Power Generation

Operator Manual

Generator Set

QSB7-G5 NR3 Engine with PowerCommand® 1.1 Control

DSGAA (Spec J-M)
DSGAB (Spec J-M)
DSGAC (Spec J-M)
DSGAD (Spec B-E)
DSGAE (Spec B-E)

English
Original Instructions
4-2016
A041B434 (Issue 4)

California

Proposition 65 Warning

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

Table of Contents

1 Important Safety Instructions

Save these instructions. This manual contains important instructions that should be followed during installation and maintenance of the generator set.

Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow fundamental rules and precautions.

1.1 Warning, Caution, and Note Styles Used in This Manual

The following safety styles and symbols found throughout this manual indicate potentially hazardous conditions to the operator, service personnel, or equipment.

⚠ DANGER

Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

NOTICE

Indicates information considered important, but not hazard-related (e.g., messages relating to property damage).

1.2 General Information

This manual should form part of the documentation package supplied by Cummins Power Generation with specific generator sets. In the event that this manual has been supplied in isolation please contact your authorized distributor.

NOTICE

It is in the operator's interest to read and understand all warnings and cautions contained within the documentation relevant to the generator set, its operation and daily maintenance.

1.2.1 General Safety Precautions

⚠ WARNING

Hot Pressurized Liquid

Contact with hot liquid can cause severe burns.

Do not open the pressure cap while the engine is running. Let the engine cool down before removing the cap. Turn the cap slowly and do not open it fully until the pressure has been relieved.

⚠ WARNING

Moving Parts

Moving parts can cause severe personal injury.

Use extreme caution around moving parts. All guards must be properly fastened to prevent unintended contact.

⚠ WARNING

Toxic Hazard

Used engine oils have been identified by some state and federal agencies to cause cancer or reproductive toxicity.

Do not ingest, breathe the fumes, or contact used oil when checking or changing engine oil. Wear protective gloves and face guard.

⚠ WARNING

Electrical Generating Equipment

Incorrect operation can cause severe personal injury or death.

Do not operate equipment when fatigued, or after consuming any alcohol or drug.

⚠ WARNING

Toxic Gases

Substances in exhaust gases have been identified by some state and federal agencies to cause cancer or reproductive toxicity.

Do not breathe in or come into contact with exhaust gases.

⚠ WARNING

Combustible Liquid

Ignition of combustible liquids is a fire or explosion hazard which can cause severe burns or death.

Do not store fuel, cleaners, oil, etc., near the generator set.

⚠ WARNING

High Noise Level

Generator sets in operation emit noise, which can cause hearing damage.

Wear appropriate ear protection at all times.

⚠ WARNING

Hot Surfaces

Contact with hot surfaces can cause severe burns.

Wear appropriate PPE when working on hot equipment and avoid contact with hot surfaces.

⚠ WARNING

Electrical Generating Equipment

Incorrect operation and maintenance can result in severe personal injury or death

Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service.

⚠ WARNING

Toxic Hazard

Ethylene glycol, used as an engine coolant, is toxic to humans and animals.

Wear appropriate PPE. Clean up coolant spills and dispose of used coolant in accordance with local environmental regulations.

⚠ WARNING

Combustible Liquid

Ignition of combustible liquids is a fire or explosion hazard which can cause severe burns or death.

Do not use combustible liquids like ether.

⚠ WARNING

Automated Machinery

Accidental or remote starting of the generator set can cause severe personal injury or death.

Isolate all auxiliary supplies and use an insulated wrench to disconnect the starting battery cables (negative [–] first).

⚠ WARNING

Fire Hazard

Materials drawn into the generator set are a fire hazard. Fire can cause severe burns or death.

Make sure the generator set is mounted in a manner to prevent combustible materials from accumulating under the unit.

⚠ WARNING

Fire Hazard

Accumulated grease and oil are a fire hazard. Fire can cause severe burns or death.

Keep the generator set and the surrounding area clean and free from obstructions. Repair oil leaks promptly.

⚠ WARNING

Fire Hazard

Materials drawn into the generator set are a fire hazard. Fire can cause severe burns or death.

Keep the generator set and the surrounding area clean and free from obstructions.

NOTICE

Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth. Class B fires involve combustible and flammable liquid fuels and gaseous fuels. Class C fires involve live electrical equipment. (Refer to NFPA No. 10 in applicable region.)

NOTICE

Before performing maintenance and service procedures on enclosed generator sets, make sure the service access doors are secured open.

NOTICE

Stepping on the generator set can cause parts to bend or break, leading to electrical shorts, or to fuel, coolant, or exhaust leaks. Do not step on the generator set when entering or leaving the generator set room.

1.3 Generator Set Safety Code

Before operating the generator set, read the manuals and become familiar with them and the equipment. Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow fundamental rules and precautions.

⚠ WARNING

Electrical Generating Equipment

Incorrect operation and maintenance can result in severe personal injury or death.

Read and follow all Safety Precautions, Warnings, and Cautions throughout this manual and the documentation supplied with the generator set.

1.3.1 Moving Parts Can Cause Severe Personal Injury or Death

- Keep hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect the battery charger from its AC source, then disconnect the starting batteries using an insulated wrench, negative (**–**) cable first. This will prevent accidental starting.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps; keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry in the vicinity of moving parts or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts.
- If any adjustments must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

1.3.2 Positioning of Generator Set

The generator set should be placed on level ground with adequate open space around it. The immediate area around the generator set should be free of any flammable material.

NOTICE

Access or service doors must be closed and locked before repositioning, and they must remain locked during transportation and siting.

NOTICE

The generator set is capable of operating at inclines of up to +/– 10 degrees, however, for optimal performance and reliability, any incline should be +/– 5 degrees.

1.3.3 Positioning of Generator Set - Open Sets

The area for positioning the set should be adequate and level, and the area immediately around the set must be free of any flammable material.

1.4 Electrical Shocks and Arc Flashes Can Cause Severe Personal Injury or Death

⚠ WARNING

Electric Shock Hazard

Voltages and currents present an electrical shock hazard that can cause severe burns or death.

Contact with exposed energized circuits with potentials of 50 Volts AC or 75 Volts DC or higher can cause electrical shock and electrical arc flash. Refer to standard NFPA 70E or equivalent safety standards in corresponding regions for details of the dangers involved and for the safety requirements.

Guidelines to follow when working on de-energized electrical systems:

- Use proper PPE. Do not wear jewelry and make sure that any conductive items are removed from pockets as these items can fall into equipment and the resulting short circuit can cause shock or burning. Refer to standard NFPA 70E for PPE standards.
- De-energize and lockout/tagout electrical systems prior to working on them. Lockout/Tagout is intended to prevent injury due to unexpected start-up of equipment or the release of stored energy. Please refer to the lockout/tagout section for more information.
- De-energize and lockout/tagout all circuits and devices before removing any protective shields or making any measurements on electrical equipment.
- Follow all applicable regional electrical and safety codes.

Guidelines to follow when working on energized electrical systems:

NOTICE

It is the policy of Cummins Inc. to perform all electrical work in a de-energized state. However, employees or suppliers may be permitted to occasionally perform work on energized electrical equipment only when qualified and authorized to do so and when troubleshooting, or if de-energizing the equipment would create a greater risk or make the task impossible and all other alternatives have been exhausted.

NOTICE

Exposed energized electrical work is only allowed as per the relevant procedures and must be undertaken by a Cummins authorized person with any appropriate energized work permit for the work to be performed while using proper PPE, tools and equipment.

In summary:

- Do not tamper with or bypass interlocks unless you are authorized to do so.
- Understand and assess the risks - use proper PPE. Do not wear jewelry and make sure that any conductive items are removed from pockets as these items can fall into equipment and the resulting short circuit can cause shock or burning. Refer to standard NFPA 70E for PPE standards.
- Make sure that an accompanying person who can undertake a rescue is nearby.

1.4.1 AC Supply and Isolation

NOTICE

Local electrical codes and regulations (for example, *BS EN 12601:2010 Reciprocating internal combustion engine driven generating sets)* may require the installation of a disconnect means for the generator set, either on the generator set or where the generator set conductors enter a facility.

NOTICE

The AC supply must have the correct over current and earth fault protection according to local electrical codes and regulations. This equipment must be earthed (grounded).

It is the sole responsibility of the customer to provide AC power conductors for connection to load devices and the means to isolate the AC input to the terminal box; these must comply with local electrical codes and regulations. Refer to the wiring diagram supplied with the generator set.

The disconnecting device is not provided as part of the generator set, and Cummins Power Generation accepts no responsibility for providing the means of isolation.

1.5 Fuel and Fumes Are Flammable

Fire, explosion, and personal injury or death can result from improper practices.

- Do not fill fuel tanks while the engine is running unless the tanks are outside the engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- Do not permit any flame, cigarette, pilot light, spark, arcing equipment, or other ignition source near the generator set or fuel tank.

- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible line. Do not use copper piping on flexible lines as copper will become brittle if continuously vibrated or repeatedly bent.
- Make sure all fuel supplies have a positive shutoff valve.
- Make sure the battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc.

1.5.1 Spillage

Any spillage that occurs during fueling or during oil top-off or oil change must be cleaned up before starting the generator set.

1.5.2 Fluid Containment

NOTICE
Where spillage containment is not part of a Cummins supply, it is the responsibility of the installer to provide the necessary containment to prevent contamination of the environment, especially water courses and sources.

If fluid containment is incorporated into the bedframe, it must be inspected at regular intervals. Any liquid present should be drained out and disposed of in line with local health and safety regulations. Failure to perform this action may result in spillage of liquids which could contaminate the surrounding area.

Any other fluid containment area must also be checked and emptied, as described above.

1.5.3 Do Not Operate in Flammable and Explosive Environments

Flammable vapor can cause an engine to over speed and become difficult to stop, resulting in possible fire, explosion, severe personal injury, and death. Do not operate a generator set where a flammable vapor environment can be created, unless the generator set is equipped with an automatic safety device to block the air intake and stop the engine. The owners and operators of the generator set are solely responsible for operating the generator set safely. Contact your authorized Cummins Power Generation distributor for more information.

1.6 Exhaust Gases Are Deadly

- Provide an adequate exhaust system to properly expel discharged gases away from enclosed or sheltered areas, and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust system daily for leaks per the maintenance schedule. Make sure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.
- Make sure the unit is well ventilated.

1.6.1 Exhaust Precautions

⚠ **WARNING**
Hot Exhaust Gases ***Contact with hot exhaust gases can cause severe burns.*** ***Wear personal protective equipment when working on equipment.***

⚠ WARNING

Hot Surfaces

Contact with hot surfaces can cause severe burns.

Wear appropriate PPE when working on hot equipment and avoid contact with hot surfaces.

⚠ WARNING

Toxic Gases

Inhalation of exhaust gases can cause asphyxiation and death.

Pipe exhaust gas outside and away from windows, doors, or other inlets to buildings. Do not allow exhaust gas to accumulate in habitable areas.

⚠ WARNING

Fire Hazard

Contaminated insulation is a fire hazard. Fire can cause severe burns or death.

Remove any contaminated insulation and dispose of it in accordance with local regulations.

The exhaust outlet may be sited at the top or bottom of the generator set. Make sure that the exhaust outlet is not obstructed. Personnel using this equipment must be made aware of the exhaust position. Position the exhaust away from flammable materials - in the case of exhaust outlets at the bottom, make sure that vegetation is removed from the vicinity of the exhaust.

The exhaust pipes may have some insulating covers fitted. If these covers become contaminated they must be replaced before the generator set is run.

To minimize the risk of fire, make sure the following steps are observed:

- Make sure that the engine is allowed to cool thoroughly before performing maintenance or operation tasks.
- Clean the exhaust pipe thoroughly.

1.7 Earth Ground Connection

The neutral of the generator set may be required to be bonded to earth ground at the generator set location, or at a remote location, depending on system design requirements. Consult the engineering drawings for the facility or a qualified electrical design engineer for proper installation.

NOTICE

The end user is responsible to make sure that the ground connection point surface area is clean and free of rust before making a connection.

NOTICE

The end user is responsible for making sure that an earthing arrangement that is compliant with local conditions is established and tested before the equipment is used.

2 Introduction

⚠ WARNING

Hazardous Voltage

Contact with high voltages can cause severe electrical shock, burns, or death.

Make sure that only a trained and experienced electrician makes generator set electrical output connections, in accordance with the installation instructions and all applicable codes.

⚠ WARNING

Electrical Generating Equipment

Faulty electrical generating equipment can cause severe personal injury or death.

Generator sets must be installed, certified, and operated by trained and experienced person in accordance with the installation instructions and all applicable codes.

2.1 About This Manual

The purpose of this manual is to provide the users with sound, general information. It is for guidance and assistance with recommendations for correct and safe procedures. Cummins Power Generation (CPG) cannot accept any liability whatsoever for problems arising as a result of following recommendations in this manual.

The information contained within the manual is based on information available at the time of going to print. In line with Cummins Power Generation policy of continuous development and improvement, information may change at any time without notice. The users should therefore make sure that before commencing any work, they have the latest information available. The latest version of this manual is available on QuickServe Online (**https://quickserve.cummins.com**).

Users are respectfully advised that, in the interests of good practice and safety, it is their responsibility to employ competent persons to carry out any installation work. Consult your authorized distributor for further installation information. It is essential that the utmost care is taken with the application, installation, and operation of any engine due to their potentially hazardous nature. Careful reference should also be made to other Cummins Power Generation literature. A generator set must be operated and maintained properly for safe and reliable operation.

For further assistance, contact your authorized distributor.

2.2 Schedule of Abbreviations

This list is not exhaustive. For example, it does not identify units of measure or acronyms that appear only in parameters, event/fault names, or part/accessory names.

AmpSentry, INSITE, and InPower are trademarks of Cummins Inc. PowerCommand is a registered trademark of Cummins Inc.

ABBR.	DESCRIPTION	ABBR.	DESCRIPTION
AC	Alternating Current	LED	Light-emitting Diode
AMP	AMP, Inc., part of Tyco Electronics	LTS	Long Term Storage
ANSI	American National Standards Institute	LVRT	Low Voltage Ride Through

ABBR.	DESCRIPTION	ABBR.	DESCRIPTION
ASOV	Automatic Shut Off Valve	MFM	Multifunction Monitor
ASTM	American Society for Testing and Materials (ASTM International)	Mil Std	Military Standard
ATS	Automatic Transfer Switch	MLD	Masterless Load Demand
AVR	Automatic Voltage Regulator	NC	Normally Closed
AWG	American Wire Gauge	NC	Not Connected
CAN	Controlled Area Network	NFPA	National Fire Protection Agency
CB	Circuit Breaker	NO	Normally Open
CE	Conformité Européenne	NWF	Network Failure
CFM	Cubic Feet per Minute	OEM	Original Equipment Manufacturer
CGT	Cummins Generator Technologies	OOR	Out of Range
CMM	Cubic Meters per Minute	OORH / ORH	Out of Range High
CT	Current Transformer	OORL / ORL	Out of Range Low
D-AVR	Digital Automatic Voltage Regulator	PB	Push Button
DC	Direct Current	PCC	PowerCommand® Control
DEF	Diesel Exhaust Fluid	PGI	Power Generation Interface
DPF	Diesel Particulate Filter	PGN	Parameter Group Number
ECM	Engine Control Module	PI	Proportional/Integral
ECS	Engine Control System	PID	Proportional/Integral/Derivative
EMI	Electromagnetic interference	PLC	Programmable Logic Controller
EN	European Standard	PMG	Permanent Magnet Generator
EPS	Engine Protection System	PPE	Personal Protective Equipment
E-Stop	Emergency Stop	PT	Potential Transformer
FAE	Full Authority Electronic	PTC	Power Transfer Control
FMI	Failure Mode Identifier	PWM	Pulse-width Modulation
FRT	Fault Ride Through	RFI	Radio Frequency Interference
FSO	Fuel Shutoff	RH	Relative Humidity
Genset	Generator Set	RMS	Root Mean Square
GCP	Generator Control Panel	RTU	Remote Terminal Unit
GND	Ground	SAE	Society of Automotive Engineers
LCT	Low Coolant Temperature	SCR	Selective Catalytic Reduction
HMI	Human-machine Interface	SPN	Suspect Parameter Number
IC	Integrated Circuit	SWL	Safe Working Load

ABBR.	DESCRIPTION	ABBR.	DESCRIPTION
ISO	International Organization for Standardization	SW_B+	Switched B+
LBNG	Lean-burn Natural Gas	UL	Underwriters Laboratories
LCD	Liquid Crystal Display	UPS	Uninterruptible Power Supply

2.3 Related Literature

Before any attempt is made to operate the generator set, the operator should take time to read all of the manuals supplied with the generator set, and to familiarize themselves with the warnings and operating procedures.

⚠ CAUTION

A generator set must be operated and maintained properly if you are to expect safe and reliable operation. The Operator manual includes a maintenance schedule and a troubleshooting guide.

