CATERPILLAR®

SEBU6150-02
May 1994

Operation & Maintenance Manual

SR4 Generators and Control Panels

Table of Contents

SEBU6150-02

Foreword

This manual contains operation instructions and maintenance information.

The operation section 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 driven generator.

The maintenance section 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, arrangement 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.

Important Safety Information

Most accidents involving 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 other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "WARNING" as 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, explaining the hazard, 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 not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

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

Safety

Warning Signs and Labels

There are several specific safety signs on your generator. Their exact location and description of the hazard are reviewed in this section. Please take the time to familiarize yourself with these safety signs.

Make sure that you can read all safety signs. Clean and replace these if you cannot read the words or see the pictures. When cleaning the labels use a cloth, water and soap. Do not use solvent, gasoline, etc.

You must replace a label if it is damaged, missing or cannot be read. If a label is on a part that is replaced, make sure a new label is installed on the replaced part. See your Caterpillar dealer for new labels.

WARNING: Do not operate this equipment unless you have read and understand the instructions in the Operation Guide. Improper operation is dangerous and could result in injury or death. Contact any Caterpillar dealer for a replacement guide. Proper operation is your responsibility.

⚠ WARNING

If this generator is to be connected to a utility electrical distribution system, it must be isolated from the distribution system by means of;

A. Opening the main switch in the case of a portable generator temporarily connected to the system or,

B. A double throw (transfer) switch in the case of a permanent connection to the system.

Failure to do so could result in personal injury or death due to electrical shock.

The above warning does not apply when a generator and utility distribution system are designed and approved by the utility to run in parallel.

Installation

All electrical equipment supplied by Caterpillar should be installed in accordance with the Application and Installation Manual, form LEBX6213 and conform to national and local electrical codes of the area and county where the equipment is operating.

General

Do not allow unauthorized or untrained personnel on or near equipment.

Do not wear loose clothing or jewelry while working around equipment.

Stop the engine before making adjustments or repairs to the engine or generator unless otherwise specified.

Attach a "DO NOT OPERATE" tag on the start switch, start button, air start knob and/or remote starting system, before servicing the engine or generator. These tags, Form SEHS7332, are available from your Caterpillar dealer.

Be sure the remote starting system is inoperative on the equipment being serviced.

Disconnect and tape the battery ground lead or put the automatic start-stop switch to the STOP position before working on the equipment to prevent accidental starting.

To prevent injury, install guards over all exposed drive shafts, pulleys and any application with exposed rotating parts.

Always use tools that are in good condition and be sure you understand how to use them before performing any service work. Remove all tools, electrical cords and any other loose items from the engine before starting.

Engine speeds, temperatures and load are the best indications of performance. Rely on your instruments, record and compare readings to detect developing abnormalities.

Wear a hard hat, face shield, clothing, shoes, respirator or other protective items when necessary.

When using pressure air, always use approved safety equipment.

Wear ear protective devices to prevent hearing damage, if working inside an enclosed engine room with engine running.

Climbing

Some engines in permanent installations may require the use of climbing equipment to provide access for normal routine maintenance. It is the responsibility of the owner and/or user to provide safe access which conforms to SAE J185 and/or local building codes.

Keep all climbing equipment, ladders, stairs, platforms clean and free of slippery surfaces and tripping hazards.

Secure the climbing equipment so it will not move or fall while in use.

Never jump from an elevated platform, ladder, or stairs.

Maintain all climbing equipment so it is in safe operating condition.

Fire or Explosion Prevention

Be sure the engine room is properly ventilated.

Keep the engine room and floor area clean.

Observe NO SMOKING signs. Do not smoke around batteries. Hydrogen gas generated by charging batteries is explosive. Keep batteries in a well ventilated area.

Never store flammable liquids near the engine.

Store oily rags in metal covered containers.

Always have a fire extinguisher on hand and know how to use it. Inspect and have it serviced as recommended on its instruction plate or label.

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

Electrical Shock Prevention

All electrical equipment must be grounded according to local building codes.

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

Be sure all electrical power is disconnected from electrical equipment being serviced.

Do not work on electrically "hot" equipment.

Do not touch the heat sink on the generator regulator when the generator is running. It is electrically "hot."

Check all connections periodically for tightness and insulation.

Insulate all connections and disconnected wires.

Keep all electrical equipment clean and dry.

Burn Prevention

Do not touch any part of an operating generator. Allow the generator to cool before any repairs are performed.

Preparing to Start

Be sure all protective guards and covers are installed if an engine must be started to make adjustments or checks. To help prevent an accident caused by parts in rotation, work carefully around them.

Starting

Do not start the engine or move any of the controls if there is a warning tag attached to the controls.

Make sure no one is working on, or close to the engine or engine driven components, before starting it.

Start and operate the engine in a well ventilated area. If it is necessary to operate in a closed area, vent the exhaust to the outside.

Stopping

Stop the engine according to the "Stopping The Engine" instructions to avoid overheating and accelerated wear of the engine components.

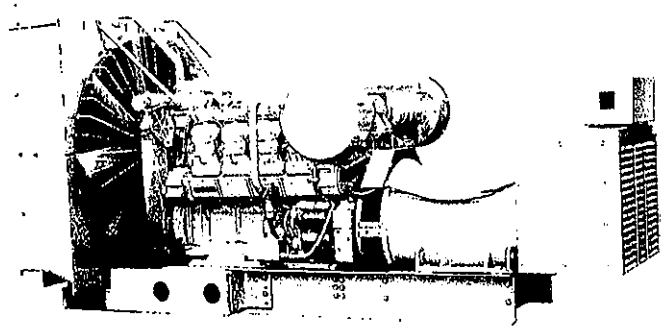
Only use the Emergency Stop button in an emergency situation. Do Not start the engine until the problem necessitating the emergency stop has been located and corrected.

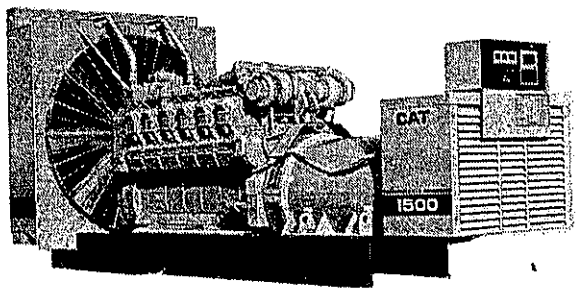
On initial startup and overhaul, be prepared to STOP the engine should an overspeed occur. This may be accomplished by cutting the fuel and air supply to the engine.

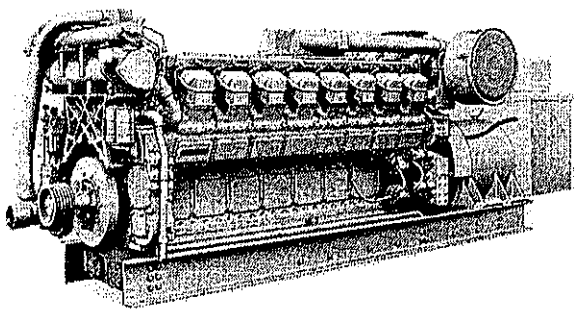
Model Views

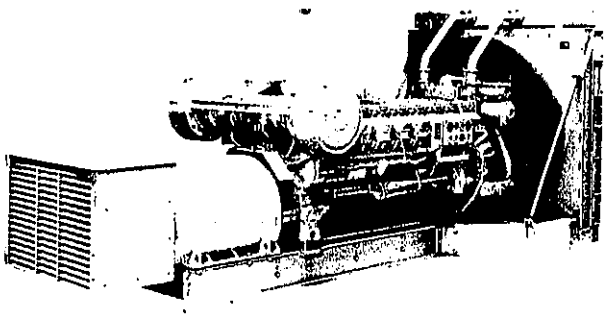
SR4 Generator

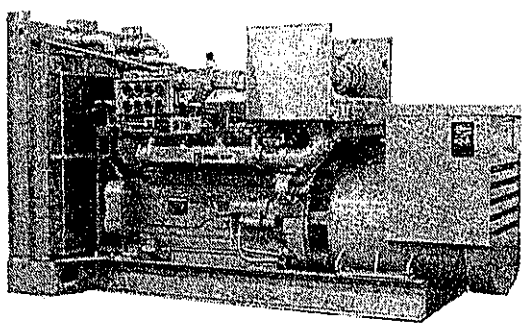
Large Frame SR4 Generator

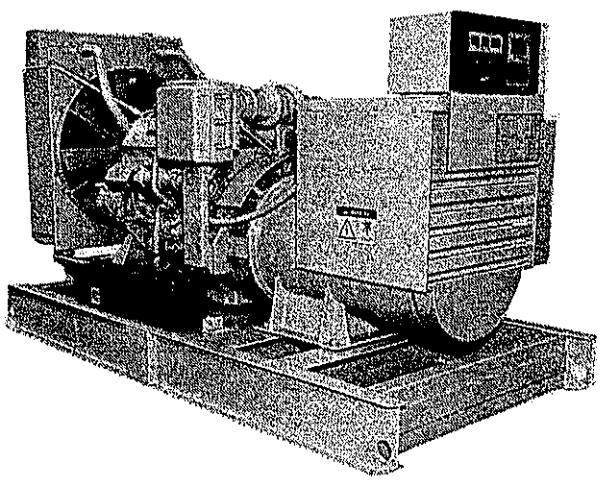


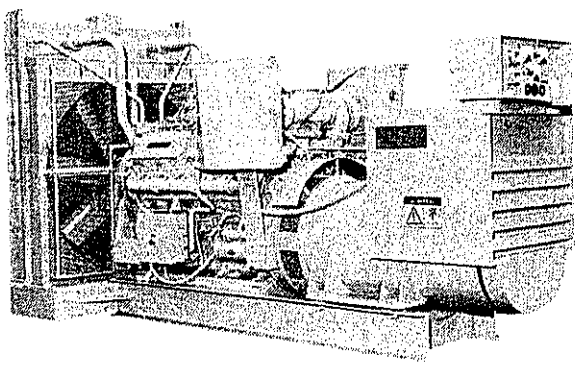




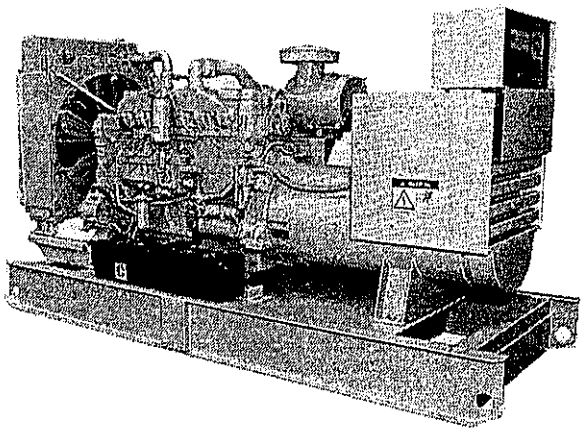


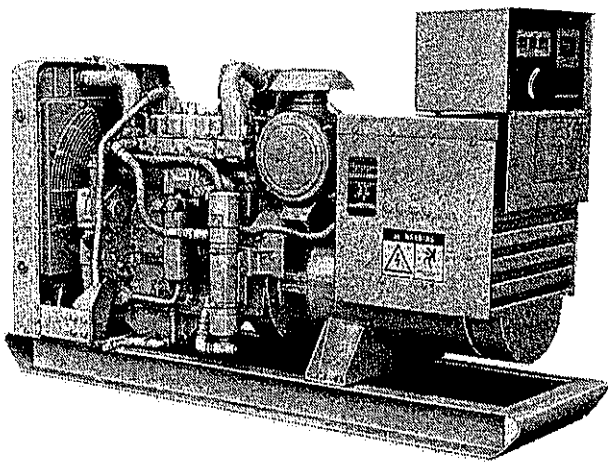


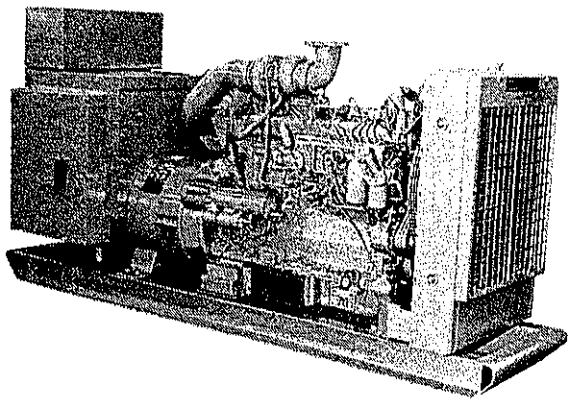


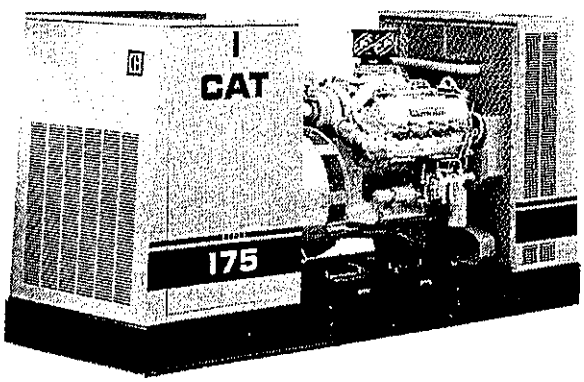


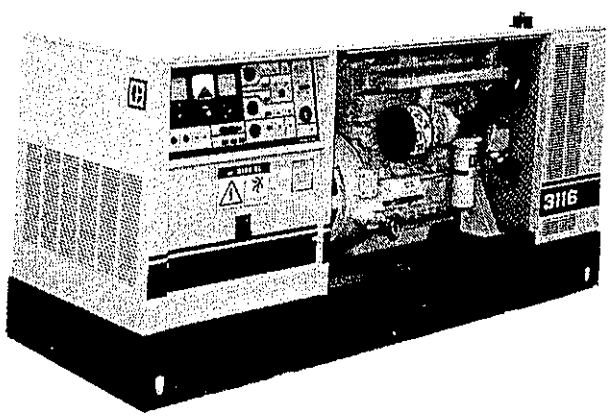
Small Package Generator Sets











General Information

The SR4 Brushless Generator is suitable for application to all kinds of loads, including, but not limited to: mixed loads of motors and lights, SCR-controlled equipment, computer centers, communication installations, and petroleum drilling applications. The elimination of brushes in the field circuit reduces maintenance, improves reliability and provides a higher degree of protection in potentially hazardous atmospheres.

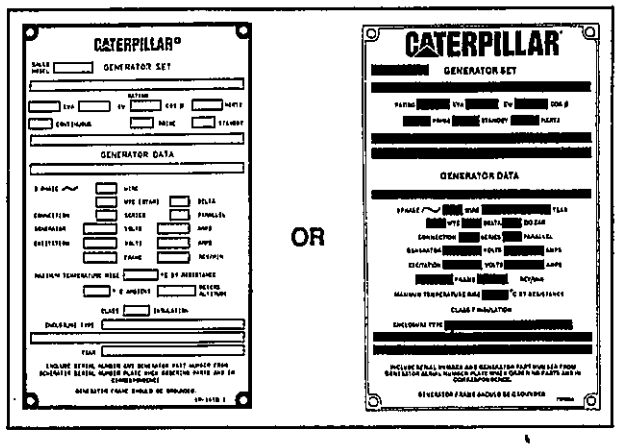
The generator set packages can be utilized for prime or stand-by power generation, in land based or marine applications.

SR4 generators are utilized in single phase, half wave excitation and regulation, and three phase, full wave excitation and regulation. The generators are either four pole or six pole design with four, six, ten or twelve lead configuration depending on frame size. They are capable of producing electrical power in either 50 Hz or 60 Hz applications.

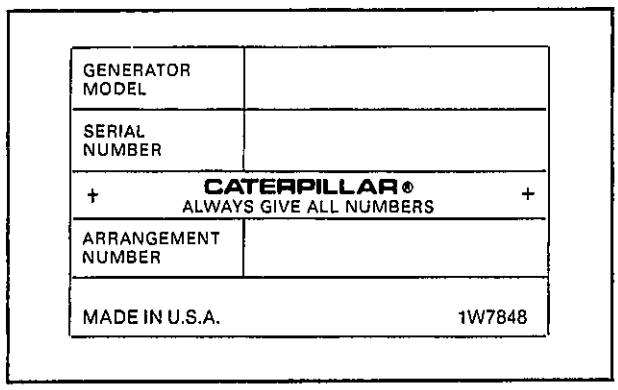
Generator Identification

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

When service is required, use the information given on these plates. The information contains the serial number, model number and the generator set (engine and generator) rating. All pertinent generator data is also included on the plate to provide the necessary information to order parts.



and



Output Lead Wiring

All generator lead wiring information can be found on the information plate, or on a decal on the power lead side of the generator for twelve lead generator sets. If the generator is equipped with a circuit breaker, the decal will be mounted on the sheet metal of the circuit breaker panel.

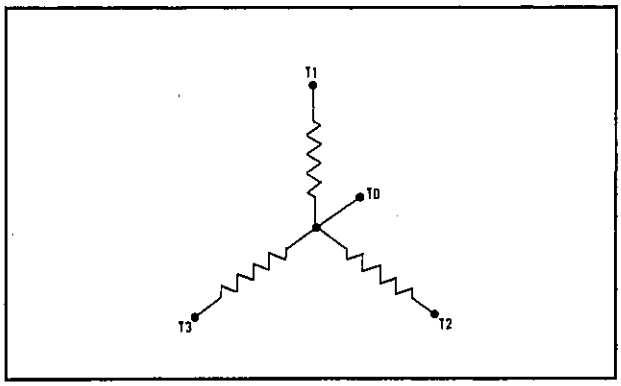
Generator Lead Connections

Lead Numbering

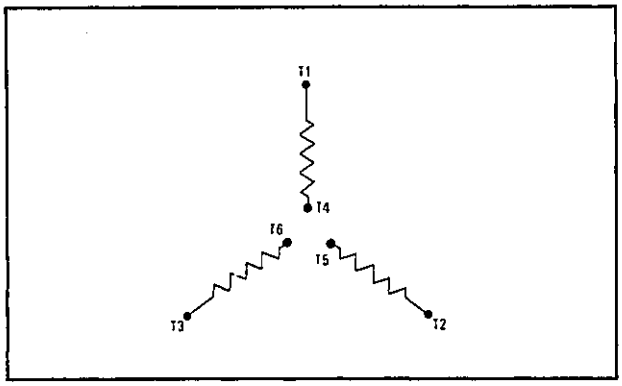
Each coil lead is marked according to the following diagrams. The diagrams contained show the four, six, ten, and twelve lead configurations available in present day SR4 generators.

The standard generator diagram and the terminal connections are on the nameplate of each generator.

Numbering is clockwise from the top and from the outside inward.

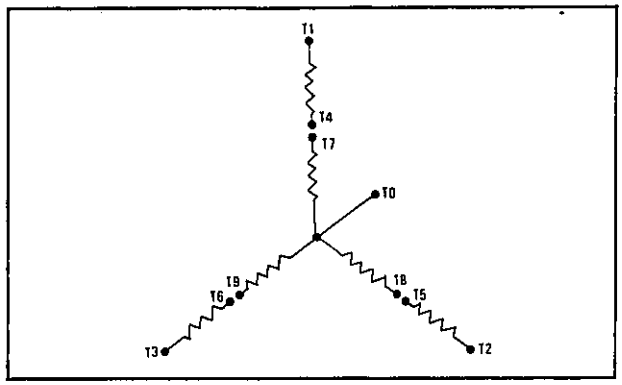


4 Lead Wye Configuration



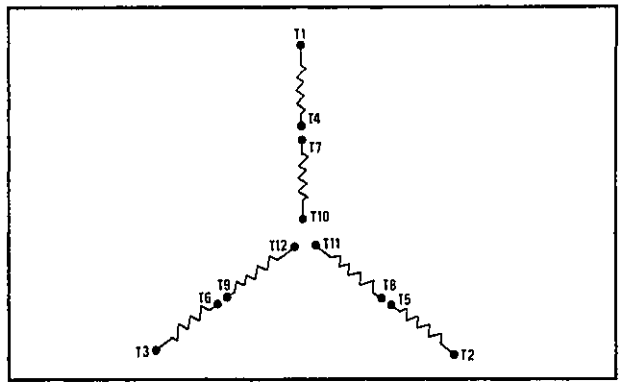
6 Lead Wye Configuration

Terminal T_4, T_5 and T_6 become the neutral connection when tied together in the 6 Lead Wye Configuration.



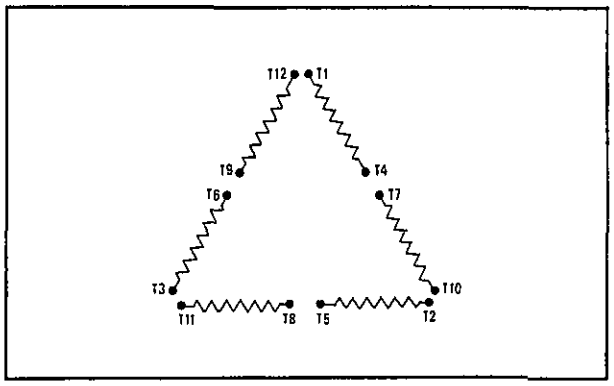
10 Lead Wye Configuration

Terminal T_0 is the neutral lead for the 4 lead and 10 lead generators.



12 Lead Wye Configuration

Terminals T_{10}, T_{11}, and T_{12} become the neutral connection when tied together in the 12 Lead Wye Configuration.



