direction in a given circuit.

Damping – Damping refers to decreasing the amplitude of a signal.

De-energized – A de-energized input refers to stopping the current that is going to a component.

Distribution Winding – Distribution windings go from one end of the core to the other end of the core. These windings are arranged in groups that are located in several slots.

Droop – Droop refers to a decrease.

Excitation – Excitation is controlled direct current (DC) that is used to make a magnetic field.

Energized – An energized input refers to activating a device.

Electrostatic Charge – Electrostatic charge is electricity that is caused by induced voltage and stored charge.

Exciter – An exciter supplies direct current (DC) to the field windings of the generator.

Field – A field is a magnetic line of force that surrounds a conductor. This force is caused by current flow in the conductor.

Field Windings – Field windings are many turns of wire that are wrapped around an iron core. When direct current (DC) flows through the field windings, a magnetic field is produced. This magnetic field is comparable to the magnetic field of a bar magnet.

Flashing – Flashing is a process of putting direct current from an external source into the field windings. This process causes the generator to produce an output voltage.

Flux – Flux is magnetic lines of force.

Frequency – Frequency is the number of cycles that are completed in a one second period. The unit of frequency is the Hertz (Hz). One hertz is equal to one cycle per second.

Full-Wave Rectifier – A full-wave rectifier changes the positive phase and the negative phase of alternating current to direct current.

Gain – Gain relates to the ratio of input magnitude to output magnitude.

Gate – A gate is an electronic part of a controlled rectifier (thyristor).

Generate – The production of electricity.

Grounded – A device is grounded by making a connection to ground. A device could also be grounded by making a connection to a component that is connected to ground.

Hertz (Hz) – Hertz is the unit of measurement for frequency. One hertz is equal to one cycle per second.

Humidity – Humidity is the water content that is present in the air.

Impedance – Impedance is the resistance to alternating current.

Impulse Modulation – Impulse modulation changes the following characteristics of a wave: amplitude, frequency, and phase. This is accomplished by impressing one wave on another wave that has constant properties.

Induce – This refers to the transfer of power from one device to another device. The transfer is done via a magnetic field or via an electric field.

Interference – Interference is an unwanted mixture of electrical signals. Interference is usually associated with electrical noise.

Instrumentation – Instrumentation is a group of instruments that are used for measuring a system function.

Insulated – An insulated device is a device that is covered with a nonconductive material.

kVA – This is the abbreviation for Kilovolt Amperes. kVA is a term that is used when electrical devices are rated. In order to calculate a device's kVA rating, multiply the rated output (amperes) by the rated operating voltage.

KVAR – Kilovolt Amperes Reactive is abbreviated as KVAR. KVAR is associated with the reactive power that flows in a power system. Reactive power does not load the generator set's engine. Reactive power will cause thermal loss in the generator.

KVAR Regulation – KVAR Regulation is one of the two methods that are used to regulate the reactive power output. Regardless of the generator's real power output, the voltage regulator causes the generator to produce a constant value of KVAR. In this case, the generator's power factor will change when the generator's real power output changes. KVAR regulation is used when the generator is connected in parallel with an infinite bus (utility) and it is not possible to change the system voltage.

Kilowatts (kW) – Kilowatt is the electrical rating of the generator. One kilowatt equals 1000 watts. Actual power is measured in kilowatts.

Lead – A lead is a wire.

Line Voltage – Line voltage is the output voltage of the generator that is measured between the generator leads (phases).

Lock In – Lock in occurs when a contact closes in order to keep a device in an energized state.

Lock Out – Lockout occurs when a contact opens in order to keep a device in a de-energized state.

Magnetic – A magnetic device is a device that has the characteristics of a magnet.

Magnification – Magnification refers to the enlargement of an item.

Module – A module is an assembly of electronic components and electronic circuits.

Moisture – Moisture is the presence of water.

Oscillation – Oscillation is the flow of electricity that periodically changes direction and/or magnitude.

Permanent Magnet (PM) – A permanent magnet supplies the initial magnetism that is required to start a PMPE generator.

Permanent magnet pilot excited (PMPE) – A PMPE generator receives power for the voltage regulator from a pilot exciter. A PMPE generator consists of a permanent magnet and a pilot exciter.

PF Regulation – PF Regulation is one of the two ways to regulate the reactive power output. PF regulation is used when the generator is connected in parallel with an infinite bus (utility) and it is not possible to control the system voltage.

Phase Winding – A phase winding is a group of generator stator coils. Electric power for one phase of the load is induced in the phase winding.

Polarity – Polarity is the positive characteristics or the negative characteristics of two poles.