The relevant manuals appropriate to your generator set are also available, the documents below are in English:

- Operator Manual for DSGAA, DSGAB, DSGAC, DSGAD, and DSGAE Generator Sets with Engine QSB7-G5 and PowerCommand® 1.1 Control (A041B434)
- Operator Manual for DSGAA, DSGAB, DSGAC, DSGAD, and DSGAE Generator Sets with QSB7-G5 Engine and PowerCommand® 2.2 Control (A041B436)
- Installation Manual for DSGAA, DSGAB, DSGAC, DSGAD, and DSGAE Generator Sets with QSB7-G5 Engine and PowerCommand® 1.1 or 2.2 (A041B432)
- Service Manual for DSGAA, DSGAB, DSGAC, DSGAD, and DSGAE Generator Sets with QSB7-G5 Engine and PowerCommand® 1.1 or 2.2 (A041B438)
- Controller Service Manual for PowerCommand® 1.1 (A034L440)
- Controller Service Manual for PowerCommand® 2.2 (900-0666)
- Engine Owner Manual for QSB5 and QSB7 (4915973)
- Alternator Service Manual for UC alternator (900-9901)
- *Specification* and *Data Sheet* (For engineering data specific to the generator set)
- Application Manual T-030, *Liquid Cooled Generator Sets* (For application information)
- Parts Manual for DSGAA, DSGAB, DSGAC, DSGAD, and DSGAE Generator Sets (A040K031)
- Recommended Spares List (RSL) for DSGAA Generator Sets (A040C677)
- RSL for DSGAB Generator Sets (A040C678)
- RSL for DSGAC Generator Sets (A040C679)
- RSL for DSGAD Generator Sets (A040C680)
- RSL for DSGAE Generator Sets (A040C683)
- Standard Repair Times - CX Family (900-0912)
- Warranty Manual (F1117-0005)
- Global Commercial Warranty Statement (A028U870)

2.3.1 Further Information - Literature

Contact your authorized distributor for more information regarding related literature for this product.

2.4 After Sales Services

Cummins Power Generation offers a full range of maintenance and warranty services.

2.4.1 Maintenance

⚠ WARNING

Electrical Generating Equipment

Incorrect operation and maintenance can result in severe personal injury or death

Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service.

For expert generator set service at regular intervals, contact your local distributor. Each local distributor offers a complete maintenance contract package covering all items subject to routine maintenance, including a detailed report on the condition of the generator set. In addition, this can be linked to a 24-hour call-out arrangement, providing year-round assistance if necessary. Specialist engineers are available to maintain optimum performance levels from generator sets. Maintenance tasks should only be undertaken by trained and experienced technicians provided by your authorized distributor.

2.4.2 Warranty

For details of the warranty coverage for your generator set, refer to the *Global Commercial Warranty Statement* listed in the Related Literature section.

In the event of a breakdown, prompt assistance can normally be given by factory trained service technicians with facilities to undertake all minor and many major repairs to equipment on site.

Extended warranty coverage is also available.

For further warranty details, contact your authorized distributor.

NOTICE

Damage caused by failure to follow the manufacturer's recommendations will not be covered by the warranty. Please contact your authorized distributor.

2.4.2.1 Warranty Limitations

For details of the warranty limitations for your generator set, refer to the warranty statement applicable to the generator set.

2.4.3 How to Obtain Service

When a product requires servicing, contact the nearest Cummins Power Generation distributor. To locate the distributor, refer to **power.cummins.com** and select Distributor Locator. When contacting the distributor, always supply the complete model, specification, and serial number as shown on the nameplate.

2.4.3.1 Locating a Distributor

In North America

To easily locate the nearest certified distributor/dealer for Cummins generator sets in your area, or for more information, contact us at 1-800-344-0039 or visit **power.cummins.com**.

If unable to contact a distributor using the automated service, consult the Internet.

If unable to arrange a service or resolve an issue, contact the Service Manager at the nearest Cummins Power Generation distributor for assistance.

When contacting the distributor, always supply the complete Model, Specification, and Serial Number as shown on the product nameplate.

Outside North America

Refer to **power.cummins.com** and select Distributor Locator, or send an email to ask.powergen@cummins.com.

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3 System Overview

This section provides an overview of the generator set.

3.1 Generator Set Identification

Each generator set is provided with a nameplate similar to that shown below. The nameplate provides information unique to the generator set.

3.1.1 Nameplate

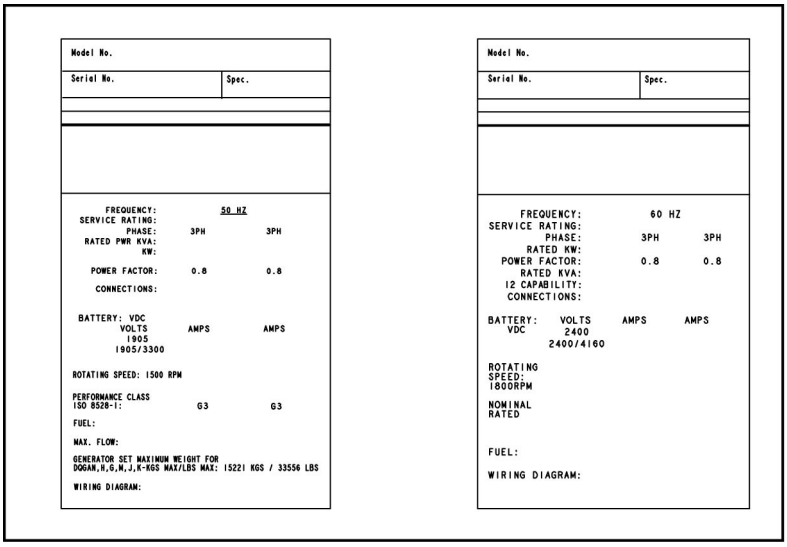
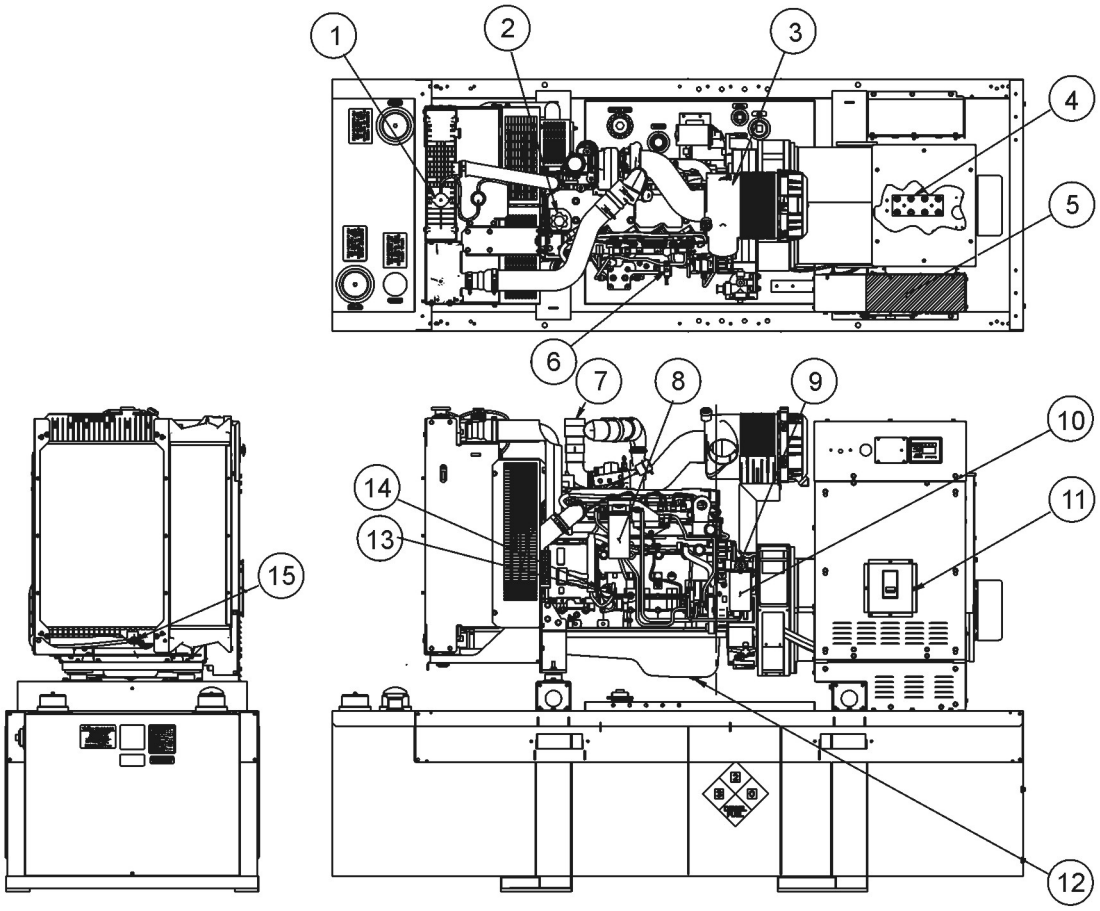


FIGURE 1. TYPICAL GENERATOR SET NAMEPLATE

3.2 Generator Set Components

The main components of DSGAA, DSGAB, DSGAC, DSGAD, and DSGAE generator set are shown below, and referred to within this section.

There are various options listed although they may not be available for all models.



No.	Description	No.	Description
1	Radiator Fill	9	Fuel Supply
2	Oil Fill	10	Fuel Filter
3	Air Cleaner	11	Circuit Breaker (Optional)
4	Generator Electrical Load Connections	12	Oil Drain Plug
5	Electrical Stub Up	13	Oil Check
6	Fuel Return	14	Oil Fill
7	Exhaust Connection	15	Coolant Drain
8	Fuel Filter		

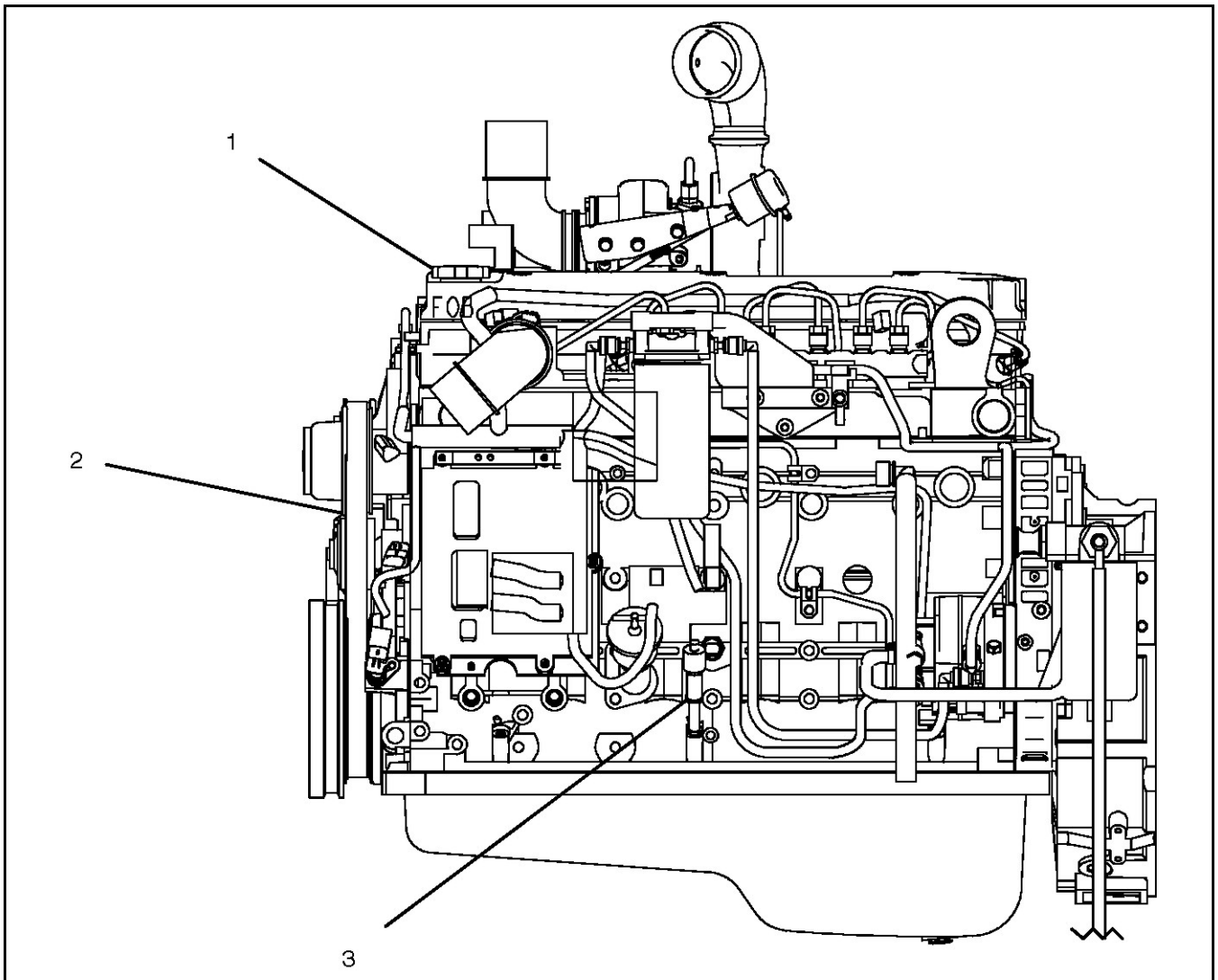
FIGURE 2. A040K622 REVISION A

3.3 Generator Set Rating

Refer to the generator set nameplate for generator set rating. Refer to **Section 5.4 on page 48** for operation at temperatures or altitudes above those stated on the nameplate.

3.4 Engine

For additional engine specific information, refer to the relevant engine manual for your generator set.



No.	Description
1	Oil filler cap
2	Fan belt
3	Dipstick

FIGURE 3. TYPICAL ENGINE COMPONENTS

3.4.1 Generator Set Performance Data

3.4.1.1 Acoustic Information

3.4.1.1.1 Acoustic Information (1800 RPM)

TABLE 1. ACOUSTIC DATA (1800 RPM)

Model	DSGAA	DSGAB	DSGAC	DSGAD	DSGAE
Engine	**QSB7**	**QSB7**	**QSB7**	**QSB7**	**QSB7**
Enclosed Set Acoustic Data - LWA (Weather Protective F182 Steel Enclosure with Exhaust System, and 60 Hz set operating with doors closed)[1,2]	87.1	87.7	88.2	88.8	89.3
Enclosed Set Acoustic Data - LWA (Weather Protective F216 Aluminum Enclosure with Exhaust System, and 60 Hz set operating with doors closed)[1,2]	87.1	87.7	88.2	88.8	89.3
Enclosed Set Acoustic Data - LWA (Weather Protection F173 Steel Enclosure with Exhaust System, and 60 Hz set operating with doors closed)[1,2]	71.9	72.5	73.1	73.5	73.9
Enclosed Set Acoustic Data - LWA (Weather Protective F217 Aluminum Enclosure with Exhaust System, and 60 Hz set operating with doors closed)[1,2]	73.2	73.8	74.4	74.8	75.2

Enclosed Set Acoustic Data - LWA (Weather Protective F232 Steel Enclosure with Exhaust System, and 60 Hz set operating with doors closed)[1,2]	68.9	69.4	69.9	70.3	70.6
Enclosed Set Acoustic Data - LWA (Weather Protective F233 Aluminum Enclosure with Exhaust System, and 60 Hz set operating with doors closed)[1,2]	70.2	70.7	71.2	71.6	71.9
Open Set Acoustic Data - db(A) at 7m[3] - SPL (or enclosed set with doors open)	86.3	86.6	86.8	86.9	86.9

1. Doors closed figures are measured using ANSI S1.13 and ANSI S12.18, as applicable.
2. Based on 75% load.
3. Based on 110% load.

For Noise Spectrum Figures, refer also to your authorized distributor.

In line with the Cummins Power Generation policy of continuous improvement, these figures are subject to change.

3.4.1.2 Engine Fuel Consumption

TABLE 2. FUEL CONSUMPTION AT 1800 RPM (60 HZ)

Model	DSGAA	DSGAB	DSGAC	DSGAD	DSGAE
Engine	**QSB7-G5**	**QSB7-G5**	**QSB7-G5**	**QSB7-G5**	**QSB7-G5**
Engine Performance Data at 60 Hz[1] (L/Hr)	33.6	39	44.4	49.4	56
Engine Performance Data at 60 Hz[1] (Gal/Hr)	8.87	10.3	11.73	13.06	14.79

1. Standby/Full Load

Refer to Data Sheets for other applications. In line with the CPG policy of continuous improvement, these figures are subject to change.

3.5 Sensors

Various generator set parameters are measured by sensors, and the resulting signals are processed by the control board.

Engine-mounted sensors monitor a number of different systems, such as:

- Lube Oil Pressure
- Cooling System Temperature

3.6 Heaters

3.6.1 Heater Supply and Isolation

A power supply is required for the operation of the engine, coolant, and alternator heaters (if fitted).