12 Lead Delta Configuration

In the 12 Lead Delta Configuration Terminals T_6 and T_9 become the neutral connection when tied together and grounded, reflecting the Terminal T_2, T_{10} connection as the high phase.

Grounding the Frame

In any generator set installation, the frame of the generator must be positively connected to an earth ground or to the hull of a vessel. This connection is the first one made at installation, and the last one to be removed. If the generator set is on flexible or resilient pads, the ground connection must be flexible to avoid possible breakage in later operation.

Ground connection cable or straps should have at least the current carrying capacity of the largest line lead to the connected load. Joints in cables or straps must be clean, free of electrical resistance, and protected from possible oxidation. Bolted ground connection joints eventually oxidize, and are frequent sources of radio frequency interference. Silver soldered, bolted joints are electrically and mechanically sound.

Neutral Connections

"Y"-connected generators usually have the neutral grounded when the generator is installed unless definite measures are taken to prevent grounds on the load side. The grounding of the neutral is to prevent load side equipment damage.

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

There are some instances in which it is undesirable to ground the neutral wire. In these applications where definite measures (ground fault protective circuits) have been taken to prevent grounds to the phase leads, an ungrounded generator neutral lead is acceptable.

Ground fault protection requires that the entire group of distribution circuits be studied and treated as a system. The owner should engage a certified and registered consultant if a new distribution system is being developed, or if an existing system is to be modified for ground fault protection.

Single Units

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

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

Multiple Units

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

Parallel to Utility

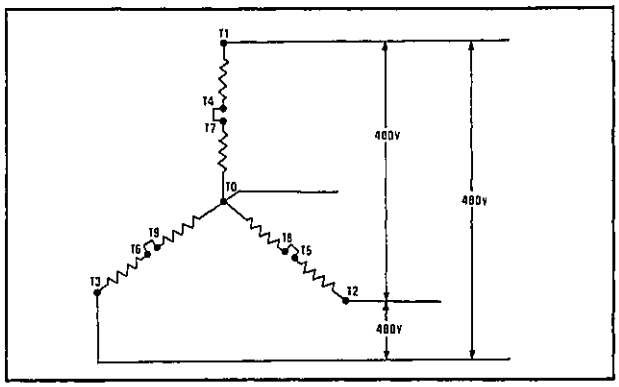
When a Wye connected generator is to operate in parallel with a utility system (infinite bus), and the secondary of the utility system step-down transformer is also a Wye connection, grounding of both Wye neutrals may result in circulating currents through the neutrals. Plus, the coordination of a ground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

Voltage Connections

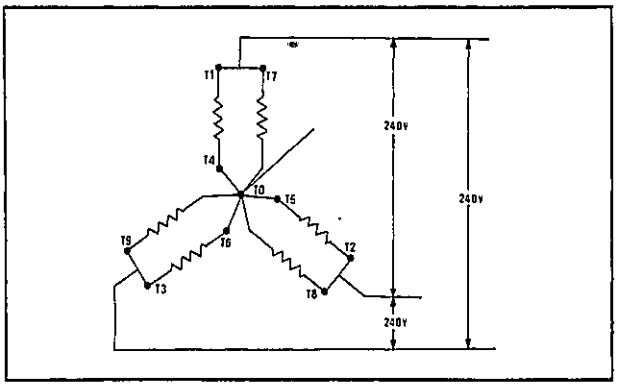
Three Phase

The connections for high and low voltage and delta are given in the following diagrams.

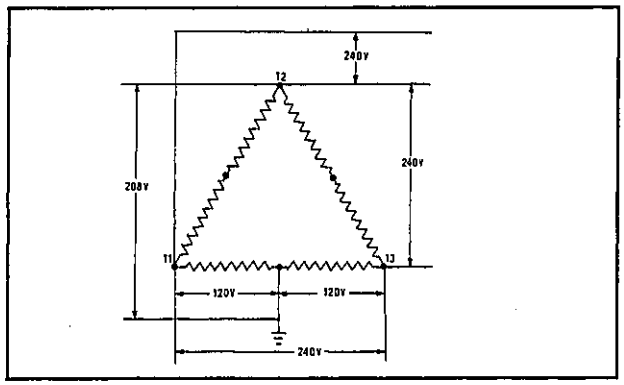
The terminals must be connected securely and insulated with a good quality electrical tape.



Typical High Voltage (Series Wye) Connection (60 Hz)



Typical Low Voltage (Parallel Wye) Connection (60 Hz)



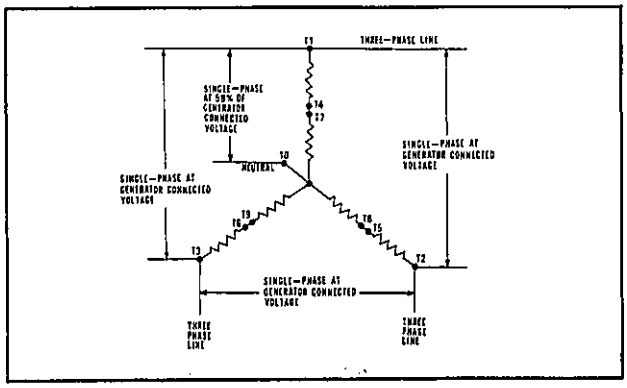
Typical Delta Connection (60 Hz)

Single Phase Current From a Three-Phase Generator

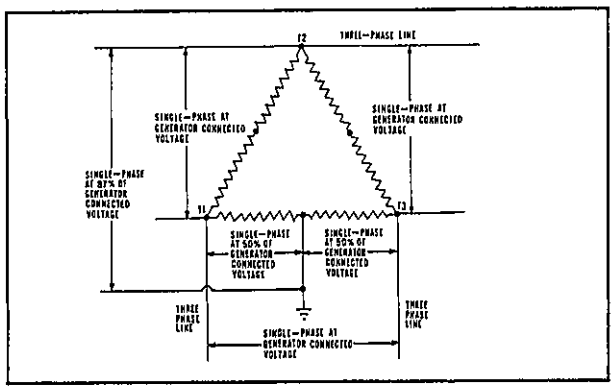
Three phase and single phase current can be taken simultaneously from a generator connected for three phase service. Connecting the load to any two of the three phase leads in both Wye and Delta configurations will provide single phase voltage at the same voltage as three phase power. Connecting the load to any phase lead and neutral of the Wye configuration will produce voltage at 58% of three phase voltage. In the Delta configuration producing 240 volt 60 Hz three phase power, the high phase to neutral would produce 208 volts and either low phase to neutral would produce voltage at 120 volts of three phase voltage.

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

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



Single Phase Voltage Using Wye Configuration



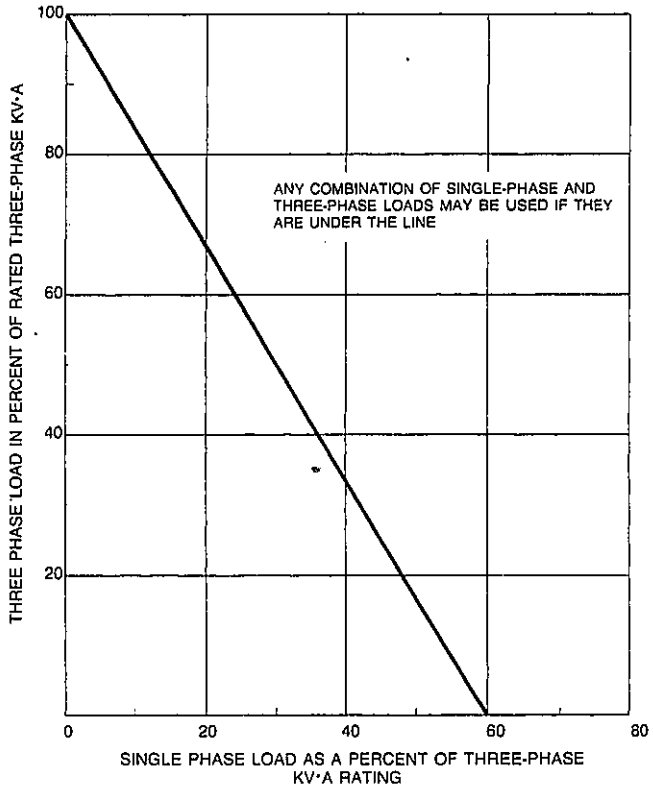
Single Phase Voltage Using Delta Configuration

Generator Performance & Options

Generator Loading

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

ALLOWABLE COMBINATIONS OF UNBALANCED LOADS



When operating with significant single phase loads, the three phase/single phase load combinations must lie below the line on the graph.

Block Loading

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

The block loading capability of a generator set depends upon engine transient response, voltage regulator response and type, altitude of operation, type of load, and the amount of load at the time the block load is applied.

If block load derating is required, refer to (International Standards Organization) ISO 3046 or SAE J1349 Standards. Also reference Engine Data Sheets, Block Loading Transient Response LEKX4066 and Transient Response LEKX4067.

Power Factor

Power factor may be thought of as the efficiency of the load – the ratio of apparent power to total power. Power factor is expressed as a decimal and denotes that portion of current supplied to a system doing useful work. The portion of current not doing useful work is absorbed in maintaining the magnetic field in motors. This current, although it is called the reactive load, does not require engine power to maintain it.

In most applications electric motors and transformers determine the power factor of the system. Induction motors usually have a 0.8 or smaller power factor. Incandescent lighting is a resistive load of about 1.0 power factor, or unity.

The power factor of a system may be determined by a power factor meter or by calculations. Determine the power requirement in kW by multiplying the power factor by the KVA supplied to the system. As the power factor goes up, the total current supplied to a constant power demand will go down. A 100 kW load at a 0.8 power factor will draw more current than a 100 kW load at 0.9 power factor. High power factor will result in full engine load at less than generator rated amperage. A lower power factor increases the possibility of overloading the generator.

NOTE: Caterpillar Generators are designed for a 0.8 power factor unless otherwise specified.

Low Idle Adjustment

Electric sets normally have a higher low idle setting than do industrial engines. Low idle will be approximately 2/3 the full load speed of 60 Hz units (4/5 full load speed of 50 Hz units).

On electric sets with some Woodward governors, there is no low idle stop. On electric sets with mechanical governors and natural gas electric sets, the low idle is set at the factory, and 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, and restarted to allow the voltage regulator to again produce an output.

Oilfield Generator

For SCR Controlled Electric Rigs

Oilfield generators are now available for use with SCR controlled electric oil rigs, that do not use a voltage regulator. The function of the generator control is performed by the drilling electrical control system.

Consult the drill rig builder on questions pertaining to generator control (voltage regulation, paralleling, load sharing, etc.).

Generator Options

Space Heaters

SR4 generators are available with space heaters installed for operation in high humidity conditions. For more information on space heaters, refer to the topic "Generator Maintenance" in this manual.

Embedded Temperature Detectors

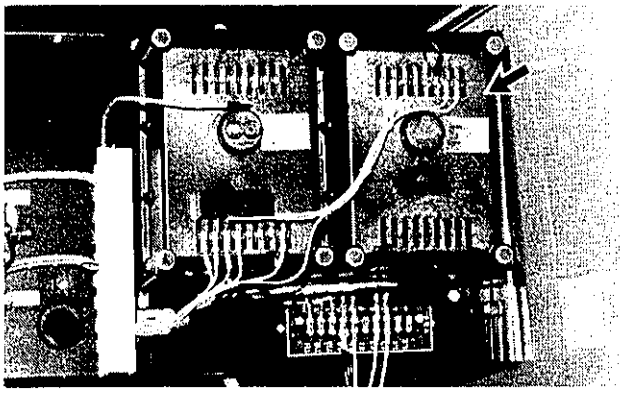
SR4 generators are available with embedded temperature detectors. The detectors are installed in the slots of the main armature (stator). The detectors are used, with customer provided equipment, to measure and/or monitor the main armature winding temperature. Three types of temperature detectors are available. Contact your Caterpillar dealer for more information.

Bearing Temperature Detectors

Bearing temperature detectors are available for large frame SR4 generators. Bearing temperature detectors measure and/or monitor main bearing temperature. Bearing temperature measurements may help to prevent premature bearing failure. Two types of temperature detectors are available. Contact your Caterpillar dealer for more information.

Voltage Regulator Options

Series Boost Option



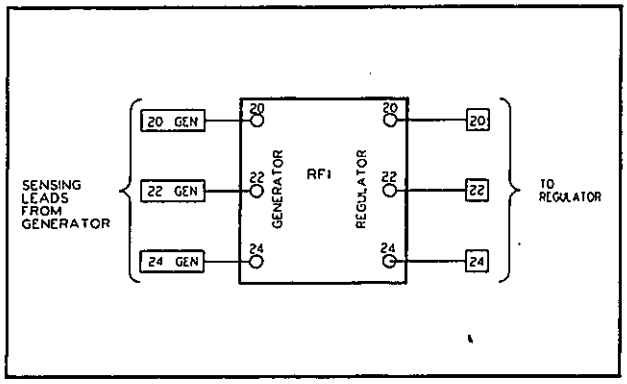
The series boost option attachment consists of a series boost module assembly, and a series boost transformer assembly.

Series boost allows Self Excited SR4 Generators to stay on the line for approximately ten seconds when there is a short in the generating or load circuits. This ten second feature allows the load circuit breakers a chance to trip in sequence, thus minimizing the possibility of power loss to the entire electrical system.

NOTE: Series boost connections are not the same for all generator sets. Refer to the SR4 Generator Service Manual for all wiring and installation information.

For a listing of Caterpillar reference literature, refer to the topic "Reference Literature" in this publication. This literature may be purchased through your Caterpillar dealer.

Electromagnetic Interference / Radio Frequency Interference (EMI/RFI) Module Option



This optional filter, connected in series with the voltage sensing leads, is used to meet compliance with MIL STD 461B and VDE 875 level N requirements.

Manual Voltage Control Option

A manual voltage control module for either the self excited, or permanent magnet excited SR4 generators is available as an option. Various specifications and certification require manual voltage control of the generator if the automatic voltage regulator should fail.

Generator Excitation Systems

Permanent Magnet Excited Generators

Permanent magnet pilot excited (PMPE) generators receive power for the voltage regulator from a pilot exciter, rather than the main armature as in self-excited generators. The pilot exciter consists of permanent magnet (PM) and PM armature. The pilot exciter operates independently from the generator output voltage. Constant excitation during large load application is possible, because the irregularities that occur in generator output voltage (caused by load conditions) are not fed back into the exciter. The independent operation also allows the generator to better sustain an overload for a short duration.

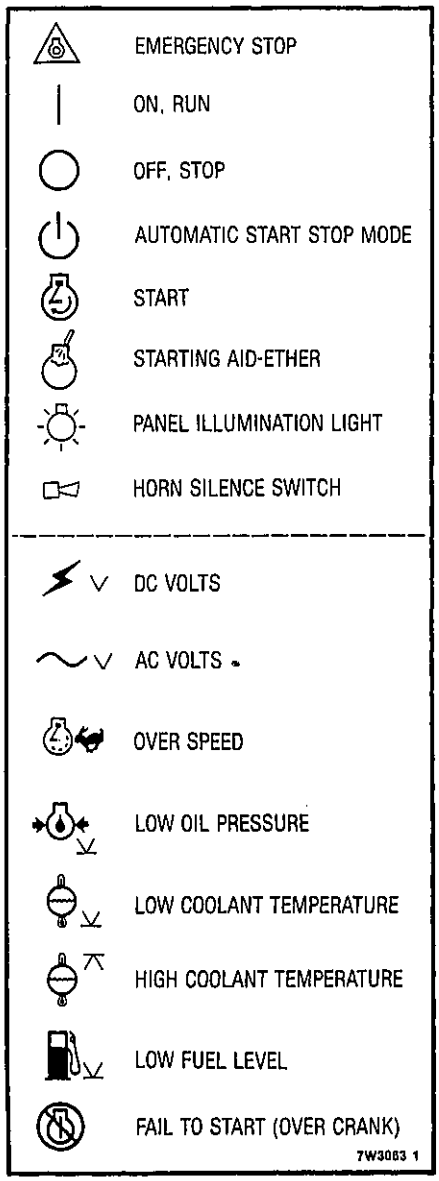
Self-Excited Generators

Self-Excited generators receive power for excitation and voltage sensing for the regulator from the main armature (stator) output of the generator. The voltage regulator senses the generator output voltage and provides regulated output to the generator exciter. The exciter then provides power to the main rotating field (rotor). As the main field rotates, a voltage is induced into the main armature (stator) to causes a generator output.

Symbols

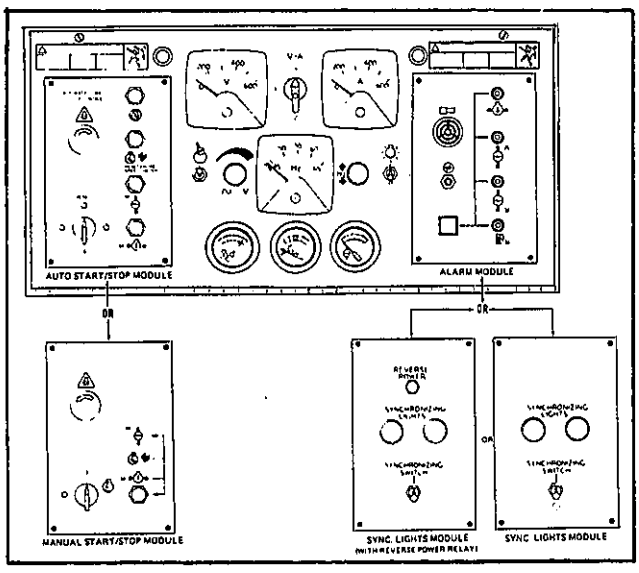
The control panel and modules utilize International Graphic Symbols to identify their function.

A typical list of the symbols used is shown below.



Generator Set Control Panel 4W-8000 (If Equipped)

Control Panel



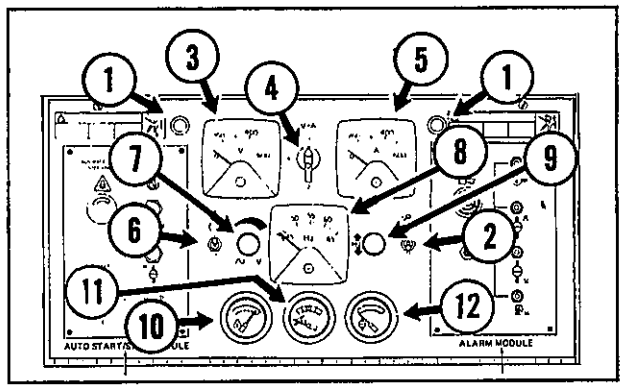
The SR4 generator set control panel is located on top of the generator set. The control panel consists of a main panel with gauges, meters, and control switches. Plug in modules are utilized to enable the user to order only the components that he requires.

The left side will contain a Manual Start-Stop module or an Automatic Start-Stop module, as required by the user.

The right side may be blank or contain any of the three optional modules. The optional modules are an Alarm module, a Synchronizing Lights module, or a Synchronizing Lights With Reverse Power Relay module.

Main Control Panel

The Main Control Panel may or may not contain all of the components shown below. Some components are optional, and may not be required for your particular application.



(1) PL; panel lights (optional).
(2) PLS; panel lights switch (optional).
(3) ACV; alternating current voltmeter.
(4) AVS; ammeter - voltmeter phase selector switch.
(5) ACA; alternating current ammeter.
(6) SAS; starting aid switch (optional).
(7) VAR; voltage adjust rheostat.
(8) Hz; frequency meter.
(9) GS; governor switch or SP; speed potentiometer (optional) (GS shown).
(10) OPG; oil pressure gauge.
(11) DCA; direct current ammeter (optional).
(12) WTG; water temperature gauge.

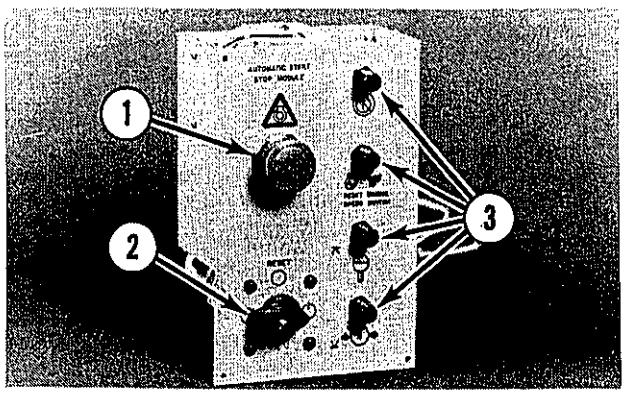
- Panel lights (1) are controlled by a panel lights switch (PLS) (2).
- Alternating current voltmeter (ACV) (3), alternating current ammeter (ACA) (5), and frequency meter (Hz) (8) show the output of the generator. Ammeter - voltmeter phase selector switch (AVS) (4) selects which phase (T_1, T_2 or T_3) of the generator output will be monitored on ACA (5) or ACV (3).
- Starting aid switch (SAS) (6) is utilized to provide a specific amount of ether when required for starting.
- Voltage level rheostat (VAR) (7) replaces the rheostat in the generator regulator assembly.

- Optional governor switch (GS) or speed potentiometer (SP) (9) are used to raise or lower the engine speed when the governor is equipped with a speed adjust motor. If the engine is equipped with a 2301 or 2301A electric governor, a Speed Potentiometer is mounted in this location.
- Oil pressure gauge (OPG) (10) indicates engine oil pressure.
- Direct current ammeter (DCA) (11) indicates starting battery charging rate in amps.
- Water temperature gauge (WTG) (12) indicates engine water temperature.