Power Factor (PF) – Power factor is the ratio of apparent power (kVA) to total power (kW). The power factor represents the portion of the current that is doing useful work. Power factor is expressed as a decimal number between 0 and 1.

Pulsating – Pulsating relates to the characteristics of current that are similar to mechanical vibration.

Radio Suppression – Radio suppression reduces the amplitude of radio frequency interference.

Reactive Droop Compensation – Reactive Droop Compensation is one of the two methods that are used for reactive power equalization. In reactive droop compensation, the voltage regulator causes an individual generator output to change in proportion to the reactive current. This reactive current is measured with a current transformer.

Reactive Power – Reactive power flows back and forth between the inductive windings of the generator. These windings are part of the electrical load. The reactive power does not perform any useful work in the electrical load. The reactive power only applies load to the generator. This limits the generator's capacity.

Reciprocating – Reciprocating motion is motion that first moves in a straight line in one direction. The direction of this motion then varies by 180 degrees.

Rectifier – A rectifier is a diode circuit that converts alternating current (AC) to direct current (DC).

Regenerative Power – Regenerative power works against primary power.

Reset – A reset returns a switch to a ready condition. In addition, a reset returns a circuit to a ready condition.

Residual Magnetism – Residual magnetism is a small amount of magnetism that is remaining in a device after excitation is removed.

RFA – An RFA is a rotating field assembly.

Rotating Rectifier – A rotating rectifier is mounted to a plate on a generator shaft. This plate then rotates with the generator shaft.

Rotor – A rotor is the rotating windings of a generator.

Saturable Reactor – A saturable reactor has characteristics that are similar to a valve. As the load changes, a valve opens in order to give more current to the output or a valve closes in order to give less current to the output.

Saturated – A device has been saturated when the device has been magnetized in excess. When saturation occurs, a large increase in current results in a small increase in magnetic force.

SCR – An SCR is a silicon controlled rectifier. An SCR is a semiconductor.

SE – An SE generator is a self-excited generator. An SE generator uses a small part of the generator output to provide excitation current back to the generator. An SE generator uses residual magnetic field for start-up.

Semiconductor – A semiconductor is a component such as one of the following components: a transistor, a diode, and a thyristor. Semiconductors have electrical characteristics that are between a conductor and insulation.

Series Boost – A series boost is an attachment that allows generator output to continue for a short time during a line failure. This allows the circuit breaker to trip in sequence.

Short – A short is an undesired electrical connection that exists between two or more components.

Shutdown – A shutdown occurs when the engine is stopped. This shutdown can occur manually or this shutdown can occur automatically.

Simultaneous – A simultaneous occurrence refers to two actions that happen at the same time.

Solid-State – A solid-state component is an electrical component that has no moving parts.

Stator – A stator is the windings of a generator that do not rotate.

Surge – A surge is a sudden increase in voltage or current.

Tap – A tap is a connection at the midpoint of a circuit. From this tap, power is taken from the circuit.

Transfer – A transfer refers to moving something from one point to another point. A transfer also refers to converting something from one state to another state.

Transient Peak Voltage – A transient peak voltage is a high voltage condition of limited duration.

Turn-on – When a device is turned on, the device is activated or the device is started.

Varistor – A varistor is a device that loses resistance as voltage increases.

Voltage Droop Resistor – A voltage droop resistor is a variable resistor. This resistor is used to control the change of voltage. This can occur when a generator is paralleled with another generator. This can also occur when the generator is paralleled with a utility.

Voltage Level Rheostat – A voltage level rheostat gives a range of control that is used when the voltage output level is adjusted.

Voltage Regulator – A voltage regulator is a circuit that senses the generator's output voltage. The field coil current is automatically adjusted in order to maintain the desired output.

Voltage Spike – A voltage spike is a brief high voltage.

Volts per Hertz Regulation – Under block loading conditions, the Volts per Hertz Regulation provides fast recovery. This regulation maintains close voltage control over the normal load range. This regulation also produces a rapid response of the generator set. This control is maintained by matching the generator output to the engine performance.

Windings – Windings are layers of wire on a core.

Wiring – Wiring relates to the wires of a circuit.

Wound – Wound refers to being circled.

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Product and Dealer Information

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

Delivery Date: _____

Product Information

Model: _____

Product Identification Number: _____

Engine Serial Number: _____

Transmission Serial Number: _____

Generator Serial Number: _____

Attachment Serial Numbers: _____

Attachment Information: _____

Customer Equipment Number: _____

Dealer Equipment Number: _____

Dealer Information

Name: _____ Branch: _____

Address: _____

_____

_____

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

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