NOTICE
It is the sole responsibility of the customer to provide the power supply and the means to isolate the AC input to the terminal box. Cummins Power Generation accepts no responsibility for providing the means of isolation. Contact your distributor for more information.

NOTICE
This disconnecting device is not provided as part of the generator set.

3.7 Mains (Utility) Powered Battery Charger

⚠ CAUTION
Hazardous Voltage ***Contact with high voltages can cause severe electrical shock, burns, or death.*** ***Disconnect the battery charger before isolating the battery.***

This unit maintains the battery in a fully charged condition without over-charging. The unit also provides rapid charging, when necessary, at a current up to the rated output.

The charger's electronic control circuit allows the charger to be left in circuit during engine cranking and to operate in parallel with the charge alternator.

The charger will supply current to the battery system until the battery terminal voltage becomes equal to the set float voltage, at which point only a trickle charge current is present. When the battery becomes discharged due to a load being present and the terminal voltage falls, the charger will again supply current to restore the voltage of the battery to the float voltage.

3.8 Air Cleaner

An air cleaner includes an element that must be replaced periodically. Some air cleaners include a service indicator that indicates when an air cleaner element is dirty and must be replaced.

3.8.1 Heavy Duty Air Cleaner

This shows the heavy duty air cleaner.

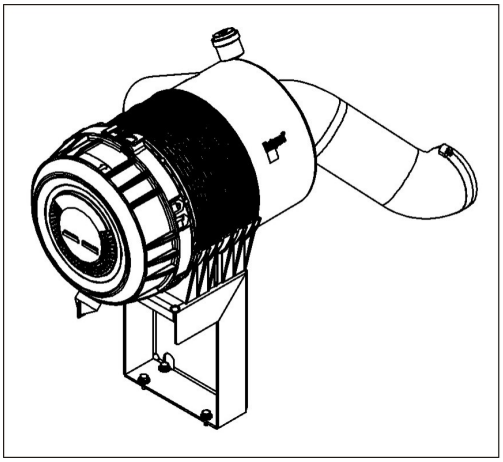


FIGURE 4. HEAVY DUTY AIR CLEANER ASSEMBLY

3.9 Coolant Heater

NOTICE
Operating the heater or heaters when the coolant system has been drained, or there is a suspicion that the coolant is frozen, can result in equipment damage. **Always make sure the coolant is not frozen and the radiator is filled to the recommended level before energizing the heater, or heaters.**

A coolant heater keeps the engine coolant warm when the engine is shut down. It heats and circulates the coolant within the engine. This reduces start-up time and lessens engine wear caused by cold starts. It is electrically operated and thermostatically controlled.

3.10 System Options

3.10.1 Alarm Module

The alarm module provides audible warnings. It includes a pushbutton switch to silence the horn. It also includes a red LED to announce an active alarm and an amber LED that indicates when the horn is silenced.

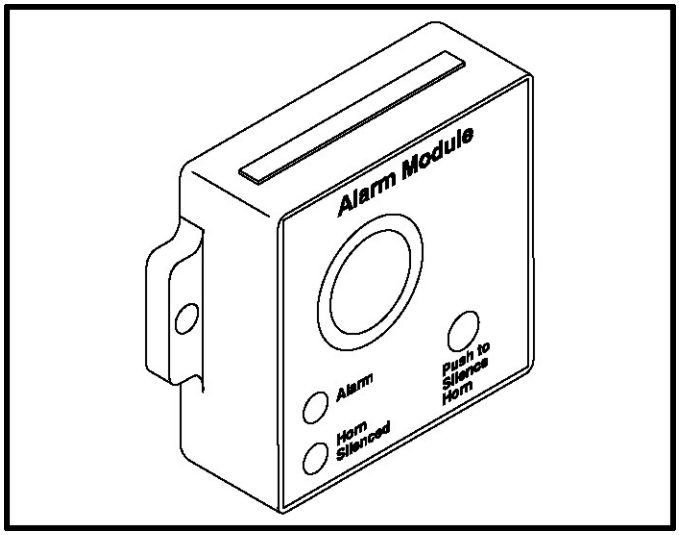


FIGURE 5. ALARM MODULE

3.10.2 PowerCommand Universal Annunciator

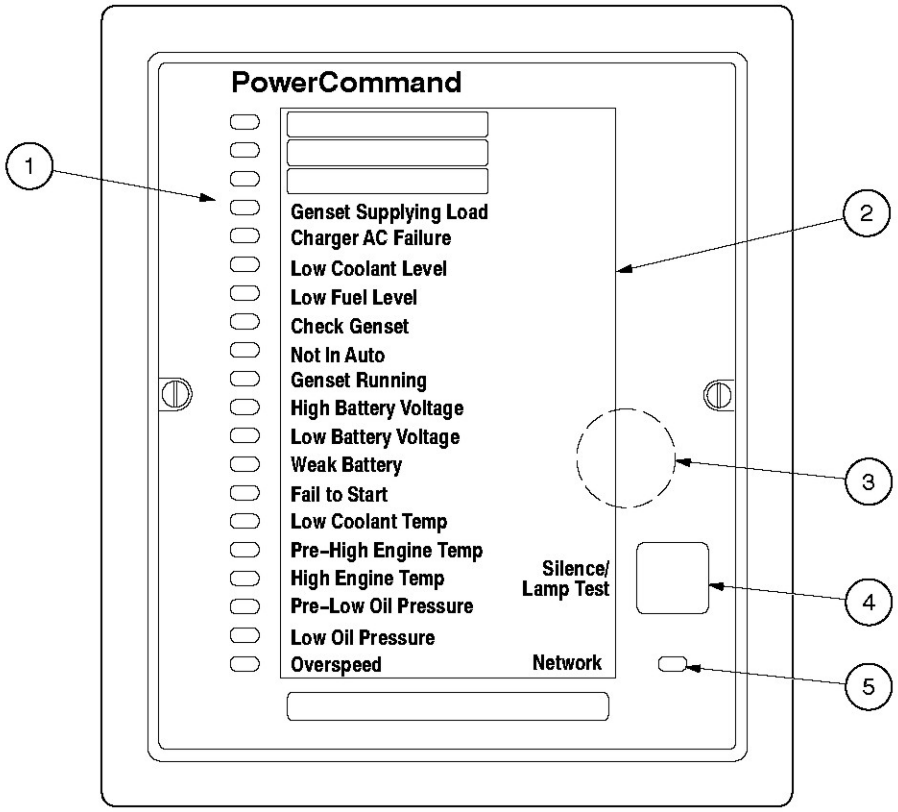
A universal annunciator provides lamps and a horn to annunciate the operating status and fault conditions of an emergency power system. It is designed for connection to either a 12 VDC or a 24 VDC control system. It can be configured to be either a positive or negative signal device.

Two versions of the PowerCommand universal annunciator are available.

- Panel Mounted
- Panel with Enclosure

The universal annunciator can communicate using either a PCCNet or a Modbus network.

Refer to the annunciator owner's manual for more information.



No.	Description	No.	Description
1	System Status Lamps	4	Silence/Lamp Test Button
2	Insert Card	5	Network Status Lamp
3	Horn		

FIGURE 6. ANNUNCIATOR COMPONENTS

3.10.3 Circuit Breaker

A circuit breaker is used to prevent the generator from being overloaded.

A line circuit breaker is mounted in the generator output box. If the load exceeds the circuit breaker current rating, the line circuit breaker will open, preventing the generator from being overloaded. If the circuit breaker trips, locate the source of the overload and correct as necessary. Manually reset the breaker to reconnect the load to the generator.

3.10.4 Day Tank

For installations that include a fuel day tank, check the liquid level gauge to make sure an adequate amount of fuel is maintained.

Some day tanks include a day tank control. A typical day tank control includes an On/Off switch, a Test/Reset switch, circuit breakers, and status indicator lights. Make sure the control is plugged into an AC outlet.

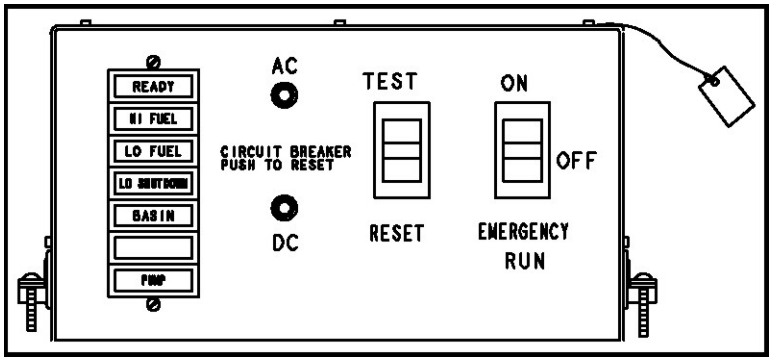


FIGURE 7. TYPICAL DAY TANK CONTROL

4 Control System - PowerCommand 1.1

4.1 Control System Description

The control system is used to start and stop the generator set, and provides full generator set monitoring capability and protection in a stand-alone situation (non-paralleling) from the display screen. It monitors the engine for temperature, oil pressure, and speed, and provides voltage and current metering. In the event of a fault, the unit will indicate the fault type and automatically shut down the generator set on critical faults.

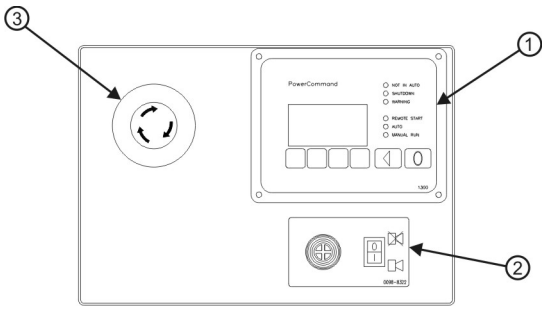
All indicators, control buttons, and the display screen are on the face of the Operator Panel.

There are two fault level signals generated by the control system:

- Warning: signals an imminent or non-critical fault for the engine. The control provides an indication only for this condition.
- Shutdown: signals a potentially critical fault for the engine. The control will immediately take the engine off-load and automatically shut it down.

The standard control system operates on 12 or 24 VDC battery power. The auxiliary equipment operates on LV AC power. The history data is stored in non-volatile memory and will not be deleted due to the loss of battery power.

4.1.1 Operator Panel



1	Operator Panel
2	Alarm Module (option)
3	Emergency Stop Button

FIGURE 8. TYPICAL CONTROL SYSTEM PANEL

4.1.2 Operating Modes

The PowerCommand® control is operated by the **Manual Run**, **Off**, and **Auto** buttons on the operator panel.

4.1.2.1 Off Mode

When in the Off mode, the control does not allow the generator set to start.

If the generator set is running in either Manual Run or Auto mode and the **Off** button is pressed, a normal shutdown sequence is initiated.

Pressing the **Off** mode button resets all active faults.

4.1.2.2 Manual Run Mode

When in Manual Run mode, the generator set starts and continues to run until the control is put into the Off mode. Pressing the **Off** button initiates a normal shutdown sequence that does not include a time delay stop. While in the Manual Run mode, any remote start signal is ignored.

4.1.2.3 Auto Mode

When in Auto mode, the control allows the generator set to be started at any time with a remote signal only. When a remote start signal is received, the generator set starts after a time delay start is completed (default delay is zero seconds).

When all remote start signals are removed, the control performs a normal shutdown sequence which includes a time delay stop (default delay is zero seconds).

If the generator set is running in Auto mode and the **Off** button is pressed, the control immediately stops the generator set and the control transitions to the Off mode.

4.1.2.4 Sleep Mode

The PowerCommand® control enters a low power (Sleep) mode of operation where the current drawn is less than 60 milliamps (DC) at normal battery voltage levels. Sleep mode is automatically enabled, and the operator panel turns itself off after five minutes of keypad inactivity in the Off or Auto mode. It awakes from the sleep mode if any button is pressed.

The control will not enter the Sleep mode if there are any active unacknowledged shutdown faults when the control is in the Manual Run mode.

NOTICE
Sleep mode can be disabled; contact your authorized distributor.

4.1.2.5 Battle Short Mode

⚠ WARNING
Automated Machinery
Battle Short mode overrides some parameters of generator set control. Unmonitored generator sets can cause a fire or electrical hazard, resulting in severe personal injury or death.
Make sure that the operation of the set is supervised during Battle Short operation.

The purpose of Battle Short mode is to satisfy local code requirements, where necessary. To use this feature, the necessary software must be installed at the factory when a PowerCommand® 1.1 control is purchased.

Battle Short mode is a generator set mode of operation that prevents the generator set from being shutdown by all but a few, select, critical shutdown faults.

NOTICE
All shutdown faults, including those overridden by Battle Short, must be acted upon immediately to ensure the safety and well being of the operator and the generator set.

This feature must only be used during supervised, temporary operation of the generator set. The faults that are overridden when in Battle Short mode can affect generator set performance, or cause permanent engine, alternator, or connected equipment damage.

Only trained and experienced service personnel should enable this feature. When shipped from the factory, this feature is disabled.

NOTICE
If this mode of operation is selected, the protection of load devices is disabled. **Cummins Power Generation will not be responsible for any claim resulting from the use of this mode.**

Battle Short is turned on or off with an external switch connected to one of the two customer configured inputs or a soft switch on the operator panel.

NOTICE
The Battle Short feature can only be enabled or disabled using the PC service tool.

When enabled, Battle Short switch input can be set using a Setup menu. To turn Battle Short mode on using the soft switch in the Operator Panel, Battle Short must be set to Operator Panel and enabled using the InPower service tool (default is Inactive).

When Battle Short mode is enabled, the Warning status indicator lights, and code 1131 – Battle Short Active – is displayed.

When Battle Short mode is enabled and an overridden shutdown fault occurs, the shutdown lamp remains lit even though the set continues to run. Fault code 1416 – Fail to Shutdown – is displayed. If the ▲, ▼ or ◄ button is pressed to acknowledge the fault, the fault message is cleared from the display but remains in the Fault History file with an asterisk sign (* indicates an active fault) as long as Battle Short mode is enabled.

Battle Short is suspended and a shutdown occurs immediately if any of the following critical shutdown faults occur:

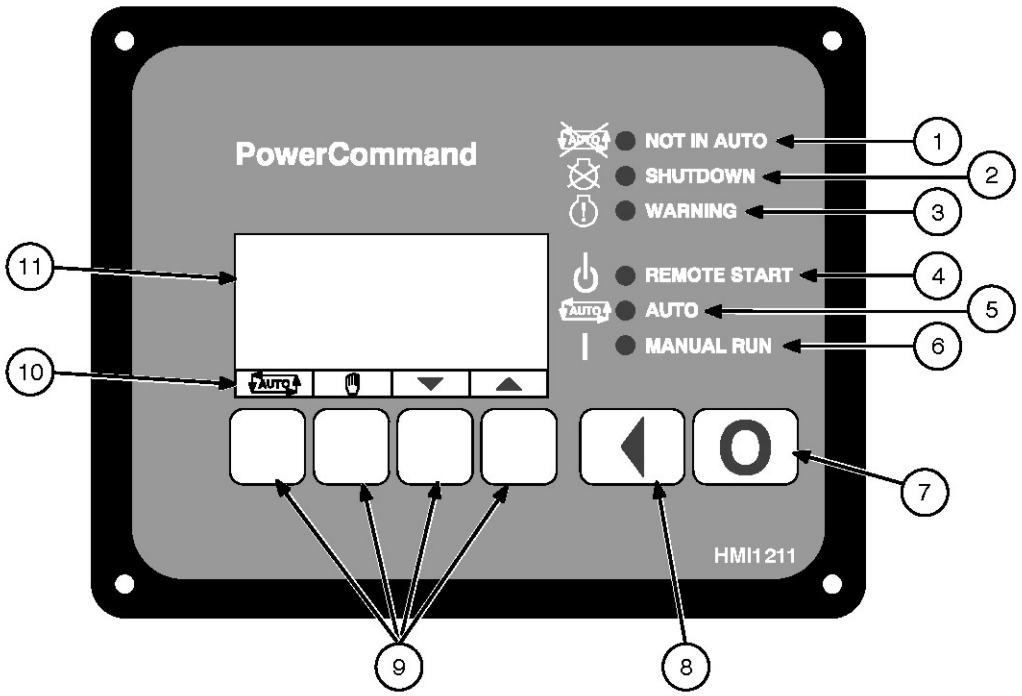
- Speed Signal Lost (Loss of Speed Sense) Fault code 121
- Overspeed Fault code 234
- Local Emergency Stop Fault code 1433
- Remote Emergency Stop Fault code 1434
- Excitation Fault (Loss of Voltage Sense) Fault code 2335

  Or

- The Battle Short feature is disabled after an overridden shutdown fault occurred while in Battle Short mode. Fault code 1123 – Shutdown After Battle Short – is then displayed.

4.2 Operator Panel

Figure 9 on page 28 shows the features of the front panel. It includes six LED indicators, the graphical display, and six buttons used to navigate through the menus and adjust parameters.