Automatic Start-Stop Module

The Automatic Start-Stop Module (if equipped) is designed to automatically start and stop the engine as required. It also has the capability to shut down the engine for various malfunctions or to prevent starting for the same causes.

It is located in the left side on the control panel.



(1) ESPB; emergency stop push button.
(2) ECS; engine control switch.
(3) Engine fault lights.

In an emergency situation, if emergency stop push button (ESPB (1) is pressed, the fuel and air shutoffs will activate, and the engine will shutdown. The switch will need to be reset and the problem corrected before starting the engine.

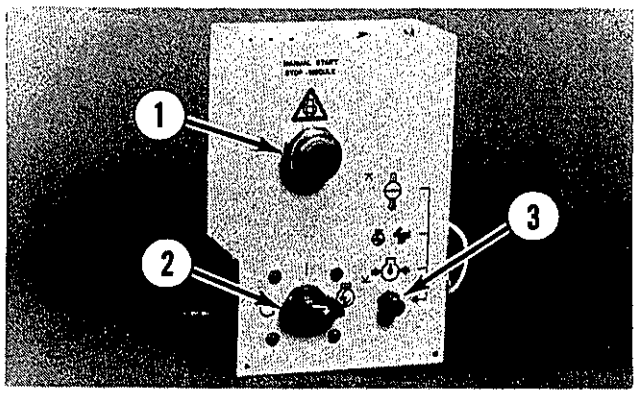
If the engine has a malfunction, the panel will activate a shutdown relay to stop the engine. Engine fault lights (3) will indicate if the fault is caused by either low oil pressure, high coolant temperature, engine overspeed, or overcrank condition.

The engine control switch (ECS) (2) allows manual or automatic operation of the engine and the generator set. In the Automatic Start position, the generator set can be started when a customer supplied contact closes. The Manual (On, Run) position allows the operator to start the generator set.

Manual Start-Stop Module

The Manual Start-Stop Module (if equipped) is used in applications where an operator is present to start and stop the generator set.

It is located in the left side in the generator control panel.



(1) ESPB; emergency stop push button.
(2) ECS; engine control switch.
(3) Engine fault lights.

In an emergency situation, if emergency stop push button (ESPB) (1) is pressed, the engine will shutdown. The switch will need to be reset and the problem corrected before starting the engine.

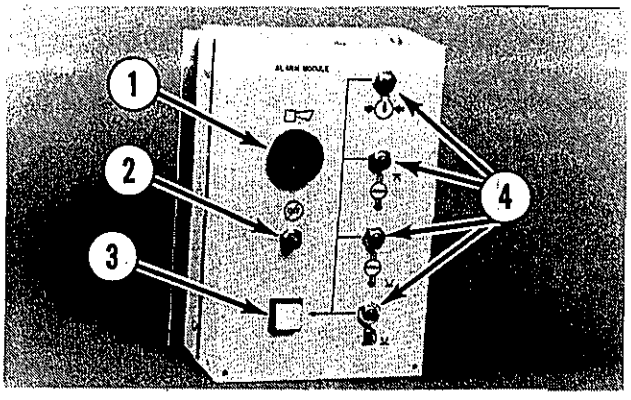
If the engine has a malfunction, the panel will activate a shutdown relay to stop the engine. Engine fault lights (3) will indicate if the fault is caused by either low oil pressure, high coolant temperature, engine overspeed, or overcrank condition.

The engine control switch (ECS) (2) allows manual operation of the engine and the generator set. The engine is manually started and stopped using this switch.

Alarm Module (ALM)

The Alarm Module (ALM) is an attachment designed to give a warning of conditions that can become a problem before they are bad enough to shutdown the engine, or keep it from starting. It does not shutdown the engine, it activates a warning alarm.

It is located in the right side of the control panel.



(1) Alarm.
(2) Alarm silence switch.
(3) Preliminary alarm light.
(4) Fault lights.

The alarm (or horn) (1) provides the operator with an audible indication of a problem that could shutdown the generator set or keep the engine from starting. The alarm (horn) is silenced by alarm silence switch (2).

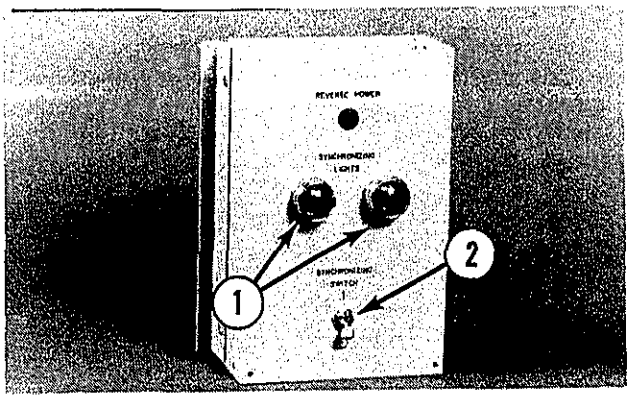
Preliminary alarm light (3) provides the operator with a visual indication even though the alarm or horn is silenced.

The alarm module (ALM) will activate and fault lights (4) will light for conditions such as: low idle oil pressure, low rated rpm oil pressure, high coolant temperature, low coolant temperature, or low fuel level.

Synchronizing Lights Module (SLM)

The optional synchronizing lights module is not used when the panel is equipped with the 2301 governor, 2301A governor or 2301 governor with pre-regulator.

This module is located in the right side of the control panel (same location as the optional alarm module).



(1) SL; synchronizing lights.
(2) SS; synchronizing switch.

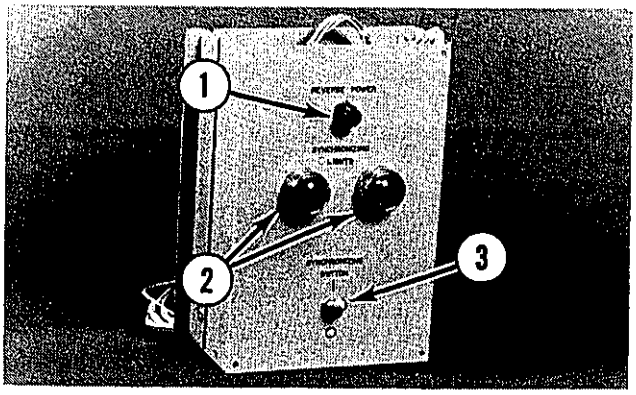
Synchronizing lights (SL) (1) are used as an aid in *paralleling units at no load or load conditions.*

Synchronizing switch (SS) (2) is used to turn on synchronizing lights (SL) (1) to make the phase check for parallel operation or to turn off the lights when not needed. When both synchronizing lights (1) are OFF, they indicate when voltages are in phase so the circuit breaker may be closed.

NOTE: The synchronizing lights module (SLM) is only used to check for proper phase. If checking phase rotation, three lights must be used. For additional information refer to the topic Parallel Operation in the Operation Section of this manual.

Synchronizing Lights Module with Reverse Power Relay

This module looks and operates the same as the synchronizing lights module (SLM) except that it contains a reverse power light and relay.



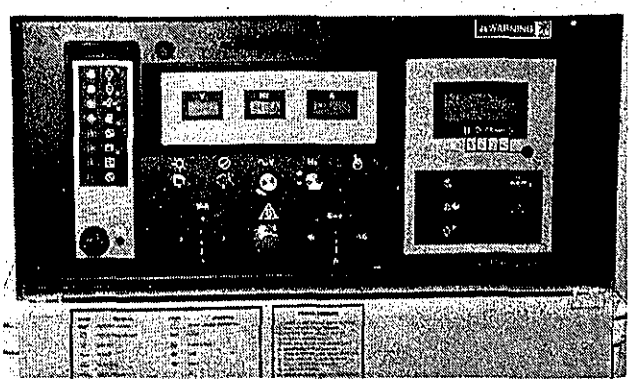
(1) RPL; reverse power light
(2) SL; synchronizing lights
(3) SS; synchronizing switch

The reverse power relay provides system protection when the generator set is in parallel with another unit. If, for some reason, the engine loses power, the other unit in parallel will attempt to motorize the engine and generator. Instead of power going out, power flows into the failing generator to make it a motor. This reverse flow of power could possibly result in overloading the other generators and the entire system.

The reverse power relay senses power coming into the generator and actuates to shutdown the engine and take the generator off line.

Generator Set Control Panel 7C-1000 (If Equipped)

Control Panel, EMCP

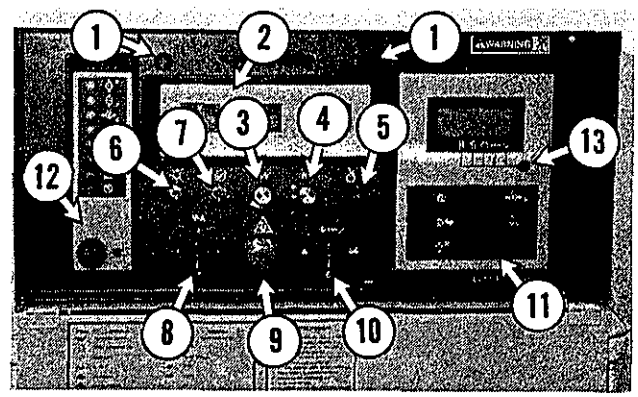


The generator set Electronic Modular Control Panel (EMCP) is located on top of the generator regulator housing. The control panel consists of a main panel with gauges, meters and control switches. This control panel may be equipped with optional modules to match the customers needs and requirements. The left side may be blank, or contain one of the alarm modules, or a synchronizing lights module.

The right side of the control panel contains the engine control module (ECM). This is the "brain" of the system and also displays fault conditions and key engine parameters.

Main Control Panel

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



(1) PL; panel lights.
(2) ACM; AC meter module.
(3) VAR; voltage adjust rheostat.
(4) GS; governor switch or SP; speed potentiometer (optional) (SP shown).
(5) SAS; starting aid switch (optional).
(6) PLS; panel light switch (optional).
(7) LTS; lamp display/test switch.
(8) AVS; ammeter - voltmeter phase selector switch.
(9) ESPB; emergency stop push button.
(10) ECS; engine control switch.
(11) ECM; engine control module.
(12) ALM; alarm module or SLM; synchronizing lights module (optional) (ALM shown).
(13) Display hold switch for ECM.

- *Panel lights (PL) (1) are controlled by panel lights switch (PLS) (6).*

- AC meter module (ACM) (2), contains digital liquid crystal displays for AC volts -(V), frequency - (Hz), and AC amps - (A). These displays indicate the status of the generator output.

- The ammeter-voltmeter phase switch (AVS) (8) is used to select the current phase and voltage phase of the generator output to be displayed by the amps and volts display.

- *Voltage adjust rheostat (VAR) (3), is used to adjust* the generator output voltage to the desired level.

- Optional governor switch (GS) or speed potentiometer (SP) (4) is used to raise or lower the engine speed when the governor is equipped with a speed adjust motor. If the engine is equipped with a 2301 or 2301A electric governor, a speed potentiometer (SP) is mounted in this location.

- Starting aid switch (SAS) (5) is used to inject ether into the engine for starting in cold weather conditions. This switch (when moved to the ON position) energizes and meters a specific amount of ether in a holding chamber. When the switch is released, the solenoid releases the ether to the engine.

- Lamp/display test switch (LTS) (7) is used to test all lamps and digital displays in the test position. All lamps will light and all liquid crystal display digits will read 8888888. If equipped with the optional alarm module, the lamps will light, and the alarm horn will sound for a maximum of ten seconds.

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

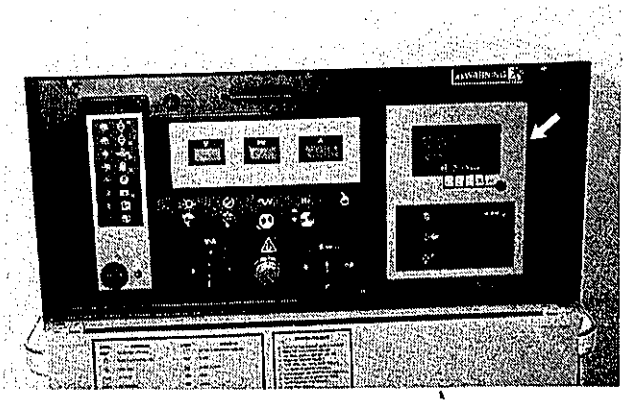
- Engine control switch (ECS) (10), determines the status of the control panel. In the Automatic position (3 o'clock), the engine will start automatically whenever the remote initiating contact is closed. The engine will shutdown after the initiating contact opens. An adjustable cooldown time is programmed to give a 0 to 30 minute cooldown period before the engine shuts down.

In the Manual Run position (6 o'clock), the engine will start and run as long as the engine control switch (ECS) (10) switch remains in this position.

In the Stop position (9 o'clock), the fuel solenoid shuts the engine down.

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

Engine Control Module (ECM)



The right side of the control panel contains the engine control module (ECM). This is the "brain" of the system, and also displays fault conditions and key engine parameters.

The ECM accepts information from the operator, magnetic pickup, oil pressure and water temperature transducer, and optional remote sources. This information is used to determine the "on/off" state of the engine's air, fuel, and starter.

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

The ECM Features and Functions:

- Cycle Crank – The ECM can be programmed to crank-rest crank etc. for adjustable time periods. Refer to the Service Manual Module SENR3535, which is included in the Service Manual SENR7958 for programming instructions.

- 2301 or 2301A Control – When the engine oil pressure increases past the low oil pressure set point, the ECM will indicate to the governor that it should increase engine speed from IDLE to RATED rpm.

- Cool Down – Upon receiving a signal to perform a normal shutdown, the ECM will wait a preprogrammed amount of time before shutting the engine down by means of the fuel control.

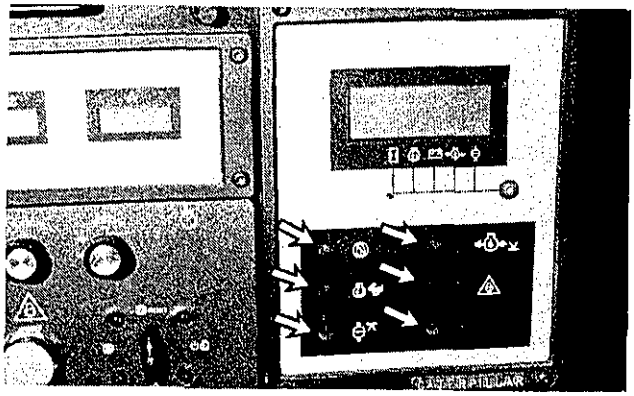
- Automatic Operation – While in the automatic mode, the ECM can be started by a remote initiate signal (contact closure). Upon loss of the signal (contact opening), the ECM will perform a normal shutdown.

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

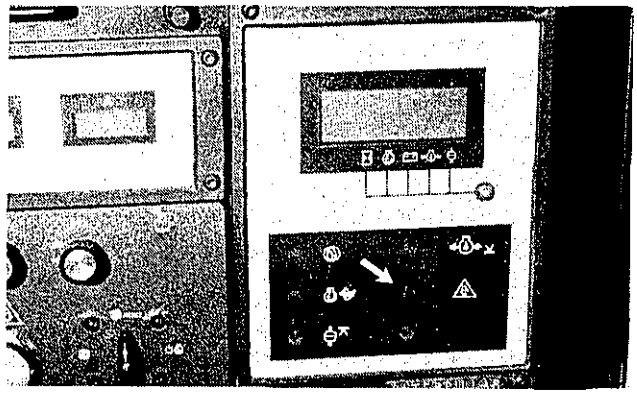
- Power Down – The Electronic Modular Control Panel (EMCP) system is designed to remove power from the ECM when in the off/reset mode and the proper jumper wire is removed. The ECM will not allow the power down until the crank termination relay and the fuel control relay are both "off" for about 70 seconds. If the wire is not removed, it will remain powered up.

Refer to the Service Manual Module SENR3535 for the wiring diagram and jumper wire location.

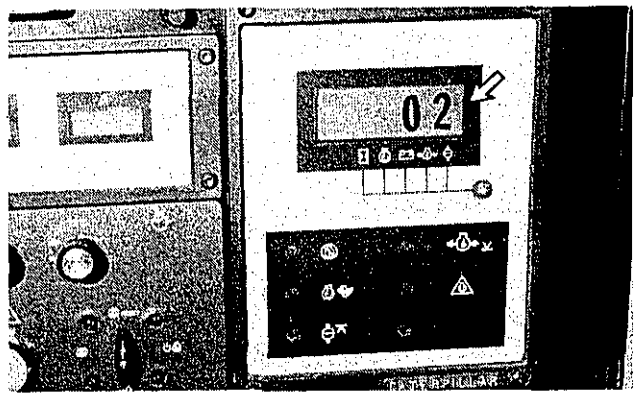
- Fuel Solenoid Type – The ECM can be programmed to work with either an energized to run (ETR) fuel system or an energized to shutdown (ETS) fuel system.



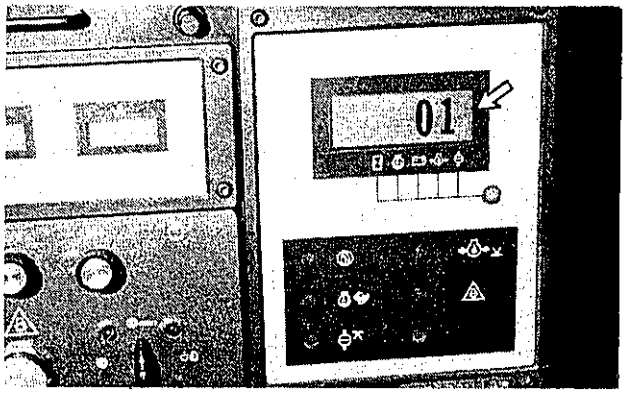
- LED Display – Six LEDs (light emitting diodes) are located on the front of the ECM to annunciate overcrank shutdown, overspeed shutdown, low oil pressure shutdown, high coolant temperature shutdown, emergency stop, and reverse power shutdown. The reverse power LED can be used as a spare fault indication when the reverse power relay option is not used.



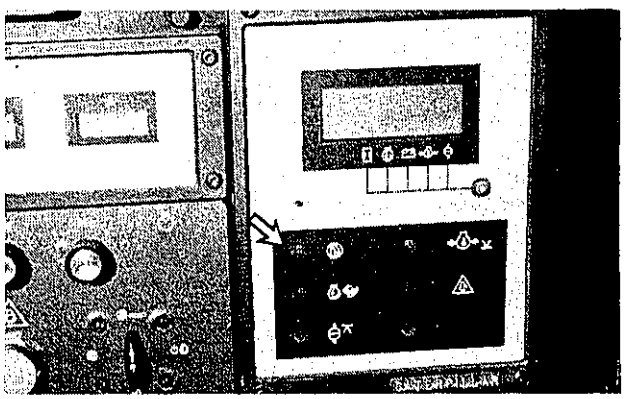
- Emergency Stop – If the ECM detects an emergency stop, the engine will shut down by means of the air and fuel control and the Emergency Stop LED will flash.



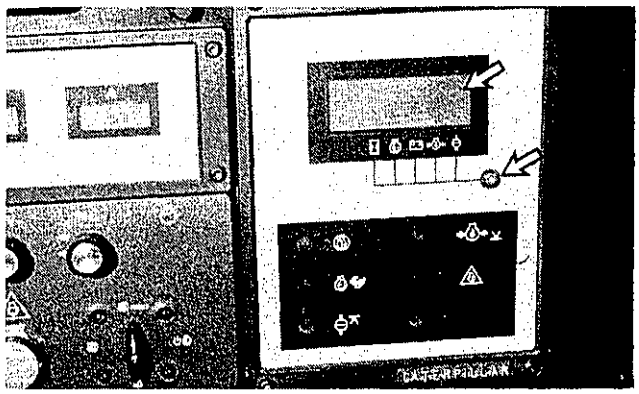
- Transducer Module Malfunction – If the signal from the engine mounted oil pressure/temperature transducer module is lost or unreadable, the engine will be shutdown by means of the fuel control and a diagnostic code will be displayed. The ECM can be programmed to ignore the transducer module malfunction. Refer to the Service Manual Module SENR3535, which is included in the Service Manual SENR7958 for programming instructions and diagnostic fault codes.



- Speed Pickup Malfunction – If the ECM loses its magnetic pickup signal, the engine will be shutdown by means of the air and fuel control and a diagnostic code will be displayed. Refer to the Service Manual Module SENR3535, which is included in the Service Manual SENR7958 for diagnostic fault codes.



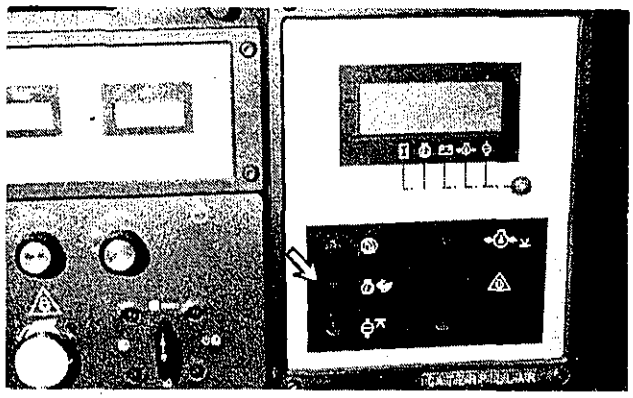
- Overcrank Protection – If the engine fails to start in a preprogrammed amount of time, the ECM will halt the starting sequence and flash the Overcrank LED. Another attempt to start the engine cannot be made without first going to the off/reset position on the ECS.