1	LED Indicator – Not in Auto	7	Generator Set Off Mode Button
2	LED Indicator – Shutdown	8	Previous Screen Button
3	LED Indicator – Warning	9	Selection Buttons (four) (for use with Item 10)
4	LED Indicator – Remote Start	10	Menu Bar (provision for four symbols)
5	LED Indicator – Auto	11	Graphical LCD Display
6	LED Indicator – Manual Run		

FIGURE 9. OPERATOR PANEL

4.2.1 Display Text or Symbolic Version

This graphical display can be set to show text (English only) or symbols for fault messages, some Operator menus, and the Mode Change menu. Descriptions of commonly used symbols are included in Table 3. Combinations of symbols are used to display some fault conditions. Additional specialized symbols are also used for some faults (see Section 7.5.1 on page 88).

When shipped from the factory, the display is set to display symbols. Qualified service personnel are required to change the default setting.

TABLE 3. SYMBOLS

SYMBOL	DESCRIPTION	
	Actual text shown – English only	**Translation**
	Generator Warning Fault	
	Generator Shutdown Fault	

SYMBOL	DESCRIPTION	
	Actual text shown – English only	**Translation**
	Coolant Temperature	
	Oil Pressure	
	Voltage Alternating Current (VAC)	
	Voltage Direct Current (VDC)	
	AC Current	
Hz	Frequency	
	Battery	
	Out of Range	
	High or Pre-High	
	Low or Pre-Low	
	Annunciator	
	Over Speed	
	Crank Fail	
	Emergency Stop	

4.2.2 LED Indicators

Figure 9 on page 28 shows the front panel of the Operator Panel. It includes six LED indicators, the graphical display and six buttons used to navigate through the menus and adjust parameters.

4.2.2.1 Not in Auto 

This red lamp is lit when the control is NOT in Auto.

4.2.2.2 Shutdown Status 

This red lamp is lit when the control detects a Shutdown condition. The generator set cannot be started when this lamp is on. After the condition has been corrected, the lamp can be reset by pressing the **Off** button.

NOTICE
When Battle Short mode is enabled and an overridden shutdown fault occurs, the Shutdown lamp lights, even though the generator set continues to run.

4.2.2.3 Warning

This amber lamp is lit whenever the control detects a Warning condition. This lamp is automatically shut off when the Warning condition no longer exists.

4.2.2.4 Remote Start

This green lamp indicates the control is receiving a **remote run** signal.

4.2.2.5 Auto

This green lamp indicates that the control is in Auto mode. Auto mode can be selected by pressing the AUTO selection button from any of the Operator menus.

4.2.2.6 Manual Run

This green lamp indicates that the control is in the Manual Run mode. Manual Run can be selected by pressing the selection button from any of the Operator menus.

4.2.3 Graphical Display and Buttons

Figure 9 on page 28 shows the graphical display and the relevant menu selection buttons.

The graphical display is used to view menus of the menu-driven operating system. The Menu Bar at the bottom of the display indicates the functions that are available by pressing each of the four selection buttons. Refer to the menu trees later in this section.

NOTICE
In the following menu trees, the submenus are shown in the order in which they are displayed when scrolling up ▲, or when scrolling down ▼.

System messages (communication, event, and fault) are also shown on the display. For more information see Section 4.3 on page 32.

4.2.3.1 Selection Buttons

Four momentary (soft-key) buttons are used to step through the various menus. These selection buttons are active when a word or symbol in the Menu Bar of the graphical display is shown above the button. Some sub-menus do not include any active buttons.

The function of the four selection buttons varies with each menu.

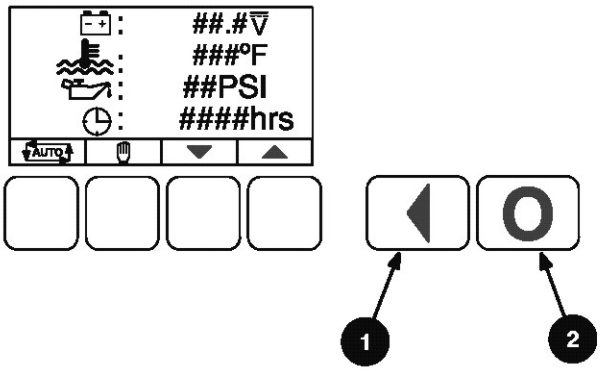
- When the AUTO symbol is displayed, the selection button can be used to switch to Auto mode.
- When the symbol is displayed, the selection button can be used to switch to Manual Run mode.
- When the up and down triangles (▲ and ▼) are displayed, the selection buttons are used to navigate between a series of submenus.

NOTICE
When a fault is displayed, it can be cleared from the front panel by pressing the ▲ or ▼ button. Clearing the front panel does not reset the fault.

- When a ◄ symbol is displayed, the selection button can be used to abort the Auto or Manual Run mode and return to the Operator menu that was displayed before the Auto or Manual Run mode was selected.
- When the → symbol is displayed, the selection button is used to navigate to an editable field within a menu.
- When the + and – symbols are displayed, the selection buttons are used to increase or decrease a parameter or value shown on the screen. When changing values, pressing the button below the + symbol increases the value and pressing the button below the – symbol decreases the value.
- When a black box ■ is displayed, the selection button has no function.

4.2.3.2 Control Buttons

The figure below illustrates the six control buttons - four selection buttons, the **Previous Menu** button, and the **Off** button.



1	Previous Menu Button
2	Off Button

FIGURE 10. CONTROL BUTTONS

4.2.3.2.1 Previous Main Menu Button

Press this button to view the previously displayed main menu.

NOTICE
Pressing the ▲ or ▼button also clears the fault from the front panel display.

4.2.3.2.2 Off Button

Press this button to switch to Off mode. Off mode disables the control's Auto or Manual Run modes. Pressing the **Off** button resets the control.

If the **Off** button is pressed during generator set operation (manual or remote start), the engine immediately shuts down. If possible, hot shutdown under load should be avoided to help prolong the reliability of the generator set.

NOTICE

Switching to Off mode can be restricted to authorized personnel. If a control panel is set-up with the mode change access code feature enabled, an access code must first be entered before the mode can be changed.

4.2.4 Default Settings

The Operator Panel can display SAE or Metric units of measurement and should be set during the initial setup of the generator set. Only trained and experienced personnel are allowed to change the default setting. Contact your authorized distributor.

4.3 Operator Panel - System Messages

A system pop-up message is displayed when the event it is displaying becomes active. These pop-up messages remain displayed until pre-empted by another pop-up message or until the ▼ or ◄ display button is pressed, or the event has expired. Once the ▼ or ◄ button is pressed, the previous menu is re-displayed.

4.3.1 Communication Messages

System messages are displayed for initial power-up or when there is a subsequent loss of communications. Auto and Manual Run modes can also be selected when communication messages are displayed.

Upon initial power-up, the message "Establishing communication with control" is displayed (see the figure below). This menu also displays the screen's software number and version.

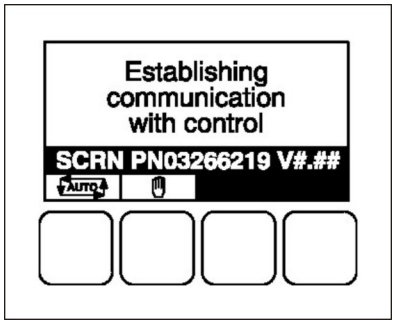


FIGURE 11. ESTABLISHING COMMUNICATIONS MESSAGE

When the display detects that it is no longer communicating with the control, the Shutdown, Warning, and Remote Start LEDs are turned off.

If communications are lost, the message "Re-establishing communications with control" is displayed (see the figure below) until communications have been re-established. The LEDs then return to the state determined by the control.

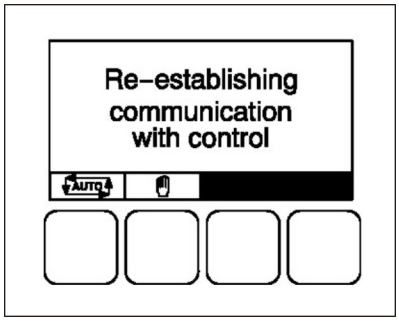
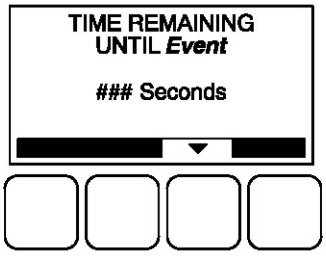


FIGURE 12. RE-ESTABLISHING COMMUNICATIONS MESSAGE

NOTICE
If either communication message remains displayed (cannot view other menus), this indicates that communications between the control panel and the control logic has been lost. Contact your authorized distributor for assistance.

4.3.2 Event Messages

When pre-set events (Start or Stop) are activated, Event messages are displayed showing the time remaining until the event occurs.



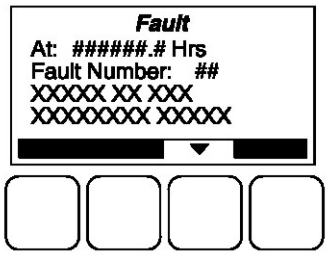
Event = START or STOP

FIGURE 13. EVENT MESSAGE

4.3.3 Fault Messages

A Fault message is an indicator of a Warning or Shutdown condition that is also announced with a lamp indicator. Text fault messages include the fault code number, a short description, and when the fault occurred in 'Time in Hours' (see **Figure 14**).

Chapter 7 on page 85 provides a list of fault codes, fault types, messages displayed, and descriptions of the faults.



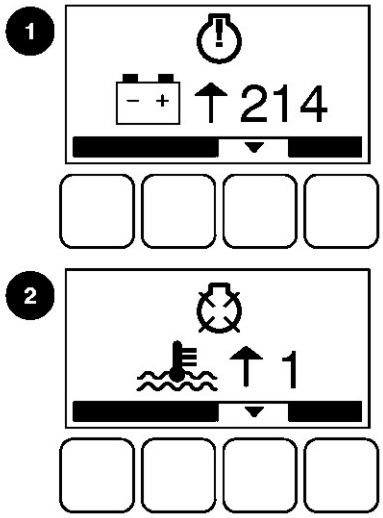
Fault = WARNING or SHUTDOWN

FIGURE 14. FAULT MESSAGE – TEXT VERSION

Symbolic fault messages include the fault code number and symbols indicating the type of fault (see **Figure 15**).

With the symbolic versions of fault messages, the and symbols flash.

Five of the most recent faults are saved in a file and can be viewed within the Fault History Menus.



1	Example of Symbolic Warning Fault
2	Example of Symbolic Shutdown Fault

FIGURE 15. FAULT MESSAGES – SYMBOLIC VERSION

4.3.4 Fault Acknowledgement

Shutdown faults must be acknowledged after the fault condition has been corrected. Shutdown faults are acknowledged by pressing the **Off** button on the display panel.

Shutdown faults can also be acknowledged when in Auto mode by using an external customer-supplied remote fault reset switch. This ability must be enabled using InPower (default condition is disabled). To reset the fault using the remote fault reset switch, the remote start command must be removed prior to the remote fault reset switch being activated.

Faults are removed from the display when they are cleared.

NOTICE

Faults are cleared from the control panel display by pressing the ▲, or ▼ button.

NOTICE

Faults are re-announced if they are detected again after being acknowledged.

4.3.5 Status Messages

Status messages for some events are displayed on the control panel with a code number but are not announced with a lamp indicator. Text status messages include the event code, a short description, and the time the event occurred. Symbolic status messages include the event code and symbols to indicate the type of event that occurred.

4.3.5.1 Full Authority Engines Only

On Full Authority Electronic engines, the engine controller saves data after each run. During this time, the message shown in the figure below is displayed. The generator can still be started while the ECM Datasave is in progress.

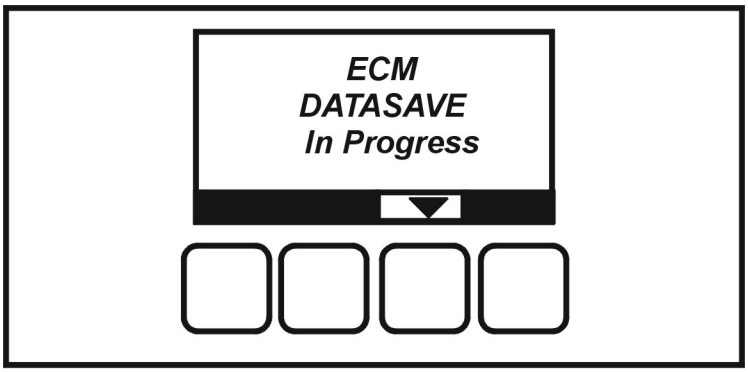


FIGURE 16. DATASAVE STATUS MESSAGE

4.4 Operator Panel - Operator Menus

Figure 17 on page 37 and Figure 18 on page 38 show block representations of the following Operator menus:

- Engine Status
- Alternator Status
- Line-to-Line Voltage
- Line-to-Neutral Voltage
- Alternator Amperage

To navigate between the Operator menus, press the buttons below the ▼and ▲ symbols in the graphical display.

The Operator menus can be used to select Auto or Manual Run modes.

4.4.1 Engine Status Menu

This menu displays the engine starting battery voltage, engine coolant temperature, engine oil pressure, and hours of engine operation.

4.4.2 Alternator Status Menu

This menu displays generator set load (in kVA), frequency (Hz), and engine speed (RPM).

4.4.3 Alternator Line-to-Line Voltage Menu

This menu displays L1-L2, L2-L3, and L3-L1 line-to-line voltages for 3-phase applications only.

4.4.4 Alternator Line-to-Neutral Voltage Menu

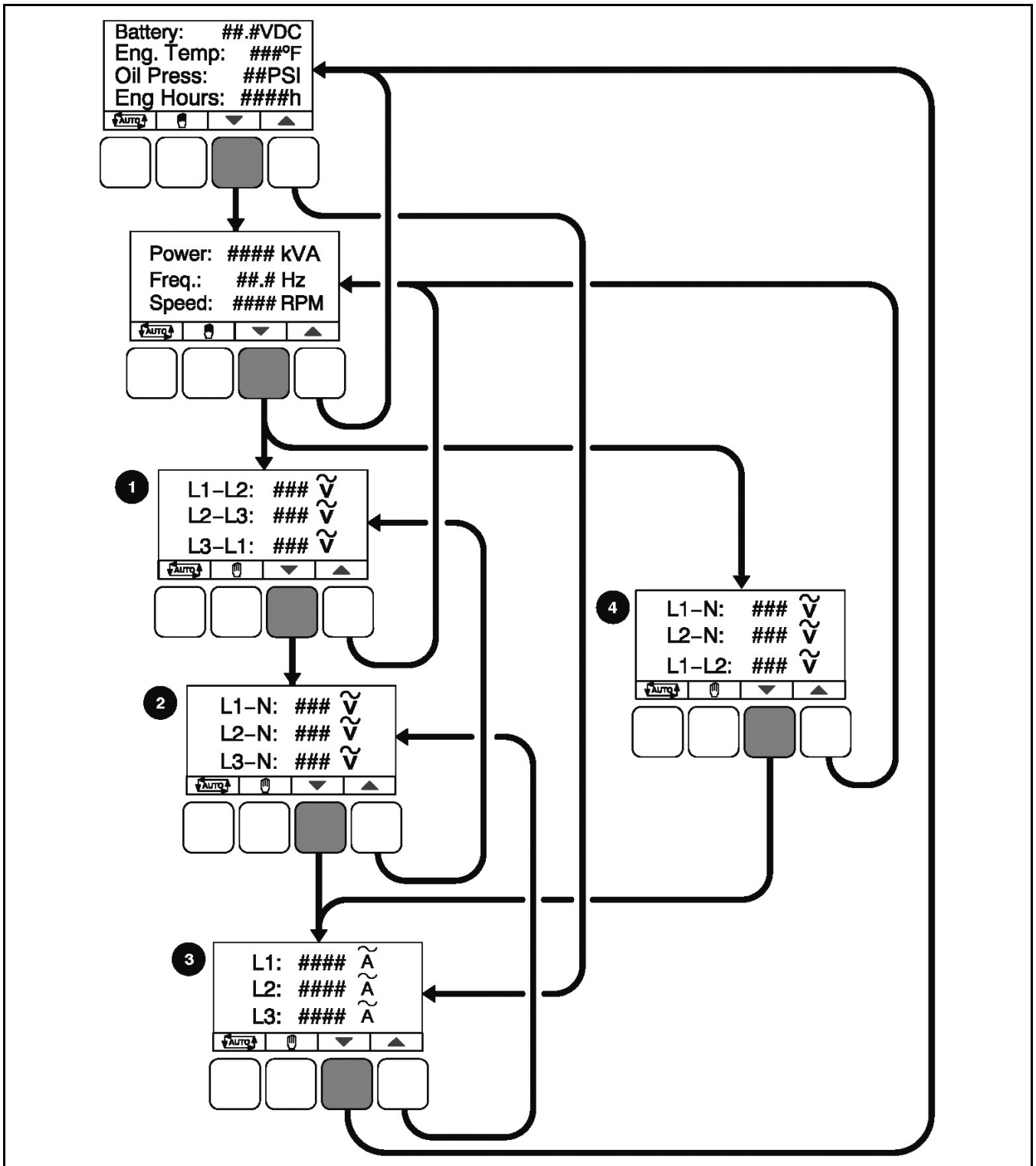
This menu displays line-to-neutral voltages for L1, L2, and L3 for 3-phase wye configurations only. In delta configurations, this menu is not shown.