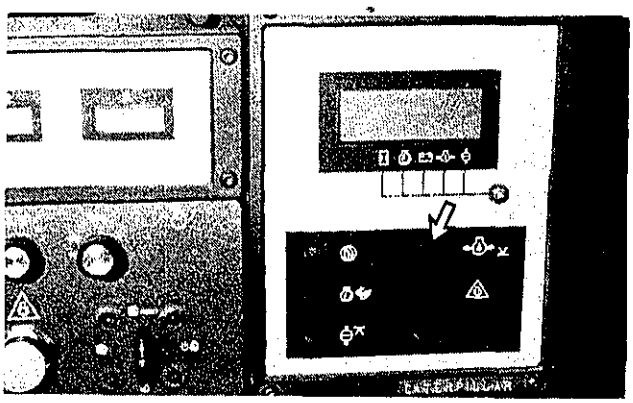
- Digital Liquid Crystal Display – Service hours, engine speed, system battery voltage, engine oil pressure, and engine coolant temperature are sequentially displayed in either English or Metric units. Pressing the Display/Hold switch on the front of the ECM will cause the display to lock (stop) on one of the engine parameters. Pressing the switch again will resume the display to normal sequencing.

The display is also used to indicate diagnostic codes, and programming, as well as an aid in troubleshooting. Refer to the topics "Troubleshooting" and "Using Diagnostic Code Interpretation" in Service Manual Module SENR3535, which is included in the Service Manual SENR7958 for this information.

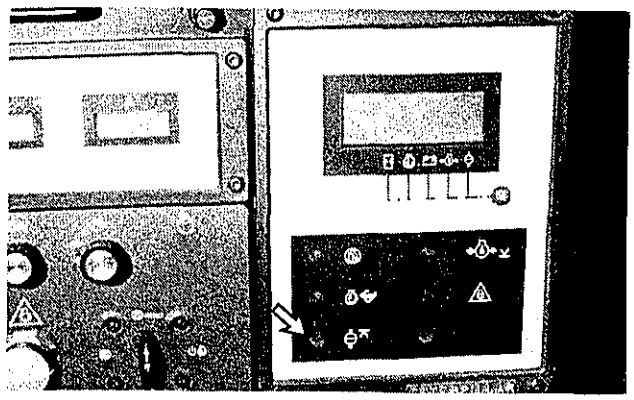
- Lamp Test – When the ECM detects a lamp test, it will turn "on" all the LCD segments and LED's. If the lamp test signal lasts for more than ten seconds, the ECM will go out of its lamp test mode and return to normal operation.



- Overspeed Protection – If the engine speed exceeds the overspeed setpoint, the engine will be shutdown by means of the air and fuel control and the Overspeed LED will flash. The overspeed setpoint is lowered to 75% of its original value while the *overspeed verify switch is depressed. This allows the* overspeed circuit to be tested while a generator set is operating at rated speed. This switch is located on the back of the ECM panel. For more information refer to Service Manual Module SENR3535, which is included in the Service Manual SENR7958.



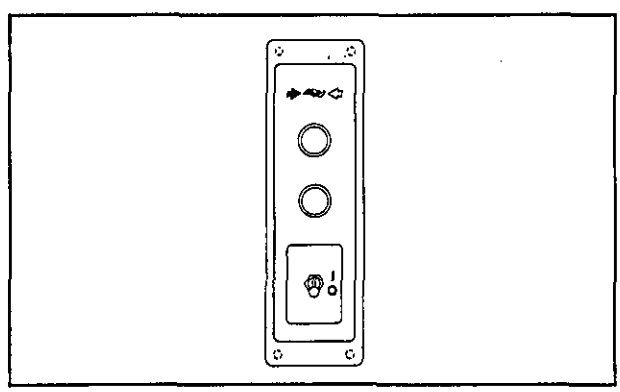
- Low Oil Pressure Protection – If the engine oil pressure drops below the low oil pressure setpoint, the engine will be shutdown by means of the fuel control and the Low Oil Pressure LED will flash. There are two low oil pressure setpoints, one for when engine speed is below the oil step speed and another for when the engine speed is above the oil step speed (rated speed).



- High Coolant Temperature Protection – If the engine coolant temperature exceeds the high coolant temperature setpoint, the engine will shutdown by means of the fuel control and the High Coolant Temperature LED will flash.

For more detailed information, programming instructions, diagnostic fault codes, and troubleshooting, refer to Service Manual Module SENR3535, which is included in the Service Manual SENR7958.

Synchronizing Lights Module (SLM) (If Equipped)



The optional synchronizing lights module (SLM) is *mounted on the left side of the control panel.* This module is not used when the control panel is equipped with either the 2301 governor, 2301A governor or 2301 governor with pre-regulator.

Synchronizing lights (SL) are used as an aid in paralleling units at no load and under load. Each of two lights are connected across the generator to the load side of the generator circuit breaker. Together, they indicate when the voltages are in phase so the circuit breaker can be closed to place the generator on line with the load.

Refer to the topic "Parallel Operation" in this publication for a complete explanation on how to parallel two generators. Refer to the Service Manual Module SENR3535, which is included in the Service Manual SENR7958 for all wiring and installation information.

Synchronizing Lights Module With Reverse Power Relay (If Equipped)

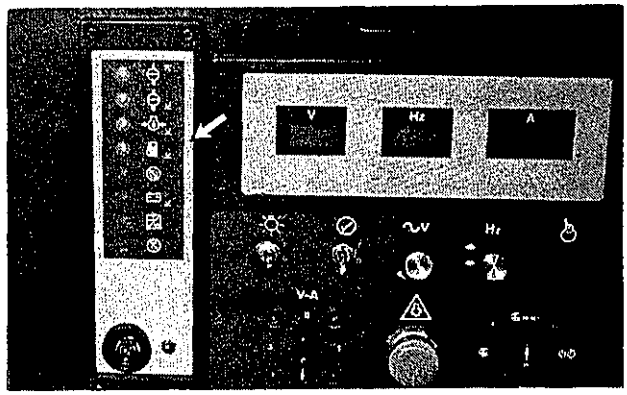
The synchronizing lights module (SLM) with reverse power relay (RPR) is the same as the synchronizing lights module with the following exceptions:

- The reverse power relay is mounted on the control panel interior.
- There is a reverse power fault LED mounted on the front of the control module.

The reverse power relay is a single phase protective relay which is energized by power (amps-volts) in only one direction (power into generator instead of out). In a reverse power fault, the relay closes its contacts causing the engine to shutdown , taking the generator off line. The reverse power relay is equipped with a test switch and adjustments.

For additional information, refer to Service Manual Module SENR3535, which is included in the Service Manual SENR7958.

Alarm Module (ALM) (If Equipped)



The alarm module (ALM) (optional) is located on the left side of the control panel. The function of the alarm module is to provide a visual and audible warning of engine conditions before they become severe enough to shut the engine down or keep it from starting.

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.

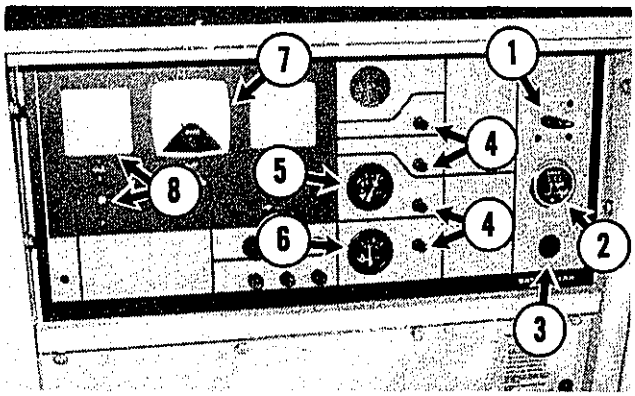
Refer to the Service Manual Module SENR3535, which is included in the Service Manual SENR7958 for all wiring and installation information as well as a listing of LED and Alarm (Horn) functions to meet NFPA requirements for your application.

The front of the alarm module consists of:

- Four (4) amber LED's which can (depending on module configuration) indicate High Coolant Temperature, Low Coolant Temperature or Low Coolant Level, Low Oil Pressure, Generator On Load, Charger Malfunction, Low Oil Level and Low Fuel Level.
- Four red LED's which can indicate a Not In Auto condition, Low DC voltage, Air Damper Closed, Low Oil Pressure Shutdown, Overcrank Shutdown, High Coolant Temperature Shutdown, and Overspeed Shutdown.
- An audible alarm and Acknowledge/Silence switch. For more detailed information refer to the Service Manual Module SENR3535, which is included in the Service Manual SENR7958.

Generator Set Control Panel 9Y-1300 (If Equipped)

Control Panel



(1) ECS; engine control switch.
(2) Service hour meter.
(3) ESPB; emergency stop push button (optional).
(4) Shutdown indicator lamps for Coolant Temperature, Oil Pressure, Overcrank and Overspeed.
(5) Coolant temperature gauge.
(6) OPG; Oil pressure gauge.
(7) Single phase voltmeter
(8) Three phase ammeter and voltmeter with phase selector switch (optional).

This control panel is a minimum control feature panel designed to be used with standby generator sets. It is mounted in the generator terminal box.

The basic panel is equipped with a standard single phase voltmeter (7), service hour meter (2), engine control switch (1), oil pressure gauge (6) and coolant temperature gauge (5), as well as four LED indicators (4) for oil pressure, coolant temperature, overspeed and overcrank conditions.

Optional features available are emergency stop push button (3), 3 phase selector switch (8) (with voltmeter and ammeter), and a voltage level control.

- Engine control switch (ECS) (1), determines the status of the control panel. In the Automatic position (3 o'clock), the engine will start automatically whenever the remote initiating contact is closed. The engine will shutdown after the initiating contact opens.

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

In the Stop position (9 o'clock), the fuel solenoid shuts the engine down.

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

- Service hour meter (2) indicates the total operating hours of the engine.

- Emergency stop push button (ESPB) (3) is used to shut down the engine during an emergency situation by shutting off the fuel.

- The shutdown indicator lamps (4) indicate engine fault conditions which will light when the engine is shut down by Coolant Temperature, Oil Pressure, Overcrank, and Overspeed safety switches.

- Coolant temperature gauge (5) and oil pressure gauge (6) provide a coolant temperature and oil pressure reading for the operator.

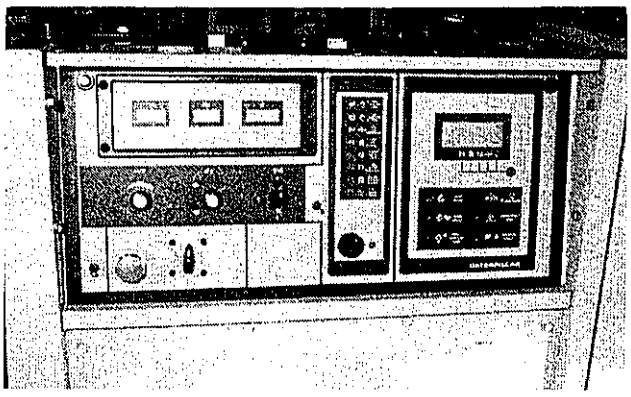
- Voltmeter (7) provides the operator with a generator voltage output reading across two phases.

- The Ammeter and voltmeter with phase selector switch (optional - not shown) (8) provide the operator the means of monitoring three phase generator output for all phase to phase voltages and phase currents.

For more detailed information refer to the Service Manual Module SENR3906, which is included in the Service Manual SENR7958.

Generator Set Control Panel 9Y-1400 (If Equipped)

Control Panel

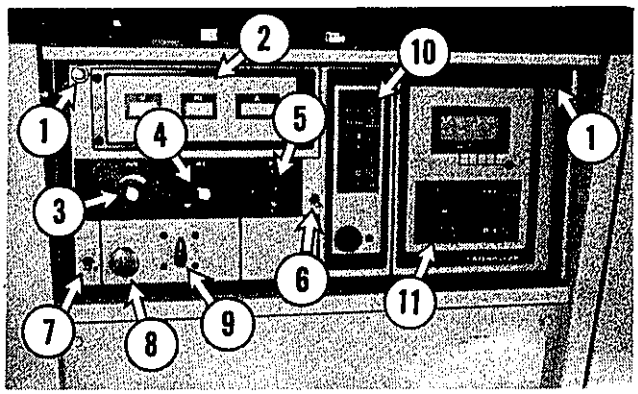


The control panel is mounted in the generator terminal box. The control panel consists of a main panel with digital gauges, digital AC metering module, and switches, alarm panel module, and ECM engine control module.

Optional alarm modules to meet (National Fire Protection Association) NFPA 99 and NFPA 110 requirements are available. Panel illuminating lights and switch, and governor control motor switch are also available as customer options.

Main Control Panel

The main control panel may or may not contain all of the components shown. Some optional components may not be required for your application.



(1) PL; panel lights.
(2) ACM; AC meter module.
(3) VAR; voltage adjust rheostat.
(4) SP; speed potentiometer or GS; governor switch (optional) (SP shown).
(5) AVS; ammeter - voltmeter phase selector switch.
(6) LTS; lamp display/test switch.
(7) PLS; panel lights switch.
(8) ESPB; emergency stop push button.
(9) ECS; engine control switch.
(10) ALM; alarm module.
(11) ECM; engine control module.

- Panel lights (1) are controlled by panel lights switch (PLS) (7).

- AC meter module ACM (2), contains digital liquid crystal displays for AC volts -(V), frequency - (Hz), and AC amps - (A). These displays indicate the status of the generator output.

- Ammeter-voltmeter phase switch (AVS) (5) is used to select phase currents and phase voltages of the generator output to be displayed by the amps and volts display.

- Voltage adjust rheostat (VAR) (3), is used to adjust the generator output voltage to the desired level.

- Optional governor switch (GS) or speed potentiometer (SP) (4) is used to raise or lower the engine speed when the governor is equipped with a speed adjust motor. If the engine is equipped with a 2301 or other electric governor, a speed potentiometer (SP) is mounted in this location.

- Lamp/display test switch (LTS) (6) is used to test all LED's and displays in the test position. All LED's will light and all liquid crystal display digits will read 8888888. If equipped with the optional alarm module (ALM), the lamps will light, and the alarm horn will sound for a maximum of ten seconds.

- Emergency stop push button (ESPB) (8) is used to shut down the engine during an emergency situation by shutting off the fuel.

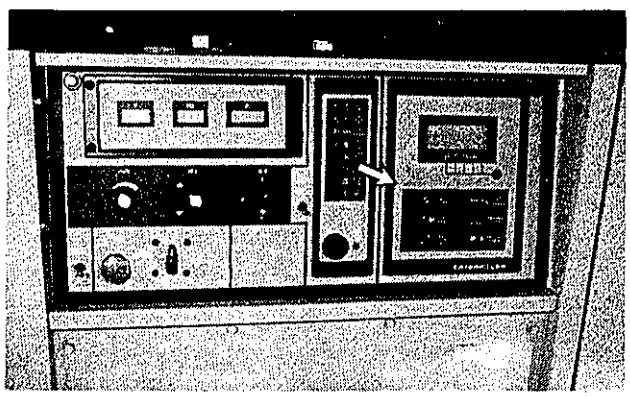
- Engine control switch (ECS) (9), determines the status of the control panel. In the Automatic position (3 o'clock), the engine will start automatically whenever the remote initiating contact is closed. The engine will cooldown and shutdown after the initiating contact opens. An adjustable cooldown time is programmed to give a 0 to 30 minute cooldown period before the engine shuts down.

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

In the Stop position (9 o'clock), the fuel solenoid shuts the engine down after cooldown.

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

Engine Control Module (ECM)



The right side of the control panel contains the engine control module (ECM). This is the "brain" of the system, and also displays fault conditions and key engine parameters. Pressing the display hold switch allows the operator to hold the display of any particular engine parameter required. To resume scanning, the display hold switch is pressed again.

The ECM accepts information from the operator, magnetic pickup, oil pressure and water temperature transducer, and optional remote sources. This information is used to determine the "on/off" state of the engine's air, fuel, and starter.

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

The ECM Features and Functions:

- Cycle Crank – The ECM can be programmed to crank-rest crank etc. for adjustable time periods. Refer to the Service Manual Module SENR3903, which is included in the Service Manual SENR7958 for programming instructions.

- 2301 or 2301A Control – When the engine oil pressure increases past the low oil pressure set point, the ECM will indicate to the governor that it should increase engine speed from IDLE to RATED rpm.

- Cool Down – Upon receiving a signal to perform a normal shutdown, the ECM will wait a preprogrammed amount of time before shutting the engine down by means of the fuel control.

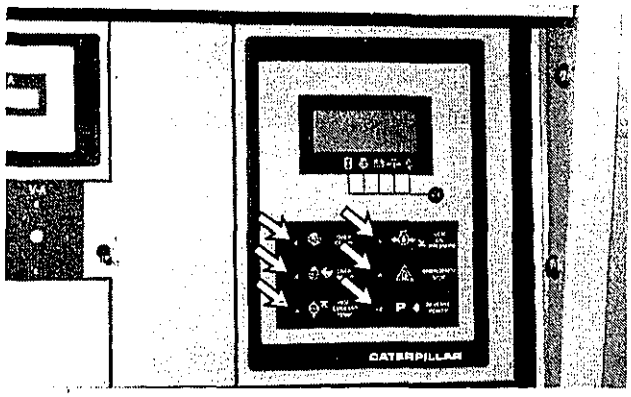
- Automatic Operation – While in the automatic mode, the ECM can be started by a remote initiate signal (contact closure). Upon loss of the signal (contact opening), the ECM will perform a normal shutdown.

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

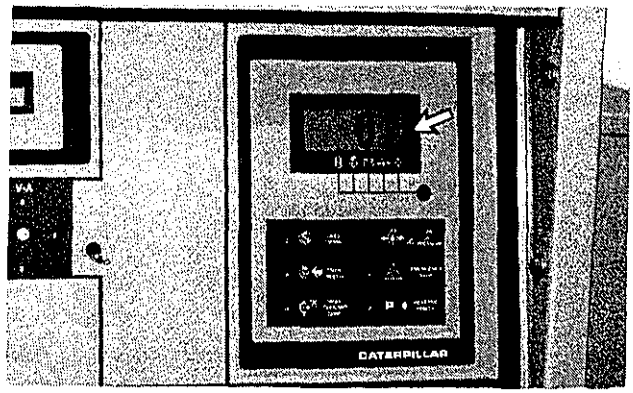
- Power Down – The Electronic Modular Control Panel (EMCP) system is designed to remove power from the ECM when in the off/reset mode, if the proper jumper is removed. The ECM will not allow the power down until the crank termination relay and the fuel control relay are both "off" for about 70 seconds. If the jumper has not been removed, it will remain powered up.

Refer to the Service Manual Module SENR3903 for the wiring schematic and the jumper wire location.

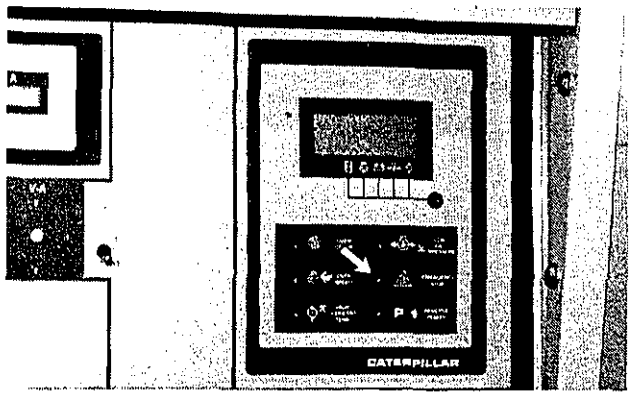
- Fuel Solenoid Type – The ECM can be programmed to work with either an energized to run (ETR) fuel system or an energized to shutdown (ETS) fuel system.



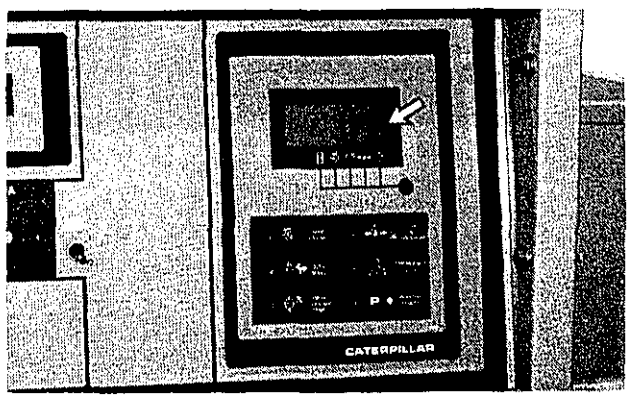
- LED Display – Six LEDs (light emitting diodes) are located on the front of the ECM to annunciate overcrank shutdown, overspeed shutdown, low oil pressure shutdown, high coolant temperature shutdown, emergency stop, and reverse power shutdown. The reverse power LED can be used as a *spare fault indication when the reverse power relay* option is not used.