4.4.5 Alternator Single Phase Voltage Menu

This menu displays L1-N, L2-N, and L1-L2 voltages for single phase applications only.

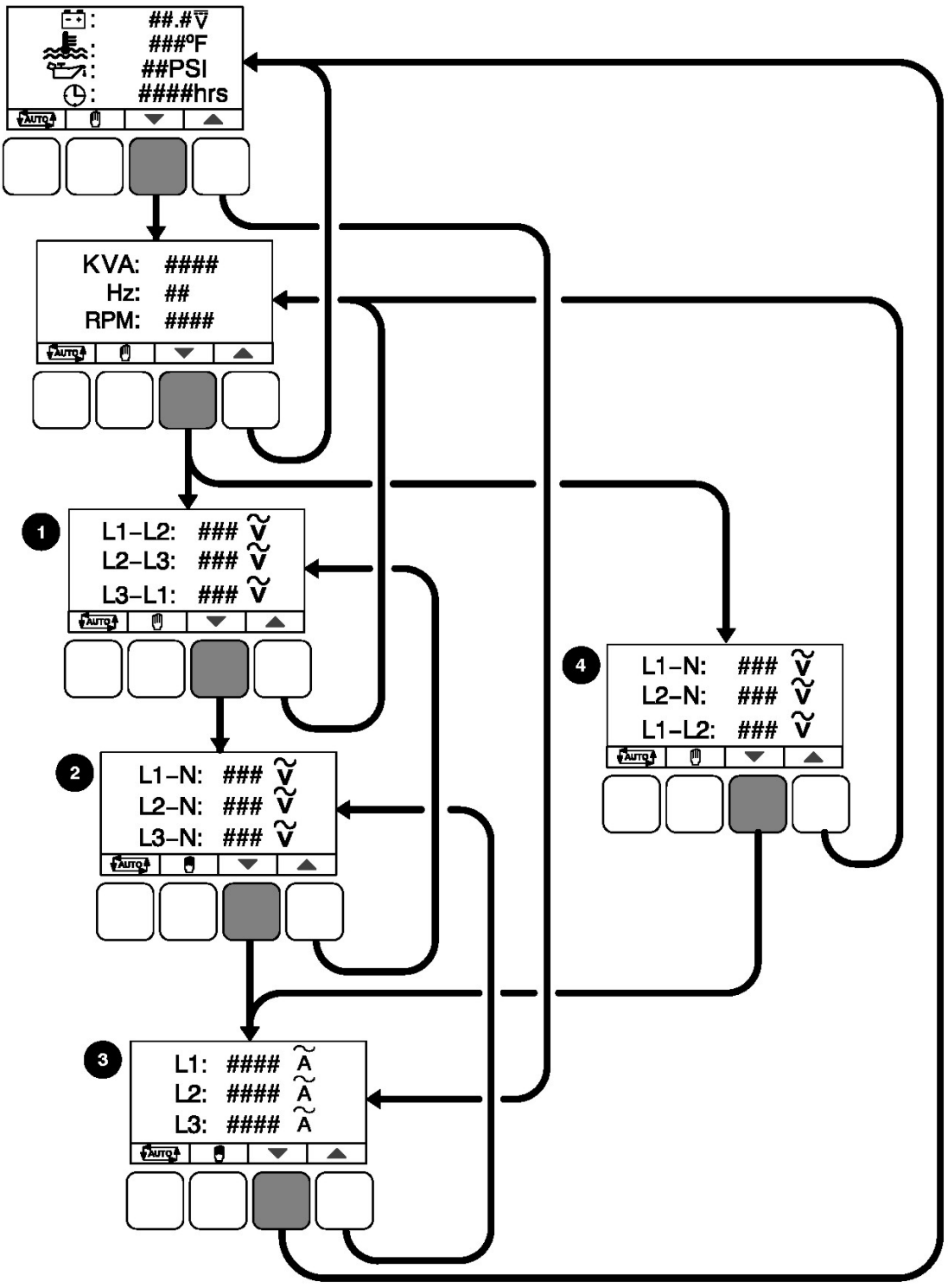
4.4.6 Alternator Amperage Menu

For applications that include current transformers, this menu displays L1, L2, and L3 current sense amperage.



1	Three Phase Only	3	Current Sense Amperage
2	Three Phase Wye Only	4	Single Phase Only

FIGURE 17. OPERATOR MENUS – TEXT VERSION



1	Three Phase Only	3	Current Sense Amperage
2	Three Phase Wye Only	4	Single Phase Only

FIGURE 18. OPERATOR MENUS – SYMBOLIC VERSION

4.5 Selecting Operating Modes

4.5.1 Passwords and Mode Change Access

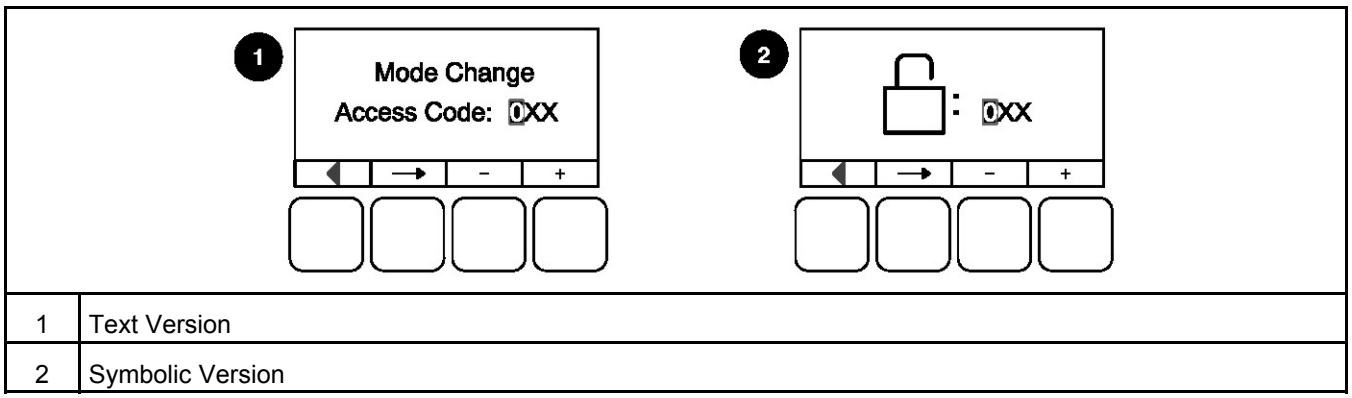
4.5.1.1 Entering the Mode Change Access Code

The Mode Change submenus are intended for qualified service personnel and site personnel only and require an access password. When a password is required, the Mode Change – Access Code menu is displayed when switching between Auto, Manual Run, or Off modes. The text and symbolic versions of the Mode Change menu are shown in the figure below.

To enter the mode change access code, use the + and – buttons to increase or decrease the values in the relevant field. Use the → button to move the cursor within a field. Selected fields will be highlighted.

1. With the required character highlighted, press the button below the + or – symbols until the required value is displayed.
2. Press the arrow selection button → to move to the next numeric character.
3. Repeat steps 1 and 2 until all three characters of the Access Code are correct.
4. After you have completed entering the password, press the → arrow selection button.

NOTICE
If an incorrect password is entered, the Operator menu that was displayed before Auto, Manual Run, or Off mode was selected is re-displayed.



1	Text Version
2	Symbolic Version

FIGURE 19. MODE CHANGE MENU

4.5.2 Selecting Manual Run Mode

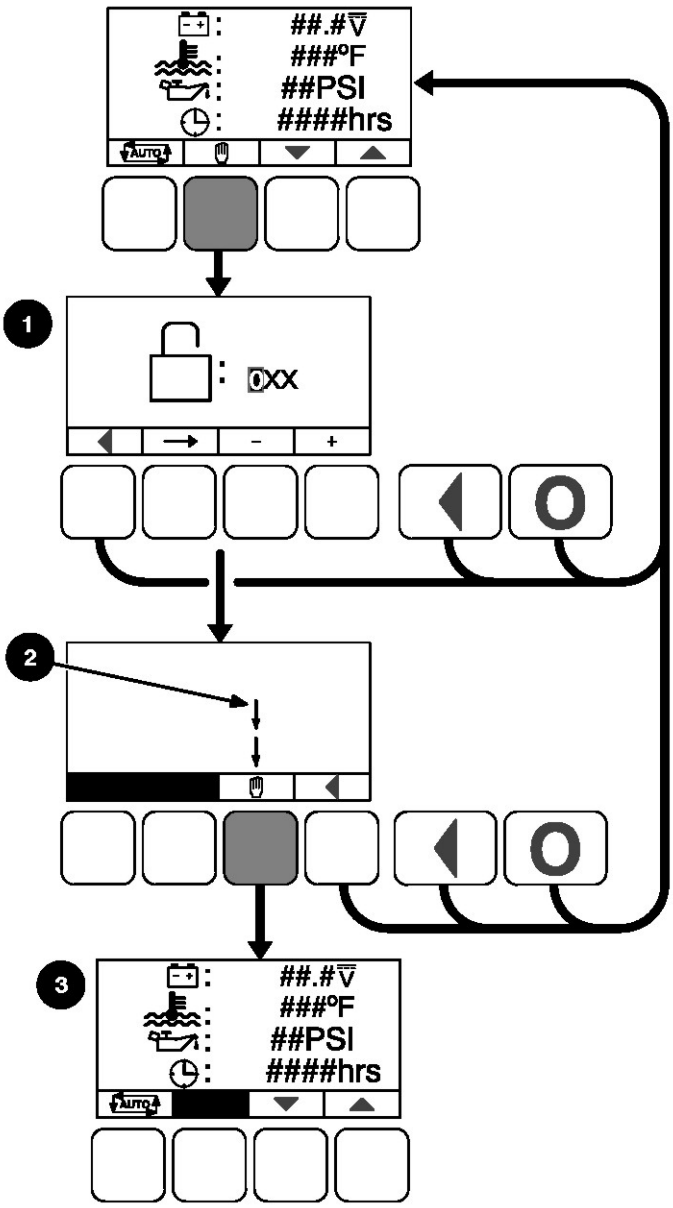
NOTICE
When changing modes, the generator set can start or stop without warning (For example: Auto Mode may have been selected with no mains (utility) power available). Make sure there is no danger to personnel or equipment, if the generator set starts or stops when changing modes.

1. Make sure that it is safe to do so before proceeding to change the mode.

2. Press the  **Manual Run** button on any of the Operator menus or the 'Establishing/Re-establishing communication with control' menus.
3. If the Mode Change Access Code menu is enabled, the Mode Change Access Code is displayed. Enter the Mode Change Access Code as previously described (see **Section 4.5.1 on page 39**).
4. A menu with alternating arrows is displayed above a second  symbol.
5. Press the second  **Manual Run** button, and the generator set will now begin the Manual start sequence. The Operator menu that was displayed before Manual Run mode was selected is re-displayed, but with the  symbol blacked out.

To disable Manual Run mode, press the **Off** button.

NOTICE
Auto mode can also be selected while in Manual Run mode. Switching to Auto mode may result in the generator set shutting down.



1	This menu is displayed only if the Mode Change Access Code feature is enabled
2	Alternating arrows are displayed
3	Manual Run mode selected

FIGURE 20. SELECTING MANUAL RUN MODE

4.5.3 Selecting Auto Mode

NOTICE
When changing modes, the generator set can start or stop without warning. Make sure there is no danger to personnel or equipment, if the generator set starts or stops when changing modes.

To switch to Auto mode (see **Figure 21 on page 43**),

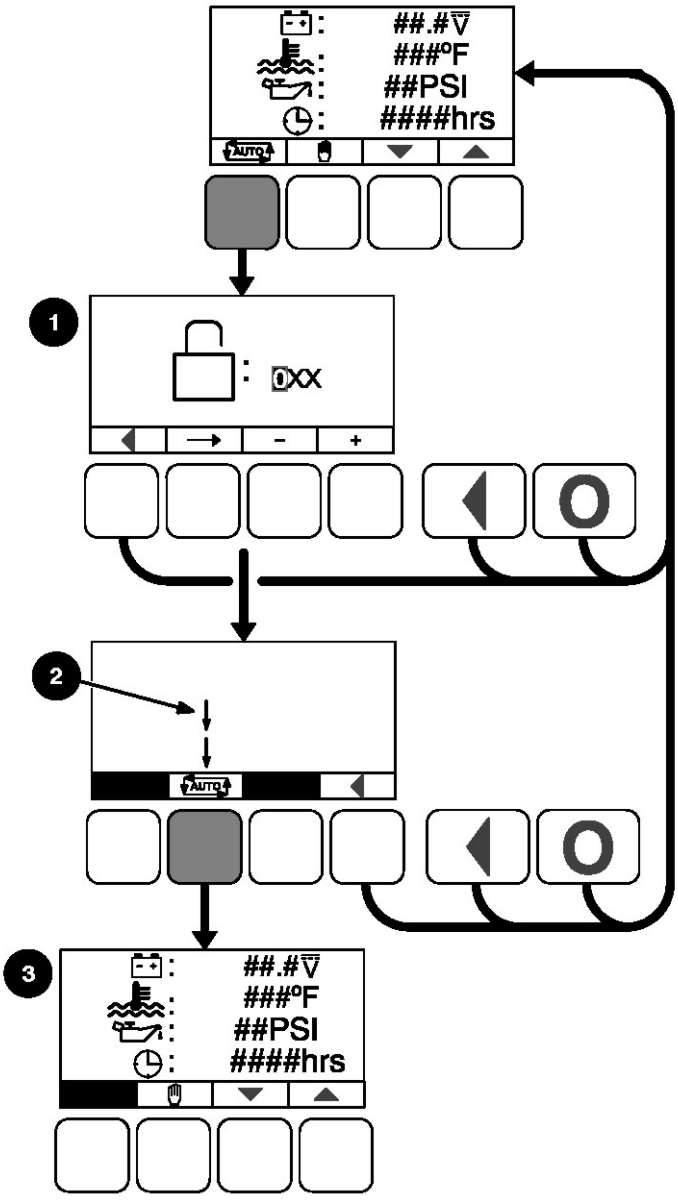
1. Ensure that it is safe to do so before proceeding to change the mode.
2. Press the AUTO **Auto** button on any of the Operator menus, or the 'Establishing/Re-establishing communication with control' menus.
3. If the mode change access code feature is enabled, the Mode Change Access Code menu is displayed. Enter the Mode Change Access Code as previously described (see **Section 4.5.1 on page 39**).
4. A menu with alternating arrows will then be displayed above a second AUTO Auto symbol.
5. Press this second AUTO **Auto** button. The Operator menu that was displayed before Auto mode was selected is re-displayed, but with the AUTO Auto symbols blacked out and Manual Run symbols visible.

To disable Auto mode, press the **Off** button.

The generator set is now ready to receive a remote start signal that will initiate the Auto run mode.

NOTICE
If a remote start signal is received, the generator set starts automatically. Make sure there is no danger to personnel or equipment if the generator set starts without warning.

NOTICE
Manual Run mode can also be selected from Auto mode. Switching to Manual Run mode results in the generator set starting up.



1	This menu is displayed only if the Mode Change Access Code feature is enabled
2	Alternating arrows are displayed
3	Auto mode selected

FIGURE 21. SELECTING AUTO MODE

4.5.4 Aborting the Transition to Auto or Manual Run Mode

If the Mode Change Access Code menu or the menu showing alternating arrows above the AUTO or buttons is displayed, the transition to Auto or Manual Run mode is aborted when:

- Any of the ◄, ◄ ,or Off buttons are pressed.

  Or

- A selection button is not pressed within ten seconds.

If the transition to Auto or Manual Run mode is aborted, the Operator menu that was displayed before Auto or Manual Run mode was selected is re-displayed.