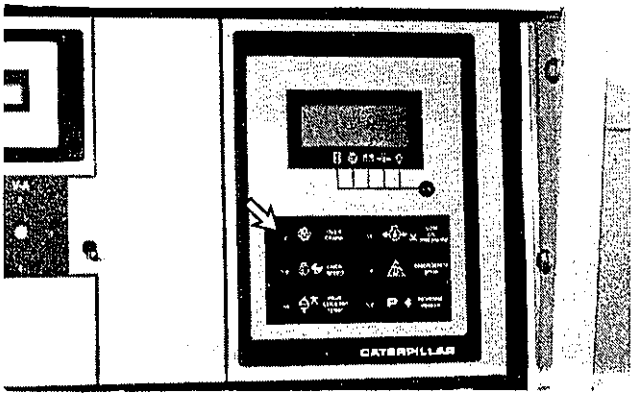
- Transducer Module Malfunction – If the signal from the engine mounted oil pressure/temperature transducer module is lost or unreadable, the engine will be shutdown by means of the fuel control and a diagnostic code will be displayed. The ECM can be programmed to ignore the transducer module *malfunction. Refer to the Service Manual Module* SENR3903, which is included in the Service Manual SENR7958 for programming instructions and diagnostic fault codes.



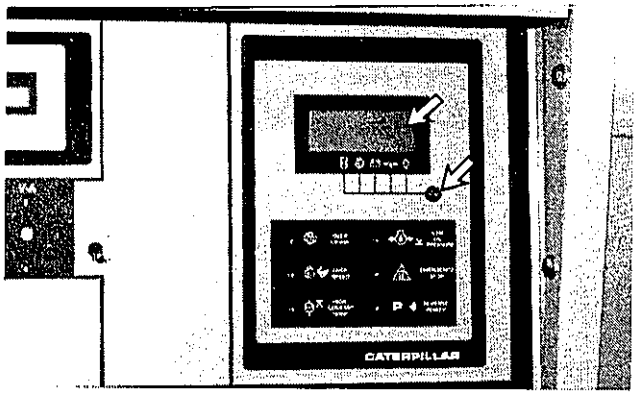
- Emergency Stop – If the ECM detects an emergency *stop, the engine will shut down by means of the fuel* control and the Emergency Stop LED will flash.



- Speed Pickup Malfunction – If the ECM loses its magnetic pickup signal, the engine will be shutdown by means of the fuel control and a diagnostic code will be displayed. Refer to the Service Manual Module SENR3903 which is included in the Service Manual SENR7958 for diagnostic fault codes.



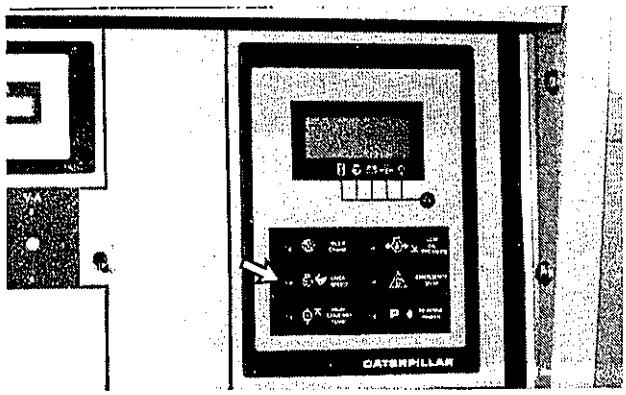
- Overcrank Protection – If the engine fails to start in a preprogrammed amount of time, the ECM will halt the starting sequence and flash the Overcrank LED. Another attempt to start the engine cannot be made without first going to the off/reset position on the engine control switch (ECS).



- Digital Liquid Crystal Display – Service hours, engine speed, system battery voltage, engine oil pressure, and engine coolant temperature are sequentially displayed in either English or metric units. Pressing the Display/Hold switch on the front of the ECM will cause the display to lock (stop) on one of the engine parameters. Pressing the switch again will resume the display to normal sequencing.

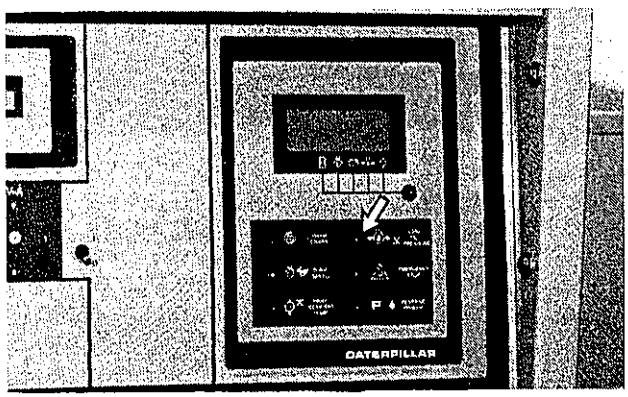
The display is also used to indicate diagnostic codes, and to aid in troubleshooting. Refer to the topics "Troubleshooting" and "Using Diagnostic Code Interpretation" in Service Manual Module SENR3903, which is included in the Service Manual SENR7958 for this information.

- Lamp Test – When the ECM detects a lamp test, it will turn "on" all the LCD segments and LED's. If the lamp test signal lasts for more than ten seconds, the ECM will go out of its lamp test mode and return to normal operation.

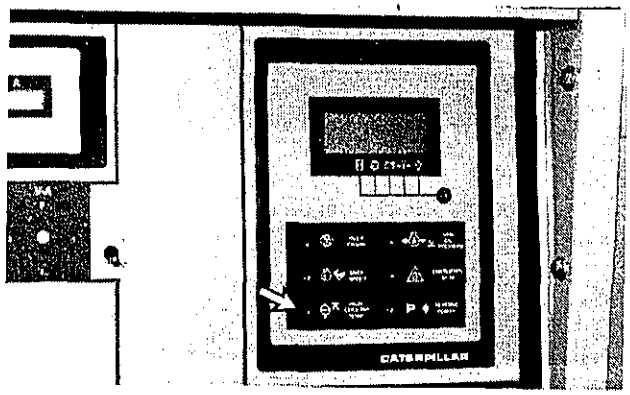


- Overspeed Protection – If the engine speed exceeds the overspeed setpoint, the engine will be shutdown by means of the fuel control and the overspeed LED will flash. The overspeed setpoint is lowered to 75% of its original value while the overspeed verify switch is depressed. This allows the overspeed circuit to be tested while a generator set is operating at rated speed. This switch is located on the back of the ECM panel.

For more information, refer to Service Manual Module SENR3903, which is included in the Service Manual SENR7958.



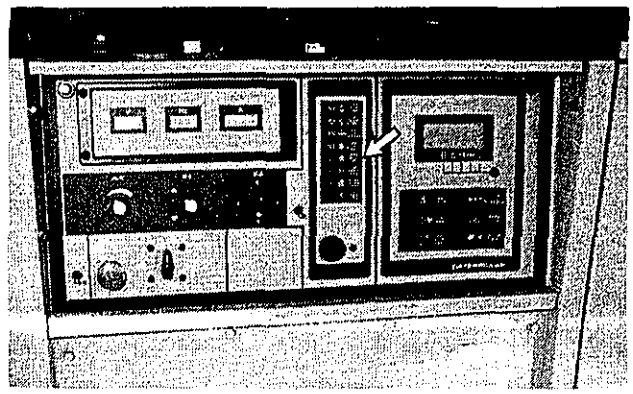
- Low Oil Pressure Protection – If the engine oil pressure drops below the low oil pressure setpoint, the engine will be shutdown by means of the fuel control and the Low Oil Pressure LED will flash. There are two low oil pressure setpoints, one for when engine speed is below the oil step speed and another for when the engine speed is above the oil step speed (rated speed).



- High Coolant Temperature Protection – If the engine coolant temperature exceeds the high coolant temperature setpoint, the engine will shutdown by means of the fuel control and the High Coolant Temperature LED will flash.

For more detailed information, programming instructions, diagnostic fault codes, and troubleshooting, refer to Service Manual Module SENR3903, which is included in the Service Manual SENR7958.

Alarm Module (If Equipped)



The alarm module (ALM) (optional) is located in the center of the control panel. The function of the alarm module is to provide a visual and audible warning of engine conditions before they become severe enough to shut the engine down or keep it from starting.

One basic alarm module is used to satisfy the requirements of standby NFPA 99 alarm module, standby NFPA 110 alarm module, and NFPA 99 remote annunciator panel. Refer to the Service Manual Module SENR3903, which is included in the Service Manual SENR7958 for all wiring and installation information as well as a listing of LED and Horn functions to meet NFPA requirements for your application.

The front of the alarm module consists of:

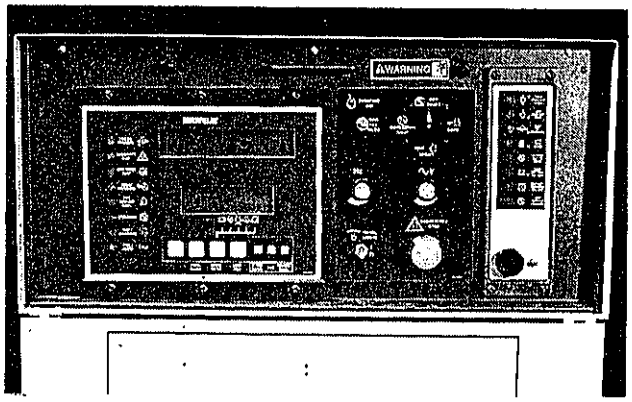
- Four amber LED's which (can depending on module configuration) indicate High Coolant Temperature, Low Coolant Temperature or Low Coolant Level, Low Oil Pressure, Generator On Load, Charger Malfunction, Low Oil Level and Low Fuel Level.

- Four red LED's which (can depending upon configuration) indicate a "Not In Auto condition", Low DC voltage, Air Damper Closed, Low Oil Pressure Shutdown, Overcrank Shutdown, High Coolant Temperature Shutdown, and Overspeed Shutdown.

- An audible alarm and Acknowledge/Silence switch. For more detailed information refer to the Service Manual Module SENR3903, which is included in the Service Manual SENR7958.

Generator Set Control Panel (103-1582 & 107-6307 If Equipped)

Control Panel, EMCP II

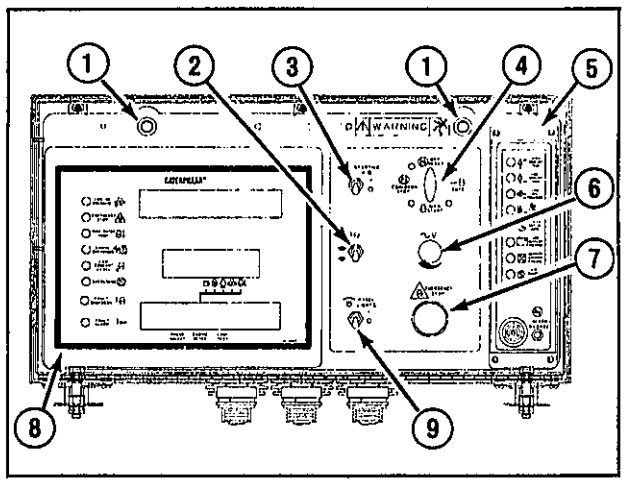


The generator set Electronic Modular Control Panel II (EMCP II) is located on top of the generator regulator housing. The control panel consists of a main panel with indicators, meters and control switches. This control panel may be equipped with optional modules to match the customers needs and requirements. The right side may be blank, or contain one of the alarm modules, or 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 and also displays generator output, fault conditions and key engine parameters.

Main Control Panel

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



(1) PL; panel lights (optional).
(2) GS; governor switch or SP; speed potentiometer (optional) (GS shown).
(3) SAS; starting aid switch (optional).
(4) ECS; engine control switch.
(5) ALM; alarm module or SLM; synchronizing lights module (optional) (ALM shown).
(6) VAR; voltage adjust rheostat.
(7) ESPB; emergency stop push button.
(8) GSC; generator set control.
(9) PLS; panel light switch (optional).

- Panel lights (PL) (1) are controlled by panel lights switch (PLS) (9).
- Voltage adjust rheostat (VAR) (6), is used to adjust the generator output voltage to the desired level.
- Optional governor switch (GS) or speed potentiometer (SP) (2) is used to raise or lower the engine speed when the governor is equipped with a speed adjust motor. If the engine is equipped with an electric governor, a speed potentiometer is mounted in this location.
- Starting aid switch (SAS) (3) is used to inject ether into the engine for starting in cold weather conditions. This switch (when moved to the ON position) energizes and meters a specific amount of ether in a holding chamber. When the switch is released, the solenoid releases the ether to the engine.

- Emergency stop push button (ESPB) (7) is used to shut down the engine during an emergency situation by shutting off the fuel and activating the optional air shutoff (if equipped).

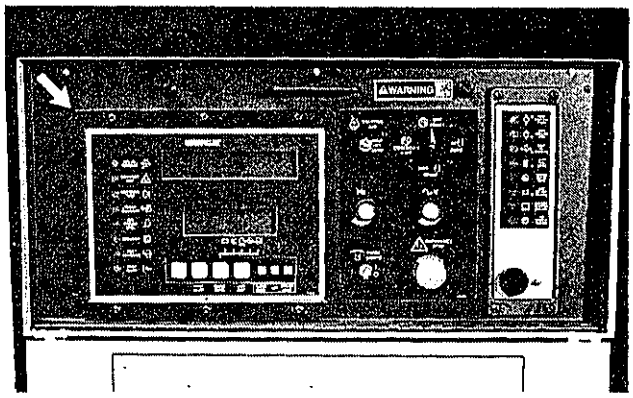
- Engine control switch (ECS) (4), determines the status of the control panel. In the Automatic position (3 o'clock), the engine will start automatically whenever the remote initiating contact is closed. The engine will shutdown after the initiating contact opens and adjustable cooldown time elapsed. The cooldown time can be programmed to give a 0 to 30 minute cooldown period before the engine shuts down.

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

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

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, and also displays generator output, generator set functions, fault conditions and key engine parameters.

The GSC accepts information from the operator, magnetic pickup, oil pressure and 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.

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

GSC Features and Functions:

- Controls normal starting and stopping of the engine.

- Shows engine conditions and generator output information on two displays. The displays also show fault codes and GSC programming information.

- Monitors the system for faults. If a fault occurs, the GSC performs a controlled fault shutdown or provides a fault alarm annunciation. The GSC uses indicators and displays to describe the fault.

- Contains programmable features for certain applications or customer requirements.

- Cycle Crank – The GSC can be programmed to crank-rest crank etc. for adjustable time periods. Refer to the Service Manual Module SENR5809 for programming instructions.

- 2301 or 2301A Control – When the engine oil pressure increases past the low oil pressure set point, the GSC will indicate to the governor that it should increase engine speed from IDLE to RATED rpm.

- Cool Down – Upon receiving a signal to perform a normal shutdown, the GSC will wait a preprogrammed amount of time before shutting the engine down by means of the fuel control.

- Automatic Operation – While in the automatic mode, the GSC can be started by a remote initiate signal (contact closure). Upon loss of the signal (contact opening), the GSC will perform a normal shutdown.

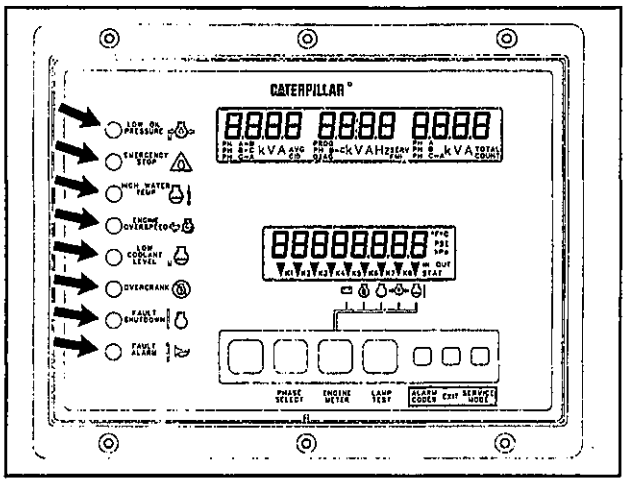
- Alarm Module Communication – The GSC can transmit fault and alarm conditions to an alarm module.

- Power Down – The Electronic Modular Control Panel II (EMCP II) system is designed to remove power from the GSC when in the off/reset mode and the proper jumper wire is removed. The GSC will not allow the power down until the crank termination relay and the fuel control relay are both "off" for about 70 seconds. If the wire is not removed, the GSC will remain powered up.

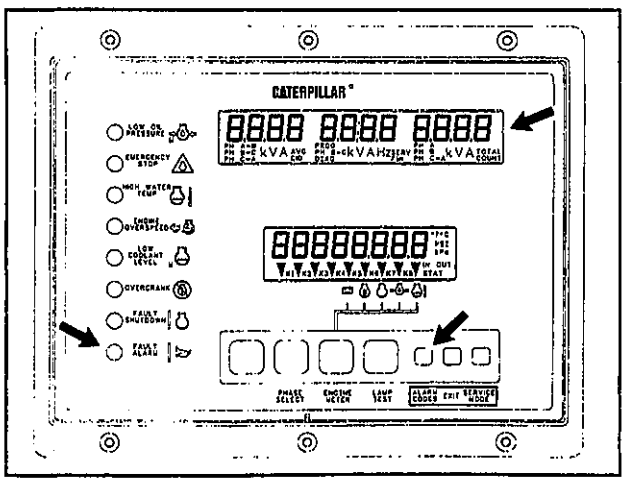
Refer to the Service Manual Module SENR5809 for the wiring diagram and jumper wire location.

- Fuel Solenoid Type – The GSC can be programmed to work with either an energized to run (ETR) fuel system or an energized to shutdown (ETS) fuel system.

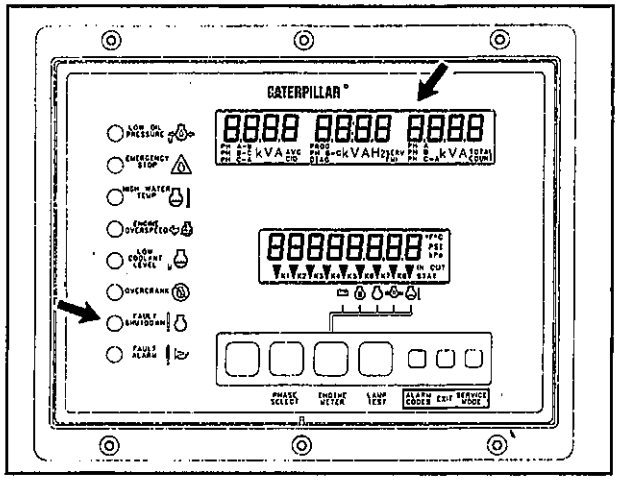
Fault Indicators



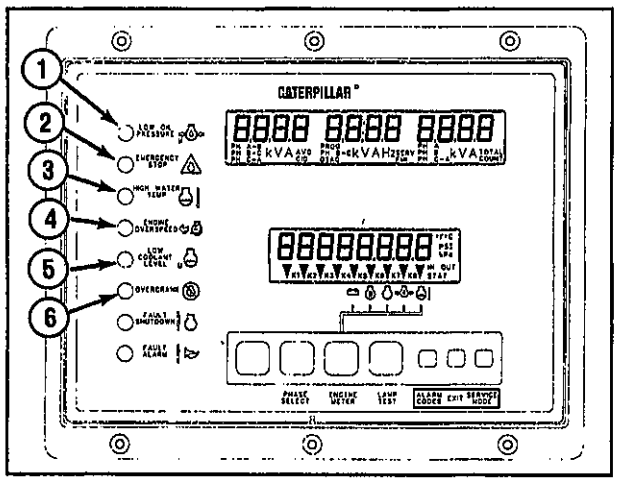
The eight fault indicators, located on the front of the GSC, are used to show and describe a fault that is present.



- The yellow fault alarm indicator FLASHES when the GSC detects a fault that is an alarm condition. The engine continues to run and start. The fault alarm indicator is accompanied by an alarm fault code that is shown on upper display when alarm codes key is pressed. Refer to SENR5809 for fault code descriptions.



- The red fault shutdown indicator FLASHES when the GSC detects a fault that is a shutdown condition. The engine is shutdown if it is running and is not allowed to start. The fault shutdown indicator is accompanied by a diagnostic fault code that is immediately shown on upper display. Refer to SENR5809 for fault code descriptions.



- The six red dedicated shutdown indicators represent the following shutdown conditions: 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 conditions, the dedicated shutdown indicator (that corresponds to the fault) FLASHES. The engine is shutdown if it is running and is not allowed to start. There are no fault codes associated with the dedicated shutdown indicators because each indicator has an interpretive label. The conditions required for each dedicated fault and the results of each dedicated fault are as follows:

Low Oil Pressure (1) – 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 for when the engine is operating at idle speed and the other for when the engine is at rated speed. The low oil pressure indicator FLASHES, the engine is shutdown and is not allowed to start.

Emergency Stop (2) – The operator presses the emergency stop push button (ESPB) on the instrument panel. The emergency stop indicator FLASHES, the engine is shutdown and is not allowed to start.

High Water Temperature (3) – The engine coolant temperature rises above the setpoint for high water temperature shutdown that is programmed into the GSC. The high water temperature indicator FLASHES, the engine is shutdown and is not allowed to start.

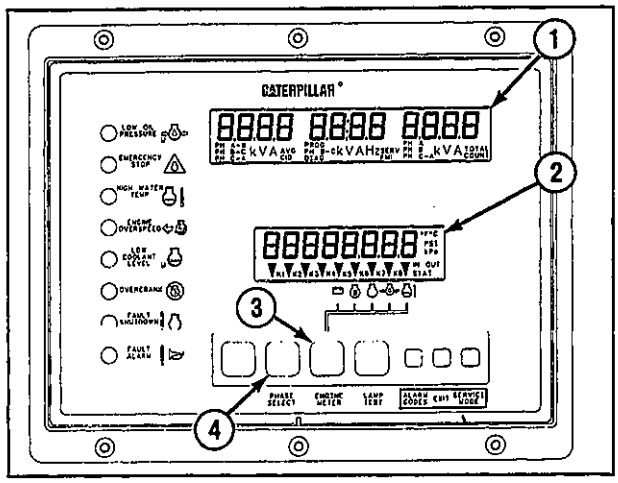
Engine Overspeed (4) – The engine speed exceeds the setpoint for engine overspeed that is programmed into the GSC. The engine overspeed indicator FLASHES, the engine is shutdown and is not allowed to start.

Low Coolant Level (5) – The engine coolant level drops below the probe of the coolant loss sensor (optional). The engine coolant level indicator FLASHES, the engine is shutdown and is not allowed to start.

Overcrank (6) – 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, high water temperature, and the low coolant level faults. When overridden, these faults are treated as alarm conditions. The corresponding dedicated shutdown indicator is ON CONTINUOUSLY (instead of flashing) and the engine continues to run and start (instead of shutting down). The dedicated shutdown indicator that is ON CONTINUOUSLY means that the setpoint for shutdown has been exceeded, but the GSC is programmed to override the shutdown condition and treat the fault as an alarm condition. As provided from the factory, the GSC treats low oil pressure, high water temperature and low coolant level as shutdowns. Refer to the Service Manual Module SENR5809 for programming procedures.

Display



Upper display (1) and lower display (2) of the GSC provide information about the generator set.

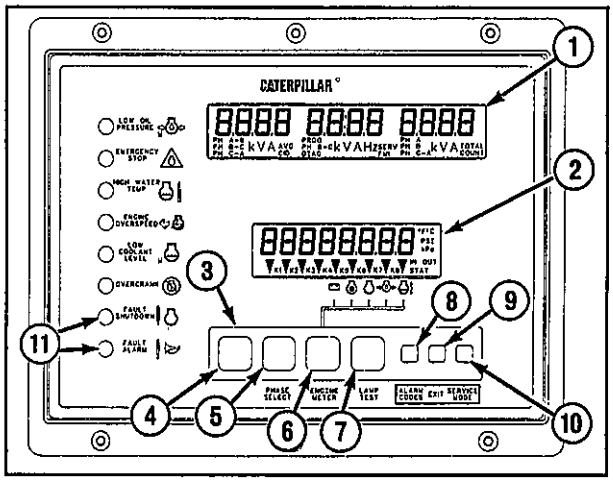
- Upper display (1) shows AC voltage, current, and frequency of one phase of the generator output. Each phase can be viewed one at a time by pushing phase select key (4). Upper display (1) is also used to show the various fault codes for system faults. For more information on fault codes, refer to the Service Manual Module SENR5809 for Fault Descriptions.

- Lower display (2) shows 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 and then 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 engine meter key (3) is pressed, lower display (2) stops scrolling and continuously shows one particular value. Now the pointer flashes above the condition whose value is showing. When engine meter key (3) is pressed a second time, display (3) will return to scrolling.

- The relay status indicator is on the lower display also. When a GSC relay is activated, the corresponding relay indicator (K1, K2, etc.) is shown on lower display (2). When a relay is not activated, the corresponding indicator (K1, K2, etc.) is not shown. Refer to the Service Manual Module SENR5809 for a description of the relay functions.

Both displays are used for programming functions when in the service mode. For more information, refer to the Service Manual Module SENR5809 for Service Modes.

Keypad



Keypad (3) is used to control the information that is shown on upper display (1) and lower display (2). The seven keys of keypad (3) have two sets of functions, normal functions and service functions. For a description of the service functions of the keys; refer to the Service Manual Module SENR5809 for Service Modes. The normal functions of the keys are:

Leftmost Key (4) – This key only functions when the GSC is in service mode. This key is used to scroll right.

Phase Select Key (5) – Selects which phase of the generator output is displayed 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 (6) – Stops the scrolling of engine conditions on lower display (2). Continuously shows the value for one particular engine condition. The pointer for the particular engine condition flashes to indicate scrolling is stopped. Pressing the key again, resumes the scrolling of engine conditions.

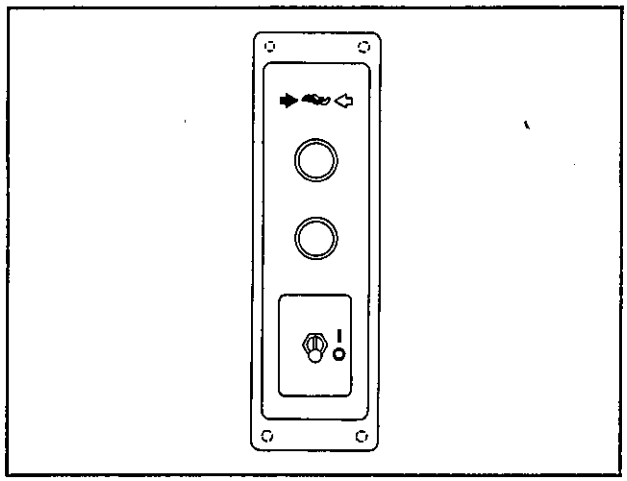
Lamp Test Key (7) – Performs a lamp test on the GSC and the optional alarm module for a maximum of ten seconds, if held pressed. On the GSC: the eight fault indicators are ON CONTINUOUSLY, every segment of upper display (1) and lower display (2) are ON. On the optional alarm module: all of the indicators are ON and the horn sounds.

Alarm Codes Key (8) – If fault alarm indicator (11) is FLASHING, pressing this key causes upper display (1) to show the corresponding alarm fault code. Pressing this key again, resumes the showing of generator output information on upper display (1). If fault alarm indicator (4) is OFF, this key has no function. For more information on alarm fault codes, refer to the Service Manual Module SENR5809 for Fault Descriptions.

Exit Key (9) – This key only functions when the GSC is in service mode. Refer to the Service Manual Module SENR5809 for Service Modes.

Service Mode Key (10) – Pressing this key causes the GSC to enter service mode. Refer to the Service Manual Module SENR5809 for Service Modes.

Synchronizing Lights Module (If Equipped)



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. Each of two lights are connected across the generator to the load side of the generator circuit breaker. Together, they indicate when the voltages are in phase so the circuit breaker can be closed to place the generator on line with the load.

Refer to the topic "Parallel Operation" in this publication for a complete explanation on how to parallel two generators. Refer to the Service Manual Module SENR5809, for all wiring and installation information.

Synchronizing Lights Module With Reverse Power Relay (If Equipped)

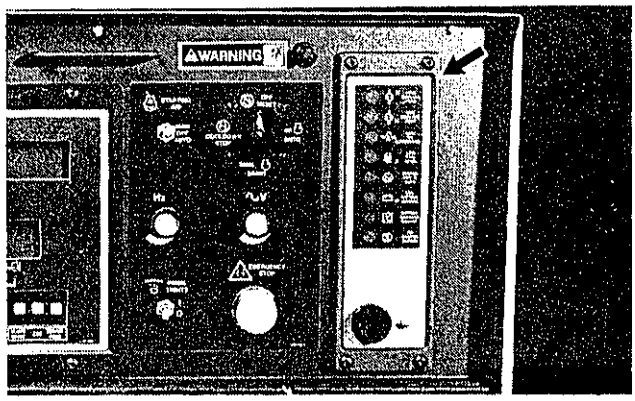
The synchronizing lights module with reverse power relay is the same as the synchronizing lights module with the following exceptions:

- 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 which is energized by power (amps-volts) in only one direction (power into generator instead of out). In a reverse power fault, the relay closes its contacts causing the engine to shutdown, taking the generator off line. The reverse power relay is equipped with a test switch and adjustments.

For additional information, refer to Service Manual Module SENR5809.

Alarm Module (If Equipped)



The alarm module (optional) is located on the right side of the control panel. The function of the alarm module is to provide a visual and audible warning of engine conditions before they become severe enough to shut the engine down or keep it from starting.

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. This is accomplished by using different inputs to the module, and different decals on the front of the module to indicate alarms or shutdown conditions.

Refer to the Service Manual Module SENR5809, for all wiring and installation information as well as a listing of Indicators and Alarm (Horn) functions to meet NFPA requirements for your application.

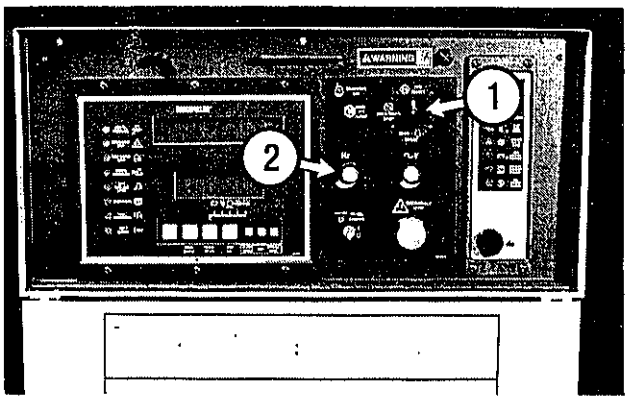
The front of the alarm module consists of:

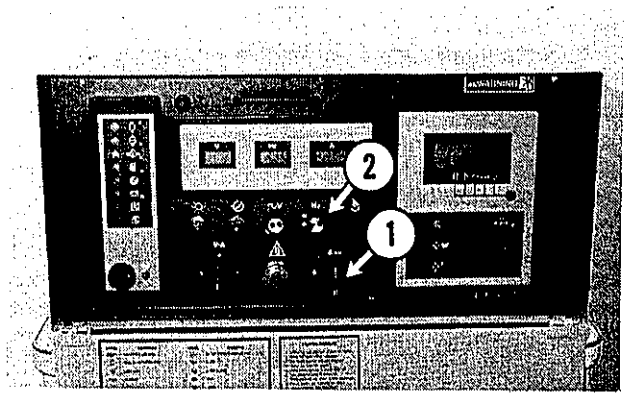
- Four amber LED's which can (depending on module configuration) indicate High Coolant Temperature, Low Coolant Temperature or Low Coolant Level, Low Oil Pressure, Generator On Load, Charger Malfunction, Low Oil Level and Low Fuel Level.
- Four red LED's which can indicate a Not In Auto condition, Low DC Voltage, Air Damper Closed, Low Oil Pressure Shutdown, Overcrank Shutdown, High Coolant Temperature Shutdown, and Overspeed Shutdown.
- An audible alarm and Acknowledge/Silence switch. For more detailed information refer to the Service Manual Module SENR5809.

Manual Operation of Control Panel

Starting the Engine

1. Perform all before-starting inspections. Refer to "Before Starting" in the Engine Operation and Maintenance Guide.





2. Turn Engine Control Switch (1) to the engine Start position.

NOTE: The switch should be held in the start position, if equipped with a Manual Start-Stop Module, until oil pressure is sufficient to deactivate (de-arm) the oil pressure failure circuit. Even though the switch is held in this position, crank termination will occur automatically when the speed switch senses crank termination speed.

3. When engine starts, the engine fault circuits are now functional (armed). Should a fault occur, the engine will be automatically shut down.

NOTE: To restart the engine after being shutdown by a fault, first correct the fault condition, then turn switch (1) to the Off-Reset position. Next start the engine as per step 2.

4. After the engine starts and its systems have stabilized, apply the load.

5. Regulate the frequency of the generator with the Governor Motor Control Switch (2) or Manual Governor Control Lever.

Stopping the Engine

1. Remove the load from the engine.

2. If it is desired to run the engine at high idle (rated speed) for cool down at no load, turn the Engine Control Switch (ECS) to the Stop position. this will allow the engine to run for the preset, or programmed cool down time before shutdown. If high idle cool down at no load is not desired proceed to Step 3.

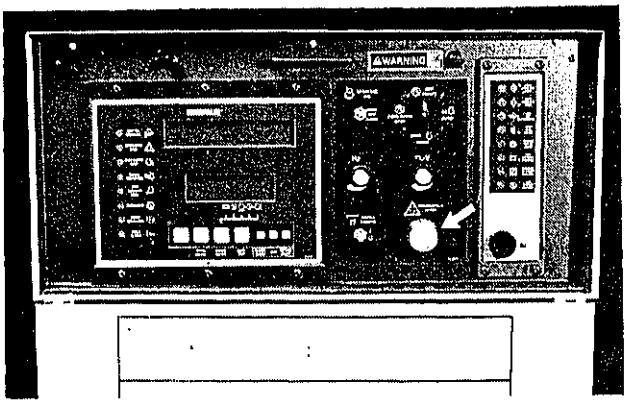
3. Reduce engine speed to Low idle (approximately 2/3 the full load speed of 60 Hz units or 4/5 full load speed of 50 Hz units). Push down on the Governor Control Switch until low idle is achieved (for electric governors), or move the Manual Governor Control lever to the low idle position (for mechanical governors).

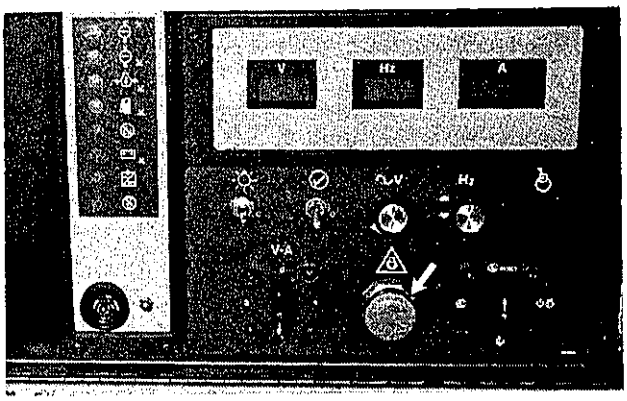
4. While the engine is at low idle, measure the engine oil level. Oil level must be maintained between the Add and Full marks on the Engine Running side of the dipstick.

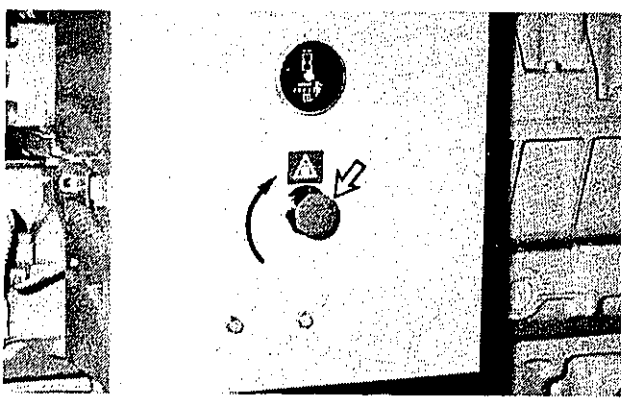
NOTE: For 3100 and 3200 Series engines, the oil level cannot be measured with the engine running.

5. Allow the engine to cool down while running at low idle (approximately five minutes). After engine cools, turn the Engine Control Switch to the Off-Reset position.

Emergency Stopping







NOTE: The Emergency Stop Button is red in color and is used to shutdown the engine only in an emergency situation.

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. To reset the switch, pull out and rotate the button in the direction shown.

NOTE: Before starting, check the emergency stop buttons located on the engine junction box (if equipped) and control panel. If the emergency stop button was used to shutdown the engine it will be necessary to reset the air shutoff (if equipped).

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

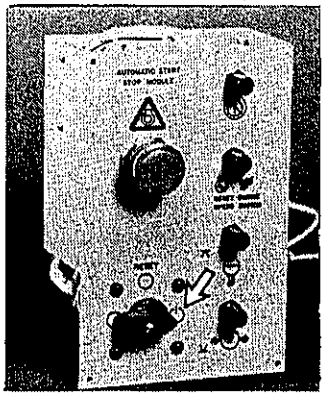
Automatic Operation of Control Panel

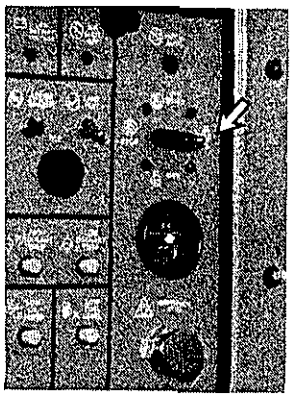
An Automatic Start-Stop system is used when an engine must start with no one in attendance. The generator set must start, pick up the load, operate the load and stop after the load is removed.

Starting the Engine

1. To start the engine when unattended, the engine room temperature must be at least 20°C (70°F) or the engine jacket water temperature must be 32°C (90°F).

NOTE: Jacket water heaters can maintain this temperature.





2. The Engine Control Switch must be in the Automatic Start position. In this position, the engine will automatically start when remote starting contacts are closed. When used together with an Automatic Transfer Switch, the engine can be signalled to start and the load automatically transferred when commercial power fails. When commercial power is restored the Automatic Transfer Switch will automatically transfer the load back to the commercial power, provide a cool down time and shutdown the engine.

In the Automatic Start position, the engine will automatically stop if the engine has a fault. The optional, or programmed Cool Down Timer will allow the engine to run unloaded at rated speed before shutting down.

Standby Sets

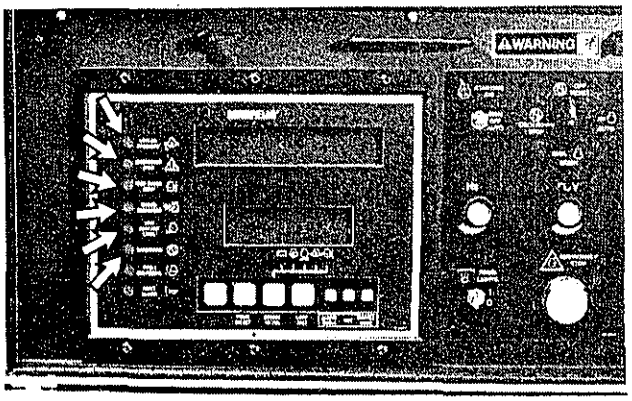
If the generator set is used for a standby application with a remote transfer switch, place the Engine Control Switch in the Automatic position and adjust speed for proper operation of the generator with load after starting.

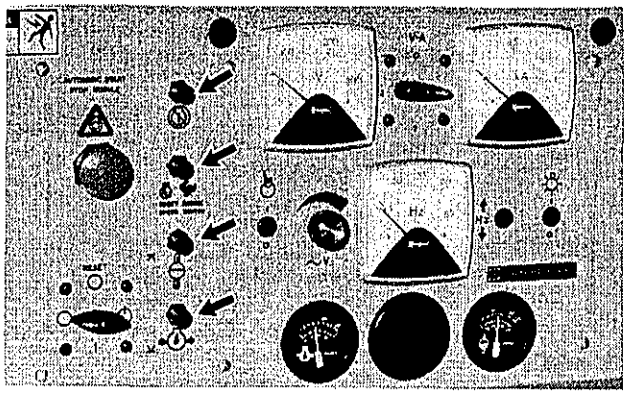
Stopping the Engine

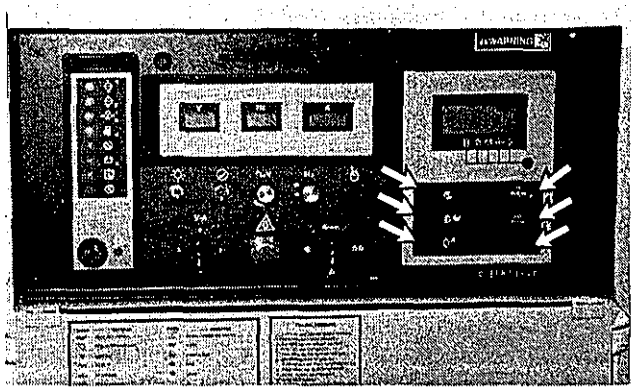
To stop the engine manually using the Automatic Start-Stop Control Panel, place the Engine Control Switch in the Stop position. If the Engine Control Switch is left in the Automatic position, the engine will stop automatically when the remote starting contacts open and the timed cool down cycle is complete (if equipped with cool down timer).

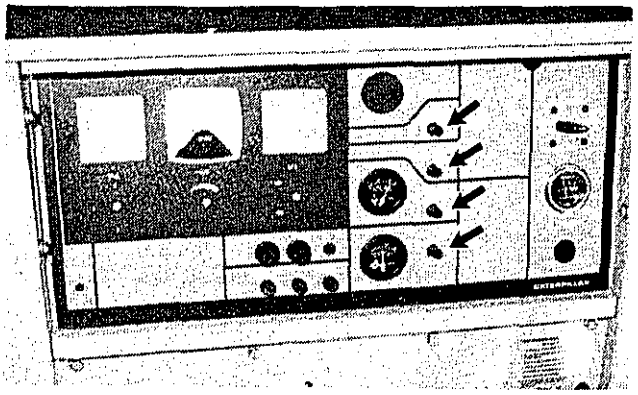
Engine Shutdown Caused By Faults

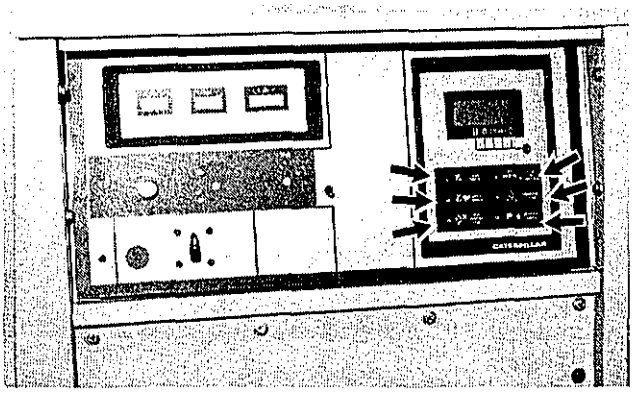
The Automatic Start-Stop Module may be equipped with engine protective devices. The shutdowns will protect the engine if a malfunction occurs that causes low oil pressure, high coolant temperature, engine overspeed, or an overcrank condition.