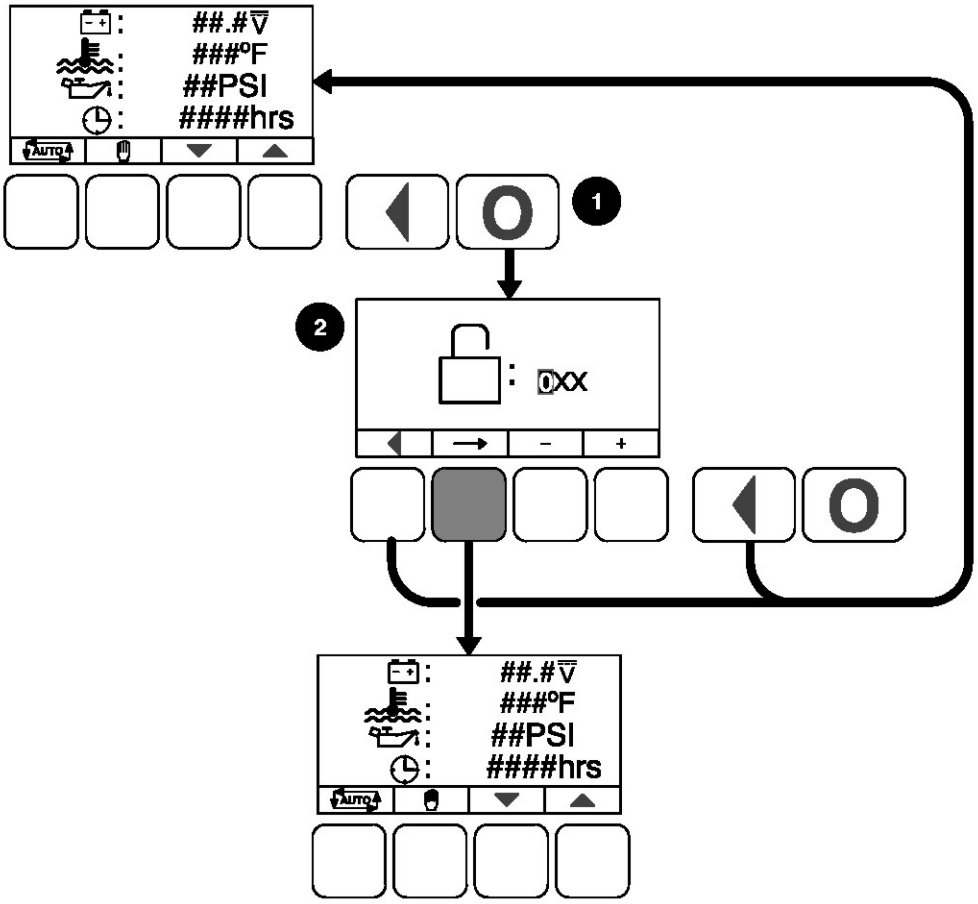
4.5.5 Selecting Off Mode

NOTICE
When changing modes, the generator set can stop without warning. Make sure there is no danger to personnel or equipment, if the generator set stops when changing modes.

To switch to Off mode (see the figure below),

1. Make sure that it is safe to do so before proceeding to stop the set.
2. Press the **Off** button on any of the Operator menus or the 'Establishing/Re-establishing communication with control' menus.
3. If the Mode Change Access Code is enabled, the Mode Change Access Code will be displayed. Enter the Mode Change Access Code as previously described (see **Section 4.5.1 on page 39**).
4. On entering the last correct digit, the basic screen will re-appear, and the set will stop without a Time Delay to Stop. Refer to **Section 5.7 on page 56**.

NOTICE
Make sure that there is no danger to personnel or equipment if the generator set is stopped.



1	Off Button
2	This mode is displayed only if the Mode Change Access Code feature is enabled

FIGURE 22. SELECTING OFF MODE

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5 Operation - PowerCommand 1.1

5.1 Safety

⚠ WARNING

Toxic Gases

Inhalation of exhaust gases can cause asphyxiation and death.

Use extreme care during installation to provide a tight exhaust system. Terminate exhaust pipes away from enclosed or sheltered areas, windows, doors, and vents. Do not use exhaust heat to warm a room, compartment, or storage area.

⚠ WARNING

Hazardous Voltage

Contact with high voltages can cause severe electrical shock, burns, or death.

Do not open the generator set output box while the generator set is running. Read and observe all warnings and cautions in the generator set manuals.

⚠ CAUTION

Hazardous Voltage

Contact with high voltages can cause severe electrical shock, burns, or death.

Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service. Even with the power removed, improper handling of components can cause electrostatic discharge.

Only trained and experienced personnel should carry out generator set operations. Before operating the system, the operator should become familiar with all health and safety procedures, warnings, cautions, precautions, and the other documentation supplied with the generator set. (See **Chapter 1 on page 1**). Observe all of the warnings and cautions at all times.

NOTICE

Before operating the generator set become familiar with the equipment and how it is operated (including all controls, manually operated valves, and alarm devices). Safe and efficient operation can only be achieved if the generator set is operated correctly.

5.2 Introduction

This section describes the operation of the generator set. The text should be read in conjunction with the *System Overview* and the *Control System* sections of this manual, together with the Operator's specific engine manual. This latter manual will contain further information regarding the running and care of the generator set and also specific equipment instructions that may differ from the standard generator set.

All indicators, control switches/buttons, and graphical display are located on the face of the Operator Panel as illustrated in **Figure 9 on page 28**.

5.3 Maintenance

To ensure maximum performance and reliability from your generator set, it is essential that certain components are inspected periodically and, where necessary, maintenance procedures are carried out, as detailed in **Chapter 6 on page 59**.

5.4 Operating Recommendations

5.4.1 Running-in

Refer to the *Maintenance* section of this manual: **Chapter 6 on page 59**. Special ‘running-in’ oils are not recommended for new or rebuilt Cummins engines. Use the same type of oil during ‘running-in’ as is used in normal operation.

The engine should be run at varying loads during the first few hours of operation to allow the components to 'bed in.' Avoid long periods of light load or full load running particularly during the early life of the engine.

5.4.2 No Load Operation

Periods of no load operation should be held to no longer than 15 minutes. Long periods of no load operation can result in engine and (if fitted) diesel particulate filter damage.

If it is necessary to keep the engine running for long periods of time when no electric output is required, best engine performance will be obtained by connecting a load of at least 30% rated load, but not to exceed rated load. Such a load could consist of a heater element or load bank.

5.4.3 Exercise Period

Generator sets on continuous standby must be able to go from a cold start to being fully operational in a matter of seconds. This can impose a severe burden on engine parts.

Regular exercising keeps engine parts lubricated, prevents oxidation of electrical contacts, and in general helps provide reliable engine starting.

Exercise the set for a minimum of ten minutes off-load at least once a week and for a minimum of 30 minutes with load at least once each month so that the engine reaches normal operating temperatures.

5.4.4 Low Operating Temperatures

Use a coolant heater if a separate source of power is available. The optional heater available from Cummins Power Generation will help provide reliable starting under adverse weather conditions. Make sure the voltage of the separate power source is correct for the heater element rating.

5.4.5 High Operating Temperatures

In high ambient temperatures, when operating at full load, it is normal for the high temperature warning to be given. This indicates that the engine is operating near to its maximum capacity and is normal. If operation in high temperature environments is anticipated, increase the frequency of checks for coolant level, obstructions of cooling air inlets and outlets, and debris at the radiator.

Refer to the generator set nameplate for the maximum operating temperature, if applicable.

5.4.6 Operating Conditions

NOTICE

All generator sets supplied by Cummins Power Generation must be run under the following operating conditions, and in accordance with the operating information contained within the literature package supplied with each generator set.

5.4.6.1 Continuous Power Rating (COP) for Constant Load Applications

The Continuous Power Rating (COP) is applicable to utility parallel and other non-variable load applications for supplying power continuously to a load of up to 100% of the continuous rating for an unlimited number of hours per year between the stated maintenance intervals and under stated ambient conditions. All maintenance must be carried out as prescribed in Cummins Power Generation manuals. No overload capability is available at this rating. This rating is applicable for utility base load operation. In these applications, generator sets are operated in parallel with a utility source and run under constant loads for extended periods of time.

5.4.6.2 Prime Power Rating (PRP)

The Prime Power Rating (PRP) is the maximum power available during a variable load sequence which may be run for an unlimited number of hours per year, between the stated maintenance intervals and under the stated ambient conditions. All maintenance must be carried out as prescribed in Cummins Power Generation manuals. Prime power applications fall into one of the following two categories:

- Unlimited time prime power (for variable load applications)

  Prime power is available for an unlimited number of annual operating hours in variable load applications. The permissible average power output under variable load shall not exceed a 70% average of the prime power rating during any operation of 250 hours. The total operating time at 100% prime power shall not exceed 500 hours per year. A 10% overload capability is available for a period of 1 hour within a 12-hour period of operation, in accordance with ISO 8528-1 2005. Total operating time at the 10% overload power shall not exceed 25 hours per year.

- Limited running time prime power (for constant load applications) (LTP)

  Prime power is available for a limited number of hours in a non-variable load application. It is intended for use in situations where power outages are contracted, such as utility power curtailment. Generator sets may be operated in parallel with the public utility up to 750 hours per year at power levels never to exceed the prime power rating. No sustained overload capability is available at this rating. The customer should be aware, however, that the life of any generator set will be reduced by constant high load operation. Any operation exceeding 750 hours per year at the prime power rating should use the Continuous Power Rating.

5.4.6.3 Emergency Standby Power Rating (ESP) for Variable Load Applications

The Emergency Standby Power Rating (ESP) is applicable for supplying emergency power for the duration of a utility power interruption, between the stated maintenance intervals and under the stated ambient conditions. All maintenance must be carried out as prescribed in Cummins Power Generation manuals. No overload capability is available for this rating and utility parallel operation is not permitted at the standby power rating. For applications requiring sustained utility parallel operation, the limited time prime power rating or continuous power rating must be utilized as applicable.

This rating is applicable to installations served by a reliable normal utility source. Generator sets should be sized for a maximum average load factor of 80% of the standby power rating with a maximum of 200 hours of operation per year, which includes less than 25 hours per year at the standby power rating. In installations served by unreliable utility sources (where outages last longer or occur more frequently), where operation is likely to exceed 200 hours per year, the prime power rating should be applied. The standby rating is only applicable for emergency and standby applications where the generator set serves as the back up to the normal utility source. Negotiated power outages are not considered as emergencies.

5.4.6.4 Applicable to all Ratings

The following information applies to all ratings, unless otherwise agreed by the Regional Sales Manager of Cummins Power Generation in writing:

- When determining the actual average power output of a variable power sequence in any of the ratings above, powers of less than 30% of the emergency standby power are taken as 30% and time at no load shall not be counted.
- Variable load is calculated in accordance with methods and formulas given in ISO 8528-1-2005.
- All three-phase generators are rated for 0.8 power factor lag. Single-phase generators are rated for 1.0 power factor.
- All ratings are based on the following reference conditions:
  1. Ambient temperature — 27 °C (81 °F).
  2. Altitude above sea level — 150 meters (490 feet).
  3. Relative humidity — 60%.
  4. Output power may be subject to de-rate if the above conditions are exceeded.
- If any of the above conditions are not satisfied, the operational life of the generating set may be reduced.
- Short term parallel operation with the utility for load transfer purposes only is permitted with all ratings.

5.4.7 De-Rating Factors

Engine power and resulting electrical output decrease as ambient temperature or altitude increases. For de-rating factors applicable at specific sites, contact your authorized distributor.

5.5 Generator Set Operation

⚠ WARNING

Combustible Vapors

Engine over speeding can cause component failure, fire, or an explosion; which can cause severe personal injury or death.

Do not operate an engine where there are or can be combustible vapors.

Correct care of the engine will result in longer life, better performance, and more economical operation.

Numerous safety devices may be available, such as air intake shutoff devices, to minimize the risk of overspeeding in which an engine, because of application, might operate in a combustible environment (from a fuel spill or gas leak, for example). Cummins Power Generation does not know how the engine will be used. The equipment owner and operator, therefore, is responsible for safe operation in a hostile environment. Consult your authorized distributor for further information.

NOTICE

Cummins Power Generation recommends the installation of an air intake shutoff device or a similar safety device to minimize the risk of overspeeding where an engine will be operated in a combustible environment.

NOTICE

Long periods of idling (more than ten minutes) can damage an engine. Do not idle the engine for excessively long periods.

5.5.1 Sequence of Operation

The generator set is run automatically using a **Remote Start** signal, or manually using the generator set control panel buttons. LEDs are provided on the operator panel to indicate the operating run mode of the generator set. The PowerCommand® control initiates a starter cranking signal and performs an automatically sequenced manual start, under a complete engine protection system combined with full monitoring capability. If a fault is sensed at start-up, the engine is locked out and will not start.

The choice of **Auto** or **Manual Run** mode is decided by authorized personnel during the generator set initial setup. An access code is required to switch between the **Auto**, **Manual Run**, or **Off** modes, and this facility may be permitted or denied by the authorized personnel during the initial setup of the generator set.

5.6 Starting

NOTICE

One operator should be in complete charge, or working under the direction of someone who is in charge. Remember that, upon starting the engine, cables and switchgear will become energized, possibly for the first time. Furthermore, equipment that does not form part of the generator set installation may become electrically charged. Only authorized and competent personnel should carry out this work.

NOTICE

Do not use the Emergency Stop button to shut down an engine unless a serious fault develops. The Emergency Stop button must not be used for a normal shut-down as this will prevent a cooling down run in which the lubricating oil and engine coolant carry the heat away from the engine combustion chamber and bearings in a safe manner.

NOTICE

Avoid off-load running for other than short periods. A minimum loading of 30% is recommended. The engine must be shut down as soon as possible after the appropriate functions have been checked.

Before attempting to start the generator set, the operator should read through this entire manual and the specific literature provided as part of the documentation pack supplied with the generator set. It is essential that the operator be completely familiar with the generator set and the PowerCommand® control.

The following sub-sections cover the systems used to start and stop the generator set.

Before starting the generator set, make sure that exhaust and fuel fittings are tight and properly positioned, and that proper maintenance and pre-start checks have been performed.

During starting automatic checks are carried out for the integrity of various protection systems. The PowerCommand® control will not allow the generator set to continue the starting sequence if the integrity of a sensor is considered to be in doubt.

The generator set can be configured for a number of starting cycles (one to seven) with set times for crank and rest periods for all starting modes (manual/remote). The default setting is for three start cycles, composed of fifteen seconds of cranking and 30 seconds of rest.

NOTICE

The number of starting cycles, and the crank and rest times are set from within the Setup menu. Trained and experienced service personnel are required to change the default setting. Contact your authorized distributor.

5.6.1 Initial Pre-start Checks

⚠ WARNING

Electric Shock Hazard

Voltages and currents present an electrical shock hazard that can cause severe burns or death.

Make sure that only personnel who are trained and experienced work with distribution voltages. Even after generator set shutdown, an electrical shock hazard may still exist, caused by induced or residual voltage within the alternator or cables. Some interfaces may display zero voltage even when voltages are present.

⚠ WARNING

Hot Pressurized Liquid

Contact with hot liquid can cause severe burns.

Do not open the pressure cap while the engine is running. Let the engine cool down before removing the cap. Turn the cap slowly and do not open it fully until the pressure has been relieved.

Before starting, be sure competent personnel have made the following checks to ensure that the unit is ready for operation:

- Generator Set Grounding – Grounding (Earthing) must be checked prior to performing service or inspection procedures that may expose personnel to conductors normally energized with voltages greater than 600 Volts. Contact your authorized distributor.
- Megger and Insulation Testing – This must be performed on all generator sets before initial start-up and after the generator set Grounding Procedure has been completed. Insulation testing for low voltage (less than 600 Volts) generator sets is recommended by Cummins Power Generation. These tests are used to verify that the windings are dry before the generator set is operated, and to develop a base line for future test comparisons. Contact your authorized distributor.

NOTICE

When Megger testing an alternator, failure to protect the voltage regulator, control and diodes could result in permanent damage to one or more of the electronic components.

- Lubrication – Check the engine lubrication oil level and ensure that the correct level is always maintained.

NOTICE

Generator sets may be shipped dry. They must be filled with the correct type and quantity of oil before use. Be sure to check oil level before initial start. Failure to fill to the recommended level can result in equipment damage.

- Coolant – Check the engine coolant level and ensure that the level is always maintained. Fill the cooling system to the bottom of the fill neck in the radiator fill or expansion tank. Do not check while the engine is hot.

NOTICE

It is essential that Cummins Power Generation's recommendations for the correct type and concentration of anti-freeze and DCA inhibitor are complied with. Warranty claims for damage will be rejected if the incorrect mix has been used. Consult your authorized distributor for the correct anti-freeze specifications and concentration for your operating conditions.

NOTICE

Some radiators have two fill necks, both of which must be filled after the cooling system has been drained.

NOTICE

Generator sets may be shipped dry. They must be filled with the correct type and quantity of coolant before use. Be sure to check coolant level, or levels, before initial start.

5.6.2 Operator's Pre-start Checks

⚠ WARNING

Arc Flash and Shock Hazard

Electric arc flash can cause electrical shock, severe burns, or death.

Make sure the alternator is dry before the generator set is operated.

⚠ WARNING

Hot Pressurized Liquid

Contact with hot liquid can cause severe burns.

Do not open the pressure cap while the engine is running. Let the engine cool down before removing the cap. Turn the cap slowly and do not open it fully until the pressure has been relieved.