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

Restarting the Engine

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

1. Turn the Engine Control Switch to Stop position.

⚠ WARNING

Accidental starting of the engine can cause personal injury. To prevent accidental starting, disconnect the batteries before performing maintenance or repair work.

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 located on the generator set control panel and the engine junction box are reset.

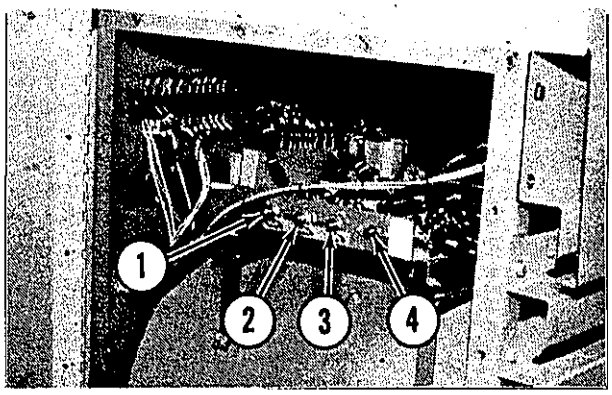
5. Make sure that the Air Shutoff Lever located at the top of the air inlet housing is reset (if equipped).

6. The system is ready to start if the Engine Control switch is turned to Manual or Automatic.

NOTE: For additional information refer to the SR4 Generator mounted Control Panel module, Form SENR4027. This module is contained in the Electric Set Generator Manual, Form SENR7958.

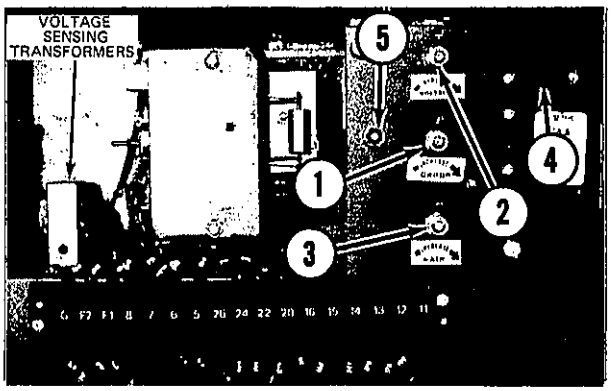
Voltage Regulators

All Caterpillar SR4 generators, except oil field generators, are provided with voltage regulators for control of the generator output voltage. The voltage regulator types are shown as follows:



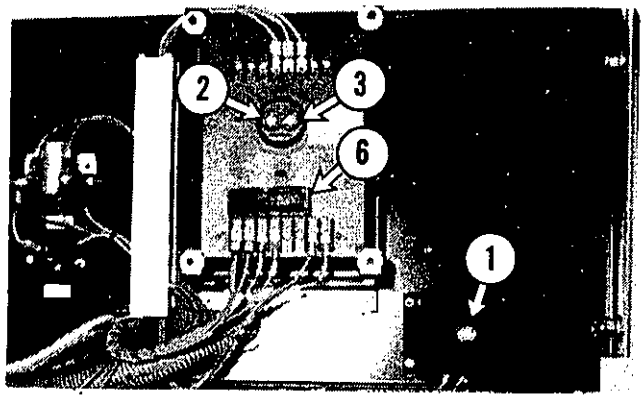
VR1 Epoxy Module (A1) - (A2) Type Regulator Voltage Adjustment Controls

(1) Voltage droop potentiometer.
(2) Voltage level potentiometer.
(3) Voltage gain potentiometer.
(4) Thermal protector.



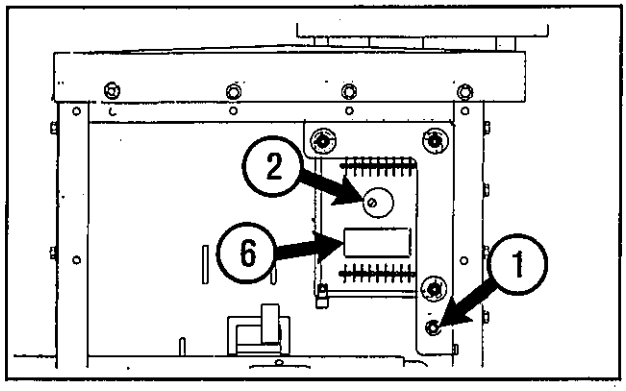
VR2 Card Cage Type Regulator Voltage Adjustment Controls

(1) Voltage droop potentiometer.
(2) Voltage level potentiometer.
(3) Voltage gain potentiometer.
(4) Thermal protector.
(5) Magnetic breaker.



VR3 Regulator Voltage Adjustment Controls

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

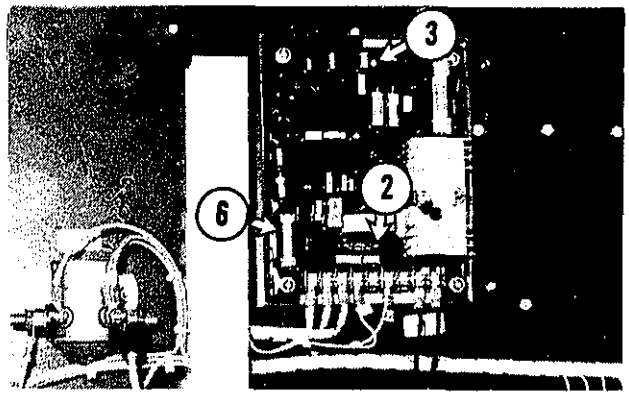


VR3F Regulator Voltage Adjustment Controls

(1) Voltage droop potentiometer.
(2) Voltage level potentiometer.
(6) Fuses.

NOTE: The VR3, VR3F and VR4 regulators have multi-turn potentiometers for voltage level and voltage gain control. The adjusting screw on the potentiometers do not have a fixed stop. When the potentiometer reaches the end of adjustment, a ratchet action begins; this 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.

NOTE: The VR4 regulator does not have voltage droop capability. The VR3F regulator does not have voltage gain capability.



VR4 Regulator Voltage Adjustment Controls

(2) Voltage level potentiometer.
(3) Voltage gain potentiometer.
(6) Fuse.

To Adjust The Voltage Regulator:

1. Remove the left side access panel of the generator.

2. VR1 and VR2 regulators - Loosen the locknuts on the voltage droop (1), voltage level (2) and voltage gain (3) potentiometers.

VR3 and VR3F regulators - Loosen the locknut on the voltage droop (1) potentiometer and remove the protective screw from the voltage level (2) potentiometer.

VR3 regulators only - Remove the protective screw from the voltage gain (3) potentiometer.

NOTE: The VR3F regulator does not have a voltage gain control.

3. Turn voltage droop potentiometer (1) counterclockwise to zero droop and tighten the locknut (VR1, VR2, VR3 and VR3F regulators only).

NOTE: Voltage droop potentiometer (1), for the VR3 and VR3F regulators, is located on a mounting bracket below the regulator, (some generators are not provided with voltage droop).

4. Turn voltage gain potentiometer (3) counterclockwise to zero, then turn voltage gain potentiometer (3) to about 1/4 of full range of clockwise travel (VR1, VR2, VR3, and VR4).

5. Perform required maintenance on engine before starting.

6. Start the engine and allow it to warm (refer to "Starting").

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

8. Observe the voltmeter reading. If desired voltage is not indicated, set no load voltage with voltage level potentiometer (2).

9. Close the load circuit breaker and apply full load gradually. Adjust governor control until nameplate rated frequency is on the Hertz (frequency) meter.

10. If voltmeter reading increases with full load applied, turn gain potentiometer (3) slightly in counterclockwise direction. **Or,** if voltmeter reading decreases with full load applied, turn gain potentiometer (3) slightly in clockwise direction (VR1, VR2, VR3, and VR4).

11. Remove load, adjust voltage level potentiometer (2) if necessary to obtain desired voltage.

12. Apply the load, *observe voltmeter reading.* Repeat steps 9 thru 11 until no load voltage equals full load voltage.

13. Tighten locknuts and install the protective screws on the respective potentiometers and install the access panel of the generator.

14. Thermal protector (4) equipped on VR1 and VR2 regulators will open if excessive field current should occur. Push to reset the circuit breaker. If breaker opens again, contact your Caterpillar dealer.

NOTE: A *magnetic breaker* is used on some self-excited VR2 regulators. It will open within ten seconds when an overload occurs.

VR3, VR3F and VR4 regulators are protected by a fuse(s) as well as solid state overcurrent protection. If a replaced fuse blows, contact your Caterpillar dealer.

Single Unit Operation

Initial Start-Up

Before initial start-up, megger test main stator winding. Refer to Special Instruction SEHS9124 for the procedure.

Starting

1. Make all preliminary engine starting checks.
2. Be sure the main or line circuit breaker is open.
3. Start the engine and allow it to warm up.
4. Adjust to full load rpm.
5. Close the main circuit breaker.
6. Apply the load. Do not try to apply full load in one move, rather apply the load in increments to maintain system frequency at a constant level.
7. Readjust 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 to cool.
4. Stop the engine.

Parallel Operation

Initial Start-up

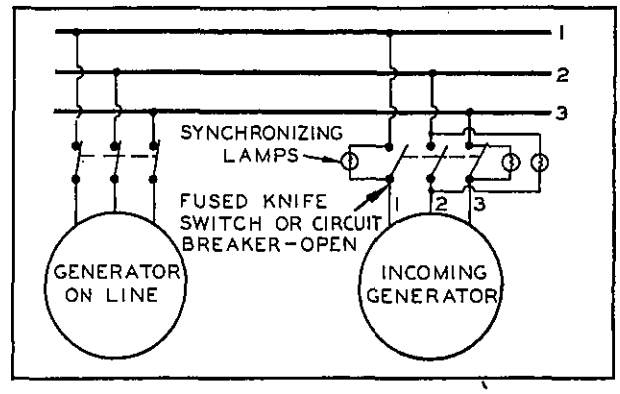
Preparing a generator for parallel operation requires special attention. Before attempting to parallel units for the first time, all units must be checked to be sure the following three conditions are met:

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

Phase Rotation

The phase rotation must be the same. A set of three light bulbs can be used to determine whether the *phase rotation of the incoming unit and the phase* rotation of the on line unit(s) are the same.

To Determine Proper Phase Rotation (Using Three Light Bulbs)



⚠ WARNING

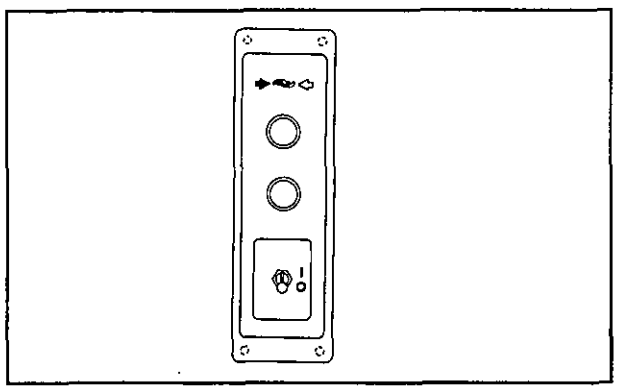
Never attempt to work on electrically hot wiring. Stop the electric set before rewiring generator leads. Open circuit breakers or remove fuses before working on the equipment which they control.

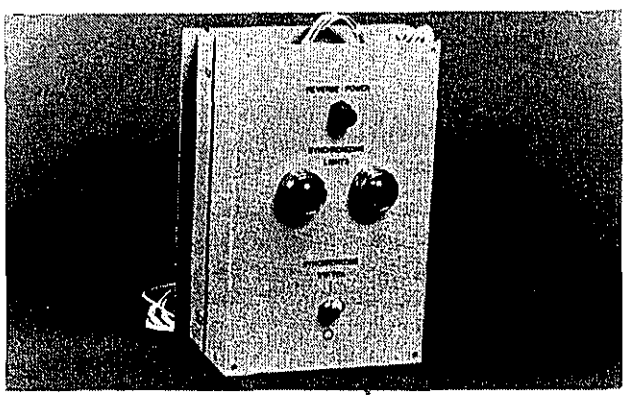
1. Connect the light bulbs, with rated voltage, between the generator leads and the corresponding line phase, i.e., terminal 1 to line 1 across the open circuit breaker.

2. Start the units to be paralleled and bring them up to speed. As they approach the same speed the lights will start to blink.

a. If the lights blink in sequence one of the units is connected backward. To correct, remove generator leads 1 and 3 at the circuit breaker and exchange them. This reverses the direction of phase rotation. Line 2 should always be connected to line 2.

b. If lights blink in unison the phase rotation of both generators is the same, and condition 1 of "Initial Start-up" has been met.





The Synchronizing Lights Module (with reverse power relay) will provide additional protection to the system. If the engine should lose power, the other units in parallel will attempt to motorize the engine and generator. Instead of power going out, power flows into the failing generator, making it a motor. When this occurs, the reverse power relay will activate to shutdown the failing engine and generator.

For more information, including wiring information, refer to the Service Manual module, Form SENR4027.

Frequency Adjustment

The speed of units to be paralleled must be the same. 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 to give rated frequency at full load.

3. Remove the load and check the high idle speed; it should be approximately 2 to 5% above full load speed (for governors equipped with droop). If these speeds can not be obtained, contact your Caterpillar dealer.

4. For the most consistent results, repeat steps 2 and 3 until condition 2 of "Initial Start-up" has been met.

Voltage Adjustment

NOTE: The following voltage adjustment is for individual compensation, also known as reactive droop correction. There is another method called differential compensation, also known as crosscurrent compensation, where the regulator is biased by the difference in reactive current outputs of the paralleled generators. Make reference to Engine Data Sheet, Zero Droop Voltage For Parallel Operation LEKX8142 for adjustment procedure.

The voltage level and voltage droop adjustments determine the amount of circulating currents between generators. Carefully matched voltage regulator adjustments will reduce the circulating currents. Loads of 0.8 power factor (primarily motors) require a generator voltage droop of about 5%. 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 unit to be paralleled.

1. Adjust voltage as described for Single Unit Operation, Initial Start-Up.

2. With the engine running at rated speed, turn the voltage droop clockwise about 1/2 of full range.

If driven load is to be unity power factor, set the voltage droop control on all generators at 1/2 of full range and proceed to Step 7. If driven load is to be normal (approximately 0.8 power factor) 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 to be paralleled with other generators, the voltage droop of each generator must be the same to satisfactorily divide reactive load.

5. Readjust the voltage droop control to obtain desired voltage with full load at 0.8 power factor.

6. Repeat Steps 3, 4 and 5 for each generator to be paralleled until line voltage is equal to desired level at full load and no load voltage is approximately 5% above rated voltage.

7. Parallel generators and apply the driven load. Check the output current of the generator. If the sum of the amps of the individual generator amperes exceeds the total amps going to the load by 10% at full load, adjust voltage droop controls to share current proportionally between generators. (Some circulating current is permitted at light load.)

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

8. Make final adjustments after paralleled generators have been running at full load for one hour or more. Tighten the locknuts on all controls and install the access cover. Condition 3 of "Initial Start-up" has been met.

NOTE: Some circulating current is to be expected when generators are cold.

Starting Multiple Units

Multiple units are started the same as single units.

Paralleling Multiple Units

Units may be paralleled at no load or paralleled with units 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 must be in phase.

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

1. Start the unit to be parallel according to the procedure in the Engine Operation section.

2. Turn the synchronizer lights on.

3. After the engine has run a few minutes, bring it up to synchronous speed (the same frequency as the unit on the line). The synchronizing lights will begin to blink.

4. Using the governor control 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 rather than add to the system load.

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

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

7. After generator temperature has stabilized (approximately one hour), adjust the droop control of each generator so as to share the reactive load and to limit the circulating currents. Less droop (moving control CCW) increases the reactive current carried by the generator.

Load Division – Speed Droop (If Equipped)

Once two units have been paralleled their share of the 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 they will share the load equally.

To transfer the load from one engine to the other follow this procedure:

The total load must not exceed the capacity of the engine.

1. Increase the governor speed control of one unit to increase the load.

2. Reduce the governor speed control of the other unit to decrease the load on that unit.

3. Raise or lower the governor speed control of both units to change system frequency.

Circulating Currents

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

Circulating currents are caused by voltage differences between the two units.

With cold generator sets, circulating current may be as high as 25% of rated amperes, without being considered harmful. Circulating current is part of the total generator current and this total must not exceed the amperage rating.

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

Parallel Operation of Governors

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

It is very important that two basic facts be understood concerning load division between generator sets operating in parallel. First, the power supplied to the generator and thus 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 delivered by the engine and the kW load carried by the generator.

If the governor control setting is advanced, the engine and generator will assume more kW load. Likewise, decreasing the governor control setting will result in a reduction of load on the unit. Any other units on the line will, conversely, either reduce or gain load at the same time, assuming no change in total load or no change in the governor settings of the other units has taken place.

Second, the division of power is not determined by generator excitation or terminal voltage. The Power Factor at which a generator will operate when paralleled with other generators is determined by its excitation. For more discussion on this subject, refer to the section on Parallel Operation of generators.

Governors furnished with Caterpillar Powered Electric Sets can be either of two types, governors with fixed speed droop or governors with adjustable speed droop. The values of speed droop used are commonly 3% and 0%. Governors with adjustable speed droop can be adjusted so their characteristics match quite closely the characteristics of governors with fixed speed droop. If adjusted for 0% speed droop (isochronous) operation, then the same speed from no load to full load can be obtained.

Summary

The preceding discussion of governor operation can be summarized as follows:

1. The simplest governor combination for parallel electric sets is to have approximately 3% speed droop characteristic for each governor. If a constant frequency from no-load to full-load is required, one governor can be adjusted for isochronous operation. This is called a "lead unit".

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

a. The same full load speed.

b. The same high idle (no-load) speed in the case of governors adjusted for speed droop operation.

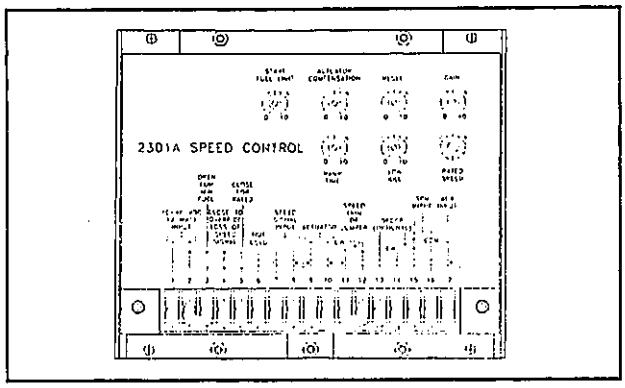
c. Governor controls set to the high idle position so the full governor range is available.

3. Operation of an isochronous governor in parallel with speed droop governors requires special techniques.

4. Any number of electric sets can be operated in parallel. However, only one governor of the group can be adjusted for isochronous operation except in the special cases of electronic governors with automatic load sharing.

Electric Governors

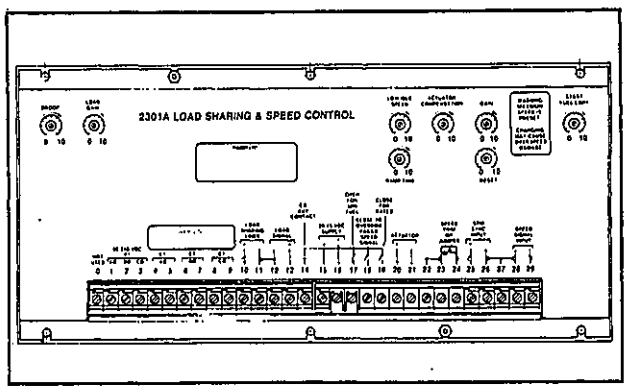
2301A Electric Speed Governor



The 2301A Electric Speed Governor Control system consists of a 2301A Electric Governor control, actuator, magnetic pickup and optional pre-regulator.

The 2301A Electric Speed Governor System provides precision engine speed control and automatic load sharing. More information is available in the 2301A Speed Control Service Manual, Form SENR4676.

2301A Electric Load Sharing Governor

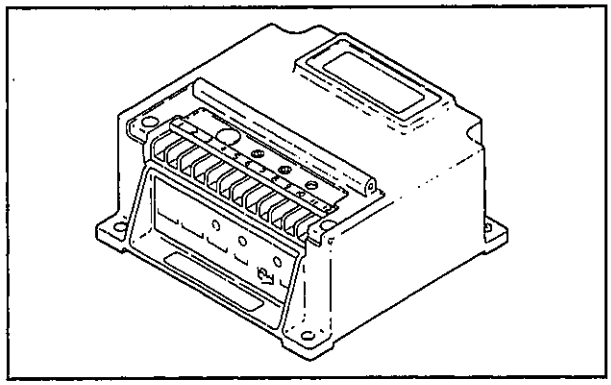


The 2301A is used for exact engine speed control and kilowatt load sharing.

The system measures engine speed constantly and makes necessary corrections to the engine fuel setting through an actuator connected to the fuel system. The system also provides isochronous load sharing for parallel electric sets.

For more detailed information refer to the 2301A Service Manual, Form SENR3585.

1724/8290 and 524/8290 Electric Governors



The 1724/8290 and 524/8290 Electric Governor Systems provide precision engine speed control. There is no mechanical drive or hydraulic supply required for this system. Each system consists of three components, a magnetic pickup, 8290 speed control and 524/1724 actuator. More information is available in the 524 and 1724 Electrically Powered Governor Systems Service Manual, Form SENR6430.

Stopping

To remove a generator from the line perform the following:

1. Check the load. It must be less than the rated capacity of the remaining units.

2. Be sure the neutral of one of the remaining units is grounded.

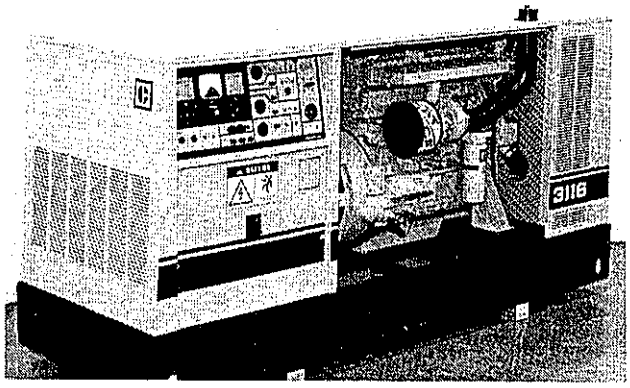
3. Remove the load from the outgoing unit as described in LOAD DIVISION. The amperage may never go to zero due to circulating currents.

4. Open the circuit breaker.

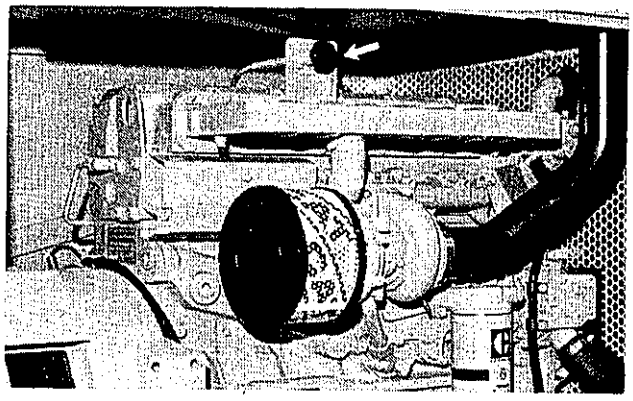
5. Allow the engine to cool for five minutes.

6. Stop the engine.

Standby Electric Sets



Most standby units are automatic. They start, pick up the load, run and stop without an operator in attendance.



Standby units can not change the governor control setting automatically. The governor control must be preset for the proper operation of that unit. Whenever the set is exercised or operated manually, be sure the governor speed setting is correct for automatic operation. Check all switches to see they are properly set: Start Selector Switch in AUTOMATIC position and any Emergency Stop Switches in RUN position.

Generator Storage

You must read and understand the warnings and instructions contained in the Safety section of this manual, before performing any operation or maintenance procedures.

When a generator is in storage, moisture condenses in the windings. To minimize condensation, always put the generator in a dry storage area. If possible, use space heaters to keep generator windings dry during storage.

After Storage

After removing the generator from storage, perform an insulation resistance check of the main stator windings. Use a megohmmeter (megger) to preform this check. Compare the resistance reading with the reading made prior to storage. If the readings are lower than specified in the Service Manual, it may be necessary to dry the windings.

The insulation resistance check is described in Special Instruction SEHS9124. A reading of one megohm or less indicates that the winding has absorbed too much moisture.

To remove moisture caused by high humidity, use one of the following methods to make the generator dry.

1. Energize space heaters in generator, if so equipped.

2. Put the generator in an oven at a temperature of not more than 85°C (185°F) for four hours.

NOTICE

If an oven is used for drying, use a forced air type rather than a radiant type. Radiant ovens can cause localized overheating.

3. Space heaters of the same type used in marine applications, can be installed on generators. (See the Parts Book.) These heaters heat the windings to remove moisture and should be connected at all times in high humidity conditions whenever the generator is not running.

4. Use a canvas enclosure around the generator and heating lamps to increase the temperature. Make an opening in the top for release of moisture.

5. Send a low voltage current through the windings to increase the temperature of the windings. Do not exceed 85°C (185°F).

If the resistance test reads under one megohm after the drying, or if it goes below one megohm shortly after drying, contact your Caterpillar dealer. The insulation has deteriorated and should be reconditioned.

Generator Maintenance

You must read and understand the warnings and instructions contained in the Safety section of this manual, before performing any operation or maintenance procedures.

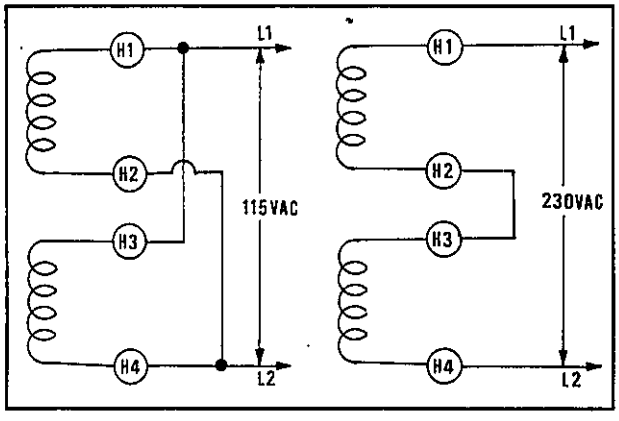
Space Heaters

Space Heaters are recommended for SR4 generators that are installed in high humid conditions.

The SR4 generator can operate 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 and result in poor performance and even result in damage to the windings. Whenever the generator is not in use, insure that the space heaters are in operation.

Whenever the generator is operating, insure the space heaters are disconnected.

An external source of either 115 or 230 volts AC (200V at 50 Hz) is required to operate the space heaters.



Space Heater Connection to External Source H1, H2, H3, H4 Terminal Strip Terminals.

If 115 VAC source is available, connect both heaters in parallel across the source (L1-L2). If 230 VAC source is available, connect both heaters in series across the source (L1-L2).

Recommended Periodic Resistance Checks

Use a megohmmeter (megger) to check generator main stator winding insulation resistance periodically. The frequency of the insulation resistance test is determined by the generator's environment and by previous megohmmeter test indicators.

NOTE: Test the main stator windings with a megohmmeter (megger) in the following situations:

1. Before initial startup of generator set.

2. After generator storage.

3. Every three months if generator is operating in a humid environment or is not protected from the elements by an enclosed area.

4. Every six months if the generator is installed in an enclosed area with relatively low humidity and minimal temperature variations.

5. If generator has not been run under load for three months or more.

6. Test every week and use space heaters if the generator is exposed to a sea water environment or if the surrounding conditions are very humid (relative humidity above 75%) or if a recent test reading was less than three megohms. In applications where salt and high humidity are present, space heaters must be operated whenever the generator is not operating under load. This is the only way to maintain megohmmeter test readings above one megohm.

The insulation resistance check is described in Special Instruction SEHS9124. A reading of one megohm or less indicates that the winding has absorbed too much moisture.

This is a guideline only. It may be necessary to megger more frequently if the environment is extremely humid, salty or if the last megger test was close to one megohm.

Clean and Inspect

⚠ WARNING

Before working inside the generator, make sure that the starter motor can not be activated by any automatic or manual signal.

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

1. the regulator terminal strip.

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

Do not short these terminals to ground with any part of the body or any conductive material. Loss of life or injury could result from electrical shock or injury from molten metal.

An electrical shock can be received from the regulator capacitor (C1) when the engine-generator is not in operation. To avoid possible injury, discharge the stored charge using an 100 ohm resistor across C1 terminals.

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. Contaminants such as dirt, dust, grease, salt, or oil films should not be allowed to accumulate on the windings.

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 used on the windings of Caterpillar generators is moisture resistant, but constant exposure to moisture will gradually lower the insulation's resistance.

Dirt can make the problem worse because it can hold the moisture in contact with the insulation. Salt (from sea air) can also make the problem much worse. This is because salt tends to absorb moisture from the air. When the salt and moisture combine, they form a good electrical conductor.

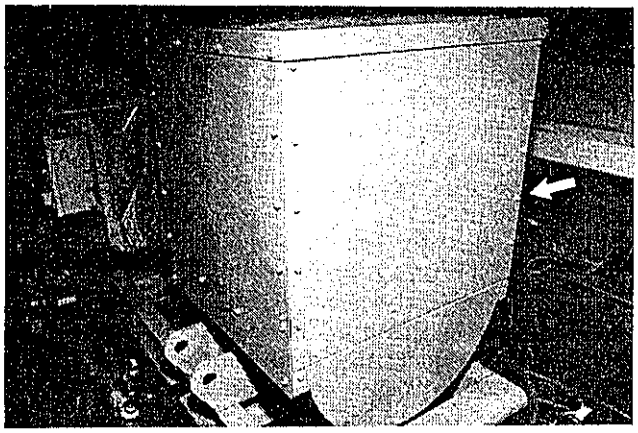
Clean the voltage regulator and generator of dirt and debris. Use a brush to loosen accumulations of dirt and a vacuum system for removal. Use of compressed air is not recommended, because of moisture present in the form of condensation.

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

Visually check for loose or broken wires and connections. Check the wires and connections on the voltage regulator assembly. Check that all circuit boards are fully plugged into their sockets. Check all wires and connections in the generator. Clean heat sinks. Make any necessary repairs to the wiring as required. Refer to the "Electric Set Generator Service Manual," Form SENR7958, for testing and adjusting or disassembly and assembly procedures.

Generator Bearings

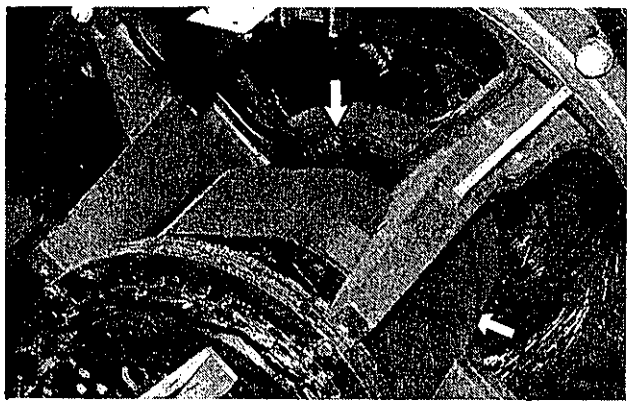
Bearing Lubrication



NOTE: Use Cat Special Purpose Grease (SPG) 2S-3230 for ball bearings. This is a NLGI No. 2 Grade (without molybdenum disulfide) with thickener Polyurea, and a temperature range of [−29 to 177°C (−20 to 351°F)]. Use NLGI No. 1 or 0 Grade for extremely low temperatures.

NOTE: Use Cat 108-8611 Grease for spherical roller bearings. This is a NLGI No. 1 ½ Grade (without molybdenum disulfide) with thickener Clay, viscosity 32cST at 40°C (104°F) and 5 cST at 100°C (212°F).

1. Remove the louver assembly or rear plate from the rear of the generator housing.



2. Remove the top and lower grease pipe plugs.

3. Install a grease fitting in the top, threaded grease pipe.

4. Grease shielded ball bearings with 1.8 to 2.0 oz of 2S-3230 Grease at an interval of every 2000 hours. Grease spherical roller bearings with 1 oz of 108-8611 Grease at an interval of every 1000 hours. 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 2S-3230 Grease for front and rear bearings.

5. Wipe off excess grease. Remove the top grease fitting and install plug.

6. Operate generator for one hour. This allows the grease to expand, forcing the excess grease out of the cavity relieving the internal pressure. The generator should continue to operate until the grease stops purging. Grease may not purge until later grease intervals.

7. Stop the engine. Install the plug in the bottom, grease pipe and wipe off excess grease.

8. Install the louver assembly or rear plate.

Bearing Inspection

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

1. Remove bearing bracket. Inspect the bracket bore and bearing outer race and rolling elements. Standby Power units should have the bearing inspected and the grease replaced every three years. The bearing bracket bore should be inspected for out of roundness, excessive wear, and a bracket step less than 0.0762 mm (.003 in). The bearing should be inspected for outer race damage, severe fretting, and smoothness of operation. If 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, that can be removed, to allow access for a visual inspection of the ball bearing elements.

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

2. Spherical Roller Bearing should be cleaned and re-packed with 108-8611 Grease. Pack the bearing and cavity to one-third to one-half of the cavity volume. (Approximately 3 - 4 oz. in the bearing and 4 - 5 oz. in the cavity.) Refer to the chart that follows.

3. All ball bearings should be cleaned and the bracket cavity re-packed with 2S-3230 Grease. The cavity should be filled to one-third to one-half of the cavity volume. Refer to the chart that follows.

4. Make sure the grease supply tube to the bearing is filled with grease.

5. Remove the bracket drain plug and operate generator for one hour. This allows the grease to expand, forcing the excess grease out of the cavity relieving the internal pressure. The generator should continue to operate until the grease stops purging. Grease may not purge until later grease intervals.

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

7. For future greasing intervals follow the recommendation on the lubrication plate (if equipped) or the Maintenance Schedule in this manual. Repeat Step 5 each time the bearings are greased. The grease amounts are not given in number of grease pumps due to the differences in quantity each grease gun delivers. DO NOT MIX GREASES.

Bearing OD mm (")	Bearing ID mm (")	Part No.	Generator Frame Size	Bearing Bore In Bracket mm (")	Bearing Shield Type	Grease Required In Cavity (oz.)	Rotor Shaft Diameter mm (")
100 (3.937)	45 (1.772)	5P-1977	All 360	100.00–100.025 (3.93708–3.93799)	Double	1.0	45.019–45.004 (1.7724–1.7718)
140 (5.5118)	65 (2.5591)	3N-1965	440 (round laminated)	140.002–140.028 (5.51188–5.51291)	Double	1.8[1] 3.2[2]	65.021–65.004 (2.5599–2.5592)
160 (6.2992)	75 (2.9527)	5P-2448	580[2]	160.002–160.028 (6.29929–6.30031)	Double	3.4–5.7	75.021–75.004 (2.9536–2.9529)
170 (6.6929)	80 (3.1496)	4L-6677	580[1]	170.002–170.028 (6.69299–6.69401)	Single	3.3–5.5	80.020–80.002 (3.1504–3.1497)
170 (6.6929)	80 (3.1496)	109-7687	580[1]	170.002–170.028 (6.69299–6.69401)	Double	3.3–5.5	80.020–80.002 (3.1504–3.1497)
180 (7.0866)	100 (3.9370)	6Y-3955	440 (sq. laminated)	179.992–180.017 (7.0863–7.0873)	Double	4.7–7.8	82.486–82.474 (3.2475–3.2470)
225 (8.8582)	105 (4.1338)	6V-0410	680[1]	225.003–225.034 (8.85838–8.85960)	Single	4.7–7.8	105.029–105.034 (4.1350–4.1344)
225 (8.8582)	105 (4.1338)	108-1760	680[1]	225.003–225.034 (8.85838–8.85960)	Double	5.0–8.0	105.029–105.034 (4.1350–4.1344)
230 (9.0551)	130 (5.1181)	2L-4444[3]	808 4 Pole[1]	230.002–230.045 (9.0548–9.0560)	Open	6.0–9.0	130.040–130.015 (5.1197–5.1187)
240 (9.4488)	110 (4.3307)	6V-3310	800[1]	240.002–240.033 (9.44889–9.45011)	Single	4.9–8.1	110.028–110.012 (4.3318–4.3312)
240 (9.4488)	110 (4.3307)	6V-6752	800[1]	240.002–240.033 (9.44889–9.45011)	Single	4.9–8.1	110.028–110.012 (4.3318–4.3312)
240 (9.4488)	110 (4.3307)	108-1761	800[1]	240.002–240.033 (9.44889–9.45011)	Double	5.0–8.0	110.028–110.012 (4.3318–4.3312)

[1] Inboard bearing.
[2] Outboard bearing.
[3] This bearing is greased from the front side of the bracket and is a spherical roller bearing. All others are ball bearings.

Generator Maintenance Schedules

Standby Power Units

Maintenance Schedule	Topics	Limits / Comments
Check once per YEAR	Insulation Test MEGGER	Minimum 1 megohm + rated V / 1000 (Typically much higher) Reference SEHS9124
Grease once per YEAR	Lubrication Rear Bearing Front Bearing [1]	 Replace grease every 3 years Refer to service literature or lubrication plate
Check during weekly scheduled maintenance check	Bearing Bracket Temperature [1]	Alarm – 85 °C (185 °F) Shutdown – 95 °C (203 °F)
	Main Stator Winding Temperature [1] (embedded detector)	Alarm – 180 °C (356 °F) Shutdown – 205 °C (401 °F) (Nominal values - depends on detector & location)
	Visual Inspection Space Heaters [1] Cleaning Looseness Walk around	 Check operation Moisture, dust, oils, grease, debris Bolts, exciter, flex plates, electrical connections Debris, cleanliness, looseness
	Generator Air Inlet filter [1]	 Differential Pressure = 15.2 mm (.6 in) of water
	Voltage & Frequency	Check for proper voltage and frequency settings and stability

[1] If equipped

Prime & Continuous Power Units

Maintenance Schedule	Topics	Limits / Comments
Every 3 MONTHS	Insulation Test MEGGER	Minimum 1 megohm + rated V / 1000 (Typically much higher) Reference SEHS9124
Grease every 2000 HOURS Ball Bearings [2]	Lubrication Rear Bearing Front Bearing [1]	Use 56.7 grams (2 ounces) of grease Inspect bearing and bracket every major engine overhaul Refer to service literature or lubrication plate
Grease every 1000 HOURS Spherical Roller Bearings [3]	Lubrication Rear Bearing Front Bearing [1]	Use 28.3 grams (1 ounce) of grease Inspect bearing and bracket every major engine overhaul Refer to service literature or Lubrication Plate
Check during weekly scheduled maintenance check	Bearing Bracket Temperature [1]	Alarm – 85 °C (185 °F) Shutdown – 95 °C (203 °F)
	Main Stator Winding Temperature [1] (embedded detector)	Alarm – 155 °C (311 °F) Shutdown – 180 °C (356 °F) (Nominal values - depends on detector & location)
	Visual Inspection Space Heaters [1] Cleaning Looseness Walk around	 Check operation Moisture, dust, oils, grease, debris Bolts, exciter, flex plates, electrical connections Debris, cleanliness, looseness
	Generator Air Inlet filter [1]	 Differential Pressure = 15.2 mm (.6 in) of water
	Voltage & Frequency	Check for proper voltage and frequency settings and stability

[1] If equipped
[2] 806 Frame and smaller are equipped with Ball Bearings.
[3] 807 Frame and larger are equipped with Spherical Roller Bearings. Some 807 Frame units may be equipped with Ball Bearings

Reference Literature

The following literature can be obtained through any Caterpillar dealer.

Operation and Maintenance Manuals

SEBU6123, 3114 & 3116 Industrial, Prime Power and Standby Generator Set Engines

SEBU5851, 3204 Industrial Engine

SEBU6367, 3208 Industrial & Generator Set Engines

SEBU6160, 3208 Standby Generator Set Engine

SEBU5559, 3304 & 3306 Marine Engines

SEBU5779, 3304, 3306, 3304B & 3306B Industrial Engines

SEBU6328, 3304B & 3306B Industrial and Generator Engines

SEBU5791, 3406 & 3406B Industrial Engines

SEBU5415, 3408 & 3412 Industrial Engines

SEBU6336, 3406B Standby Generator Set Engine

SEBU6767, 3412 EPG Generator

SEBU5853, 3508, 3512 & 3516 Industrial Engines

SEBU6156, 3508 Standby Generator Set Engine

SEBU5405, D346, D348 & D349 Industrial Engines

SEBU5364, D353 Industrial Engine

SEBU5347, D353 Marine Engine

SEBU5698, D379, D398 & D399 Industrial & Generator Set Engines

SEBU5561, D379B, D398B & D399B Marine Engines

SEBU6148, 3406 Natural Gas Engine

SEBU5560, G342C Natural Gas Engine

SEBU5678, G379, G398 & G399 Natural Gas Engines

SEBU6618, XQ125 Rental Generator Set

SEBU6499, XQ225 Rental Generator Set

SEBU6455, XQ350 Rental Generator Set

Owner's Manuals

SEBU6369, 3304B & 3306B Marine Engines

SEBU5881, 3406B Marine Engine

SEBU5454, 3408 Marine Engine

SEBU5547, 3412 Marine Engine

SEBU6100, 3508, 3512 & 3516 Marine Engines

Service Manual Modules

The Modules that follow are included in the Service Manual SENR7958.

SENR5809, Electronic Modular Control Panel II

SENR4027, SR4 Control Panel (4W-8000)

SENR3906, VR4 Voltage Regulator

SENR3903, SR4 control Panel (9Y-1400)

SENR3535, SR4 Electronic Modular Control Panel

Service Manuals

SENR7958, SR4 Electric Set Generator

SENR6480, 3412 Generator Set Engine

SENR6430, 524/1724, 8290 Governor System

SENR4676, 2301A Speed Governor

SENR3880, 3508, 3512, & 3516 Generator Set Engines

SENR3585, 2301A Load Sharing Governor

NOTE: Specific Generator Set Service Manuals (except 3300 Series Engines) will include the necessary service information for the generator and control panel. For 3300 Series Engines, order Service Manual SENR7968.

Special Instructions

SEHS9124, Cleaning and Drying of Electric Set Generators, included in the Service Manual SENR7958

Additional literature may become available and may not be included above. Contact your Caterpillar dealer to check the availability, form number, and price of all literature before placing orders.

Index

O

P

R

S

T

V

W

Printed in U.S.A.