NOTICE

Some radiators have two fill necks, both of which must be filled when the cooling system has been drained.

- Fuel Supply – Make sure the fuel tank is filled to the normal level with clean water-free fuel and that the fuel system is primed and all the valves required for operation are open. Make sure there are no leaks and that all fittings are tight.
- Lubrication – With the engine stationary, check the engine lubrication oil level and ensure that the correct level is always maintained.

- Coolant – Check the engine coolant level and make sure that the level is always maintained at the coolant expansion tank. Fill the cooling system to the bottom of the fill neck in the radiator fill or expansion tank. Do not check while the engine is hot.
- Cooling Air Inlet/Outlets – Make sure that the cooling air inlets/outlets are unobstructed.
- Exhaust Outlet **–** Make sure that exhaust components are secured and not warped; that the exhaust outlet is unobstructed; that no combustible materials are near the system, and gases are discharged away from building openings. Make sure that there are no leaks and that all fittings are tight.
- Batteries – Make sure that the batteries are charged and that all connections are correct and tight.
- Auxiliary AC Supplies – Make sure that all auxiliary equipment is receiving power from the customer's supply.
- Emergency Stop – Make sure that the emergency stop button is fully operational.

5.6.3 Starting at the Operator Panel (Manual Run Mode)

NOTICE
Make sure that all pre-start checks are carried out before starting the generator set. Do not attempt to start the generator until it is safe to do so. Warn all others in the vicinity of both the generator and the connected load equipment that the generator set is about to start.

NOTICE
One operator should be in complete charge, or working under the direction of someone who is in charge. Remember that, upon starting the engine, cables and switchgear become energized, possibly for the first time. Furthermore, equipment that does not form part of the generator installation may become electrically charged. Only trained and experienced personnel should carry out this work.

NOTICE
Do not use an Emergency Stop button to shut down an engine unless a serious fault develops. The Emergency Stop button must not be used for a normal shut-down, as this will prevent a cooling down run in which the lubricating oil and engine coolant carry heat away from the engine combustion chamber and bearings in a safe manner.

NOTICE
Avoid off-load running for other than short periods. A minimum loading of 30% is recommended. This loading will help to prevent the build up of carbon deposits in the injectors, due to unburnt fuel, and reduce the risk of fuel dilution of the engine lubricating oil. The engine must be shutdown as soon as possible after the appropriate functions have been checked.

Make sure the main circuit breaker is in the open position.

To start the generator set in the **Manual Run** mode, select the  symbol from the menu bar of the operator panel. Follow the instructions in Section 4.5.2.

NOTICE
Any Remote Start/Stop signal is ignored while in Manual Run mode.

Under a complete engine protection system combined with full monitoring capability, the PowerCommand® control initiates a starter cranking signal and performs an automatically sequenced manual start. This activates the engine control system and the starting procedure. The starter begins cranking, and after a few seconds the engine starts and the starter disconnects.

In **Manual Run** mode, the control will not complete **Time Delay to Start** or **Time Delay to Stop**.

The **Not in Auto** red LED, and the **Manual Run** green LED, are lit.

If the engine does not start, the starter disengages after a specified period of time and the control indicates a **Fail to Start Shutdown**.

Wait a minimum of two minutes for the starter motor to cool and then repeat the starting procedure. If the engine does not run after a second attempt, refer to **Chapter 7**.

5.6.4 Starting from a Remote Location (Auto Mode)

NOTICE
Make sure that all pre-start checks are carried out before starting the generator set. Do not attempt to start the generator until it is safe to do so. Warn all others in the vicinity that the generator set is about to start.

To start the generator set in the **Auto Run** mode, select the 

symbol from the menu bar of the operator panel. Follow the instructions in **Section 4.5.3 on page 41**.

The **Auto**, green LED lights.

Only on receipt of a remote start signal, and after a **Time Delay to Start**, does the PowerCommand® control initiate the starting sequence as above.

The **Remote Start** LED lights.

5.6.5 Cold Starting with Loads

NOTICE
Make sure that all pre-start checks are carried out before starting the generator set. Do not attempt to start the generator set until it is safe to do so. Warn all others in the vicinity that the generator set is about to start.

Use a coolant heater if a separate source of power is available. The optional heater available from Cummins Power Generation will help provide reliable starting under adverse weather conditions. Be sure the voltage of the separate power source is correct for the heater element rating.

Cummins Power Generation recommends equipping standby generator sets (life safety systems) with engine water jacket coolant heaters to maintain the coolant at a minimum of 32 °C (90 °F) and, for most applications, accept the emergency load in ten seconds or less. Although most Cummins Power Generation generator sets will start in temperatures down to -32 °C (-25 °F) when equipped with engine water jacket coolant heaters, it might take more than ten seconds to warm the engine up before a load can be applied when ambient temperatures are below 4 °C (40 °F).

To advise the Operator of a possible delay in accepting the load, the **Low Coolant Temp (code 1435)** message, in conjunction with illumination of the **Warning** LED, is provided. The engine cold sensing logic initiates a warning when the engine water jacket coolant temperature falls below 21 °C (70 °F). In applications where the ambient temperature falls below 4 °C (40 °F), a cold engine may be indicated even though the coolant heaters are connected and functioning correctly. Under these conditions, although the generator set may start, it may not be able to accept load within ten seconds. When this condition occurs, check the coolant heaters for correct operation. If the coolant heaters are operating correctly, other precautions may be necessary to warm the engine before applying a load.

5.6.5.1 Checking Coolant Heater Operation

⚠ WARNING

Hot Surfaces

Contact with the hot surfaces can cause severe burns.

Avoid contact with hot parts. Allow hot parts to completely cool.

Do not touch the cooling system outlet hose. The coolant heater is operating if radiant heat can be felt with your hand held close to the outlet hose and the engine is not running.

5.7 Stopping

NOTICE

The access code may be required before initiating the Off button sequence. Refer to Section 4.5.1 on page 39.

NOTICE

Run the generator set at no load for three to five minutes before stopping. This allows the lubricating oil and engine coolant to carry heat away from the combustion chamber and bearings.

5.7.1 Stopping at Operator Panel (Manual Mode)

The control will not respond to any remote stop signal when in **Manual Run** mode. When in **Manual Run** mode, pressing the **Off** button will initiate a normal (Manual) shutdown sequence.

In the **Manual Run** mode the control will not complete the time delay stop.

Reduce engine heat before pressing the **Off** button.

1. Remove the load.
2. Run the set for five minutes.
3. Press the **Off** button.

5.7.2 Stopping from Remote Location (Auto Mode)

In **Auto** mode, the control allows the generator set to be started with a remote start signal only.

If the control receives a remote stop signal, the generator set will complete its normal shutdown sequence which includes a time delay stop.

If the generator set is running in **Auto** mode and the **Off** button is pressed, the control immediately stops the generator set and the control transitions to the **Off** mode.

5.7.3 Emergency Stop (Code 1433 or 1434)

The local Emergency Stop Button is situated on the front of the operator panel. This is a mechanically latched switch that will unconditionally stop the engine when pressed, bypassing any time delay to stop. Push this button in for Emergency Shutdown of the engine.

NOTICE
If the engine is not running, pushing the button in prevents the starting of the engine, regardless of the start signal source (Manual or Auto - remote).

When the Emergency Stop Button is pressed, the display panel indicates the **Shutdown** condition by illuminating the red **Shutdown** status LED  and displaying the following message on the graphical LCD display:

Fault Number: 1433 LOCAL EMERGENCY STOP

A Remote Emergency Stop button may be incorporated within the installation. If this Stop button is activated, the following message is displayed:

Fault Number: 1434 REMOTE EMERGENCY STOP

To reset:

1. Pull, or twist and pull the button out.
2. Press the **Off** button on the Operator Panel to acknowledge this action.
3. Press the **Auto** or **Manual Run** button, as previously determined.

NOTICE
Do not use an Emergency Stop button to shut down an engine unless a serious fault develops. The Emergency Stop button must not be used for a normal shut-down as this will prevent a cooling down run in which the lubricating oil and engine coolant carry away heat from the engine combustion chamber and bearings in a safe manner.

NOTICE
Make sure the remote start control is not active or when the Emergency Stop is reset the generator set could start running.

NOTICE
Make sure that the cause of the emergency stop is fully investigated and remedied before a fault Reset and generator Start are attempted.

NOTICE
An external Emergency Stop button is situated in close proximity to the control panel viewing window in enclosed generator sets.

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6 Maintenance

⚠ WARNING

Automated Machinery

Accidental or remote starting of the generator set can cause severe personal injury or death.

Make sure that the generator set can not be started accidentally or remotely before starting work on the generator.

⚠ WARNING

Fall Hazard

Falls can result in severe personal injury or death.

Make sure that suitable equipment for performing tasks at height are used in accordance with local guidelines and legislation.

⚠ WARNING

Mechanical Hazard

Failed components may be ejected or operate incorrectly which can cause severe personal injury or death.

Do not climb the generator set; this may damage critical parts.

⚠ WARNING

Combustible Gases

Ignition of battery gases is a fire and explosion hazard which can cause severe personal injury or death.

Do not smoke, or switch the trouble light ON or OFF near a battery. Touch a grounded metal surface first before touching batteries to discharge static electricity. Stop the generator set and disconnect the battery charger before disconnecting battery cables. Using an insulated wrench, disconnect the negative (–) cable first and reconnect it last.

⚠ WARNING

Electric Shock Hazard

Voltages and currents present an electrical shock hazard that can cause severe burns or death.

Make sure that only personnel who are trained and experienced work with distribution voltages. Even after generator set shutdown, an electrical shock hazard may still exist, caused by induced or residual voltage within the alternator or cables. Some interfaces may display zero voltage even when voltages are present.

⚠ WARNING

Electrical Generating Equipment

Incorrect operation and maintenance can result in severe personal injury or death

Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service.

NOTICE

Only authorized and qualified maintenance technicians, who are familiar with the equipment and its operation, should carry out maintenance.

NOTICE

Dependent upon the control system fitted, this unit may operate automatically and could start without warning.

NOTICE

Before carrying out any maintenance work, become familiar with Section 1.3 on page 4, together with all the documentation supplied with the generator set.

NOTICE

Always disconnect a battery charger from its AC source before disconnecting the battery cables. Failure to do so can result in voltage spikes high enough to damage the DC control circuits of the generator set.

All maintenance tasks must be assessed for health and safety risks, the preventative measures identified must be actioned. Accompaniment is required for tasks where the presence of someone else will add significantly to the safety of the task.

Read, understand, and comply with all Caution and Warning notes in this section, those contained within Chapter 1 on page 1, and those contained within the documentation supplied with the generator set.

Ensure adequate lighting and staging (where required) are installed.

NOTICE

Before carrying out any maintenance work, lock the generator set out of service for safe working.

6.1 Locking the Generator Set Out of Service

Before any work is carried out for maintenance, etc., the generator set must be immobilized. Even if the generator set is put out of service by pressing the **Off** switch on the operator panel, the generator set cannot be considered safe to work on until the engine is properly immobilized, as detailed in the following procedures.

NOTICE

Refer also to the engine specific Operator Manual. This manual contains specific equipment instructions that may differ from the standard generator set.

6.1.1 Immobilizing for Safe Working

To immobilize the generator set:

1. Press the **Off** mode switch on the operator panel to shut down the generator set.
2. Press the **Emergency Stop button**. This prevents the generator set starting, regardless of the Start signal source and provides an additional safety step for immobilizing the generator set.

NOTICE

When the Emergency Stop button is pressed, the operator panel indicates a Shutdown condition. The red Shutdown status LED illuminates and a message is displayed.

NOTICE

This condition is stored in the Fault History.

3. As an additional precaution, thoroughly ventilate the plant room before disconnecting any leads.
4. Isolate and lock off the supply to the heater, where fitted.
5. Isolate and lock off the supply to the battery charger, where fitted.
6. Isolate the fuel supply to the engine.
7. Using an insulated wrench, disconnect the negative (**–**) cable first on the starting batteries and control system batteries (if separate).
8. Fit warning notices at each of the above points to indicate Maintenance in Progress **–** Plant Immobilized for Safe Working.

6.2 Periodic Maintenance

The periodic maintenance procedures should be performed at whichever interval occurs first. At each scheduled maintenance interval, perform all previous maintenance checks that are due for scheduled maintenance.

The tabular data that follows gives the recommended service intervals for a generator set on Standby service. If the generator set will be subjected to Prime usage or extreme operating conditions, the service intervals should be reduced accordingly.

Some of the factors that can affect the maintenance schedule are:

- Use for continuous duty (prime power)
- Extremes in ambient temperature
- Exposure to elements
- Exposure to salt water
- Exposure to windblown dust or sand

Consult with an authorized distributor if the generator set will be subjected to any extreme operating conditions and determine if extra protection or a reduction in service intervals is needed. Use the running time meter to keep an accurate log of all service performed for warranty support. Perform all service at the time period indicated, or after the number of operating hours indicated, whichever comes first.

6.2.1 Periodic Maintenance Schedule

TABLE 4. PERIODIC MAINTENANCE SCHEDULE 8 TO 500 HOURS

MAINTENANCE ITEMS	Daily or after 8 Hours	Weekly or after 50 Hours	Monthly or after 100 Hours	Yearly or after 250 Hours	Yearly or after 500 Hours
Perform maintenance tasks as specified using Daily or Hourly periods – whichever is the sooner					
General Genset Inspection	X[1, 2]				
Check Coolant Heater	X				
Check Oil Level	X				
Check Coolant Level	X				
Check Fuel Level	X				
Check Charge Air Piping		X[1]			
Check Air Cleaner		X[3]			
Check Battery Charging System		X			
Drain Fuel Filter(s)		X[1, 5]			
Drain Water and Sediment from Fuel Tank			X[5]		
Drain Exhaust Condensate Trap			X		
Check Starting Batteries			X		
Check Drive Belt			X[4]		
Replace lubricant oil and filters				X[1]	
Check Anti-freeze and DCA Concentration				X[1]	
Check Radiator Hoses for Wear and Cracks				X	
Change Air Cleaner Element				X[3]	
Change Crankcase Oil and Filter					X[6]
Change Fuel Filters					X[1]
Clean Cooling System					X[1, 3]
Test Rupture Basin Leak Detect Switch					X[8]
Check Valve Lash	**After 5000 hours[1, 7]**				

MAINTENANCE ITEMS	Daily or after 8 Hours	Weekly or after 50 Hours	Monthly or after 100 Hours	Yearly or after 250 Hours	Yearly or after 500 Hours
1. Refer to Cummins Engine Owners Manual for maintenance information. 2. Check for oil, fuel, cooling and exhaust system leaks. Check exhaust system audibly and visually with set running and repair any leaks immediately. 3. Perform more often in dusty conditions. 4. Visually check belt for evidence of wear or slippage. Replace if hard or brittle. 5. Drain 1 cup or more of fuel to remove water and sediment. 6. If used for prime power application, refer to Cummins Engine Owners Manual for maintenance interval. 7. Contact an authorized service center for service. 8. Check leak detect switch in sub-base fuel tank, once a year or as required by safety code. Contact your authorized service center.					

6.3 Maintenance Procedures - Daily or When Refueling

Monitor fluid levels, oil pressure, and coolant temperature frequently. During operation, be alert for mechanical problems that could create unsafe or hazardous conditions. The following sections cover several areas that should be frequently inspected for continued safe operation.

NOTICE
Components that have guards against inadvertent touching must be visually inspected only. Do not remove the guards to do the inspection.

6.3.1 General Information

Preventative maintenance begins with day-to-day awareness of the condition of the generator set.

Before starting the generator set, check and look for:

- Oil and Coolant Levels
- Leaks
- Loose or damaged parts
- Worn or damaged belts
- Any change in engine noise or performance
- Generator set appearance

6.3.2 Engine Operation Report

The engine must be maintained in good mechanical condition if the operator is to obtain optimum satisfaction from its use. Running reports are necessary to enable programmed or emergency servicing to be carried out .

Comparison and intelligent interpretation of the running report, together with a practical follow-up action will eliminate most failures and emergency repairs.

Most engine problems give an early warning. Look and listen for changes in engine performance, sound, or appearance that can indicate service or repair is needed. Some engine changes to look for and report on are:

- Low lubricating oil pressure
- Low power
- Abnormal water or oil temperature
- Unusual engine noise
- Excessive use of coolant, fuel or lubricating oil
- Any coolant, fuel, or lubricating oil leaks
- Misfire
- Unexplained frequency fluctuation
- Significant vibration
- Excessive white and/or black exhaust smoke.

6.4 Cooling System

NOTICE
Loss of coolant can allow engine to overheat if it does not have protection of shutdown device. This can cause severe damage to the engine. Maintain coolant level for proper operation of high engine temperature shutdown system.

6.4.1 Coolant Level - Check

⚠ WARNING
Scalding
Do not remove the radiator cap from a hot engine; Failure to do so can result in personal injury from heated coolant spray or steam.
Wait until the temperature is below 50 °C (122 °F) before removing pressure cap. Remove filler cap slowly to release coolant system pressure.

⚠ CAUTION
Skin Infection
Avoid prolonged or repeated skin contact with antifreeze to prevent skin infections.
Comply with all local health and safety regulations/codes when handling or disposing of antifreeze.

⚠ CAUTION
Cold coolant.
Engine castings can be damaged.
Do not add cold coolant to a hot engine, allow the engine to cool to below 50 °C (122 °F) before adding coolant.

NOTICE

Never use a sealing additive to stop leaks in the coolant system. This can result in a blocked coolant system and inadequate coolant flow causing the engine to overheat.

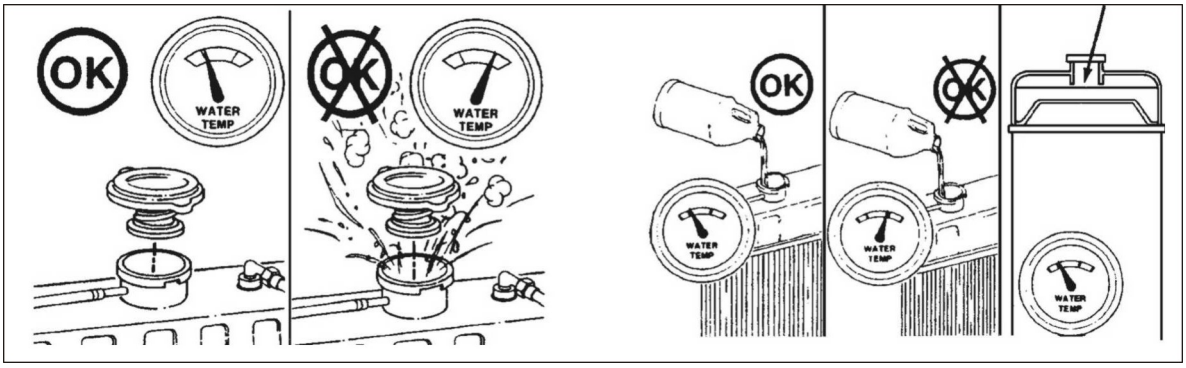


FIGURE 23. COOLANT LEVEL PROCEDURE

Coolant level must be checked daily. The standard coolant concentration is 50% Ethylene Glycol and water, this concentration must be maintained. Warranty claims for damage will be rejected if the incorrect mix of anti-freeze has been used. Consult your authorized distributor for the correct anti-freeze specifications and concentration for your operating conditions. The recommended antifreeze is Fleetguard® Compleat ES which is a low-silicate antifreeze, or its equivalent.

NOTICE

On applications that use a coolant recovery system, check to make sure the coolant is at the appropriate level on the coolant recovery tank dependent on engine temperature.

Fill the cooling system with coolant to the bottom of the fill neck in the radiator or expansion tank, with the coolant temperature at 50 °C (122 °F) or lower.

NOTICE

Some radiators have two fill necks, both of which must be filled. Refer to the generator set specific drawings supplied with the set.

6.4.2 Cooling Fan - Inspection

⚠ WARNING

Moving Parts

Moving parts can cause severe personal injury.

Use extreme caution around moving parts. All guards must be properly fastened to prevent unintended contact.

NOTICE

Never pull or pry on the fan, this can damage the fan blade(s) and cause fan failure.

A visual inspection of the cooling fan is required daily. Check for loose rivets or retaining bolts (1), for cracks (2), and bent or loose blades (3).

Do not operate the generator set with a damaged fan. Contact your authorized distributor for repair or replacement of a damaged fan.

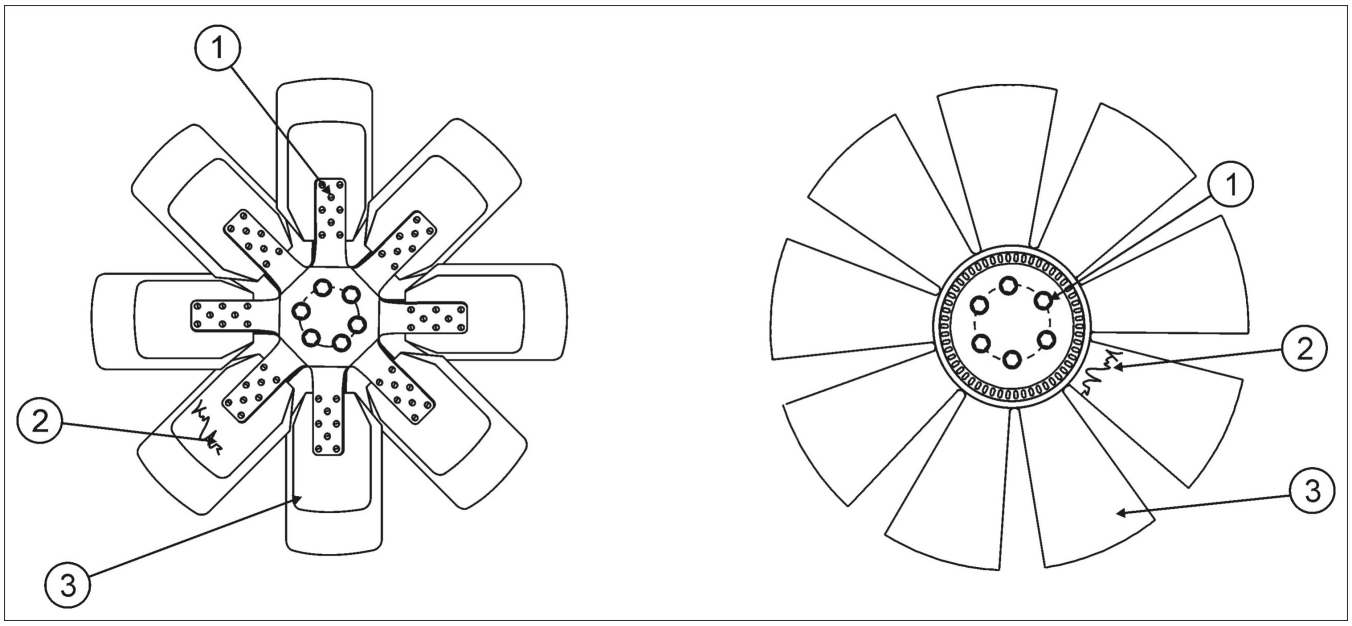


FIGURE 24. COOLING FAN INSPECTION

6.4.3 Drive Belt - Inspection

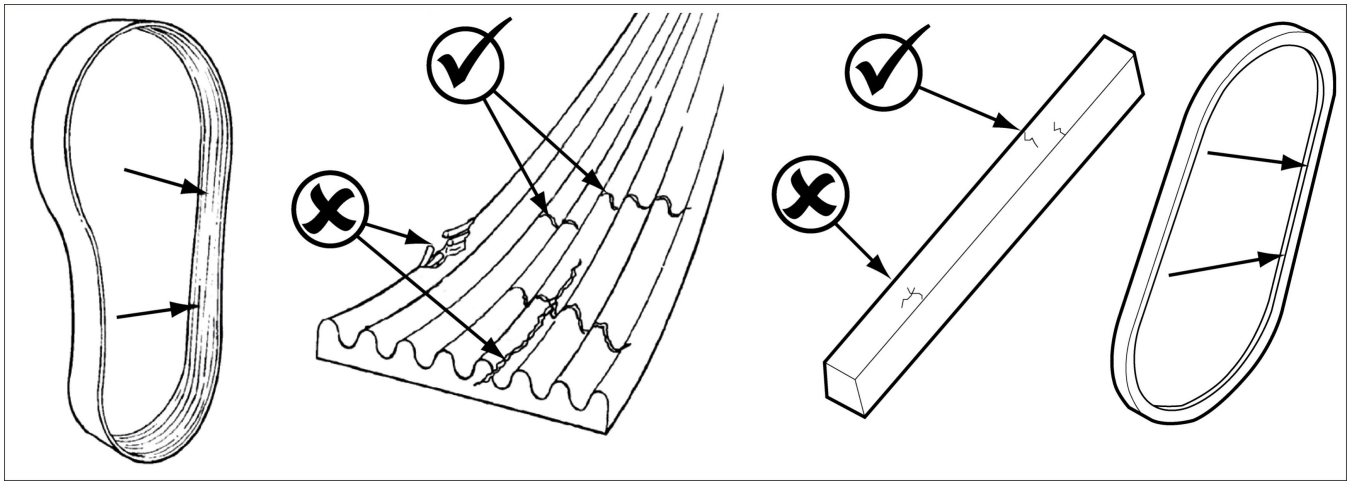


FIGURE 25. DRIVE BELT INSPECTION

Visually inspect the belt through the guarding.

Check for:

- Intersecting cracks. Small transverse (across the belt width) cracks are acceptable. Longitudinal (direction of belt length) cracks that intersect with transverse cracks are NOT acceptable.
- Frays or pieces of material missing.
- Glazed or cracked side walls.
- Uneven wear on sidewalls of belt.

NOTICE
Do not mix old and new V-belts on the same drive.

Contact your authorized distributor to have worn belts replaced.

Visually inspect sheaves through the guarding.

Check for:

- Damaged or worn grooves.
- Breaks on flanges of grooves.
- Frays or pieces of material missing.
- Glazed or cracked side walls.
- Uneven wear on sidewalls of belt.

NOTICE
V-Belts should never ride in the bottom of the groove. Damaged or worn grooves should not be used.

NOTICE
Keep foreign materials away from sheaves and belts as this may cause belt slip.

Contact your authorized distributor to have worn sheaves replaced.

6.4.4 Radiator - Check

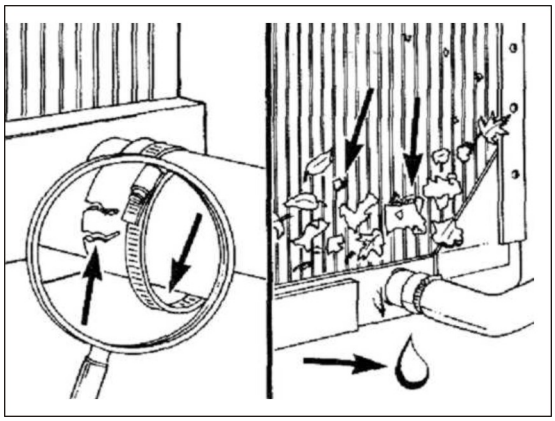


FIGURE 26. RADIATOR CHECK

Check for damaged hoses and loose and damaged hose clamps.

Inspect the exterior of the radiator (through the guarding) for obstructions. During the service life of a radiator a build up of foreign matter can obstruct the flow of air through the radiator cores, reducing the cooling capability. To continue the efficiency of the radiator, the core will require cleaning.

Cleaning of the radiator core must only be undertaken by suitably trained and experienced service personnel.

6.5 Engine Oil - Level Check

⚠ WARNING

Hot Pressurized Liquid

Contact with hot liquid can cause severe burns.

Crankcase pressure can blow out hot oil. Do not check the oil while the generator set is operating.

⚠ CAUTION

Hazardous Liquid

Prolonged or repeated skin contact can cause severe personal injury.

Avoid prolonged or repeated skin contact. Comply with all local health and safety regulations/codes during handling or disposal.

NOTICE

Do not operate the engine with the oil level below the low mark or above the high mark. Overfilling can cause foaming or aeration of the oil while operation below the low mark may cause loss of oil pressure.

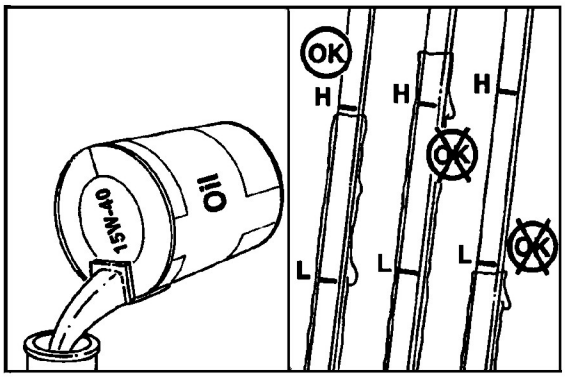


FIGURE 27. ENGINE OIL LEVEL CHECK

Check the engine oil level when the generator set is not running.

Never operate the engine with the oil level below the L (Low) mark, or above the H (High) mark. Wait at least fifteen minutes, after shutting off the engine, before checking the oil level. This allows time for the oil to drain back to the oil pan.

NOTICE

Use high-quality multi-viscosity lubricating oil such as Cummins Premium Blue® or its equivalent. Consult your authorized distributor for the correct lubricating oil specifications for your operating conditions.

6.6 Fuel System

⚠ WARNING

Combustible Liquid

Diesel fuel is a fire and explosion hazard which can cause severe personal injury or death.

Do not permit any open flame, or other igniter near the fuel system, or in areas sharing ventilation.

⚠ WARNING

Combustible Liquid

Mixing gasoline or alcohol with diesel fuel is an explosion hazard which can result in severe personal injury or death.

Do not mix gasoline or alcohol with diesel fuels.

NOTICE

Engine fuel actuators can operate at voltages up to 140 volts DC .

NOTICE

Due to the precise tolerances of diesel injection systems, it is extremely important that the fuel be kept clean and free of dirt or water. Dirt or water in the system can cause severe damage to both the injection pump and the injection nozzles.

Use ASTM No. 2D fuel with a minimum Cetane number of 40. No. 2 diesel fuel gives the best economy and performance under most operating conditions. Fuels with Cetane numbers higher than 40 are often needed in high altitudes, or extremely low ambient temperatures, to prevent misfires and excessive smoke. Contact your authorized distributor for your operating conditions.

NOTICE

A diesel fuel to BS 2869:2010+A1:2011 (Fuel oils for agricultural, domestic, and industrial engine and boilers. Specification), conforming to the requirements and test methods of that specification would be an acceptable alternative to ASTM No. 2D.

6.6.1 Fuel Level

To avoid condensation problems, keep fuel supply tanks as full as possible by filling up each time the engine is used. Condensation (water) can cause clogging of the fuel filters as well as possible freezing problems. In addition, water mixing with the sulfur in the fuel forms acid which can corrode and damage engine parts.

6.6.2 Fuel/Water Separator Drain

Fuel/water separators provide protection for the engine fuel injection system, as water-free fuel supplies cannot be guaranteed.

Drain the water and sediment from the separator daily. The fuel filters can be inspected for collected water by checking the clear bowl at the bottom of each filter.

To drain the water:

1. Shut off the engine.
2. Place a suitable container under the fuel filter.
3. With the fuel supply valve closed, open the vent cap to break the airlock in the filter.
4. Turn the valve counterclockwise until the valve drops down about one inch (25 mm). Accumulated water will drain first. Drain the filter sump of water until clear fuel is visible.
5. When fuel begins to flow out of the drain, push the valve up and turn the valve clockwise to close the drain valve.
6. Before starting the engine, be sure to open the fuel supply valve.
7. If more than 2 oz (60 ml) is drained, refilling of the filter is required to prevent hard starting.

NOTICE
Do not over tighten the valve. Over tightening can damage the threads.

NOTICE
If more than 2 oz (60 ml) is drained, refilling of the filter is required to prevent hard starting.

The drained liquids must be disposed of in accordance with local environmental regulations.

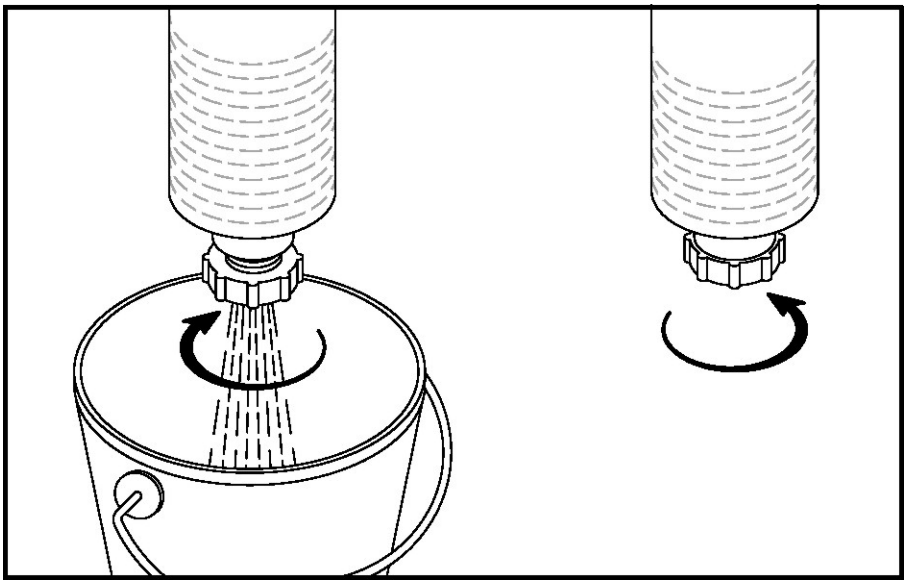
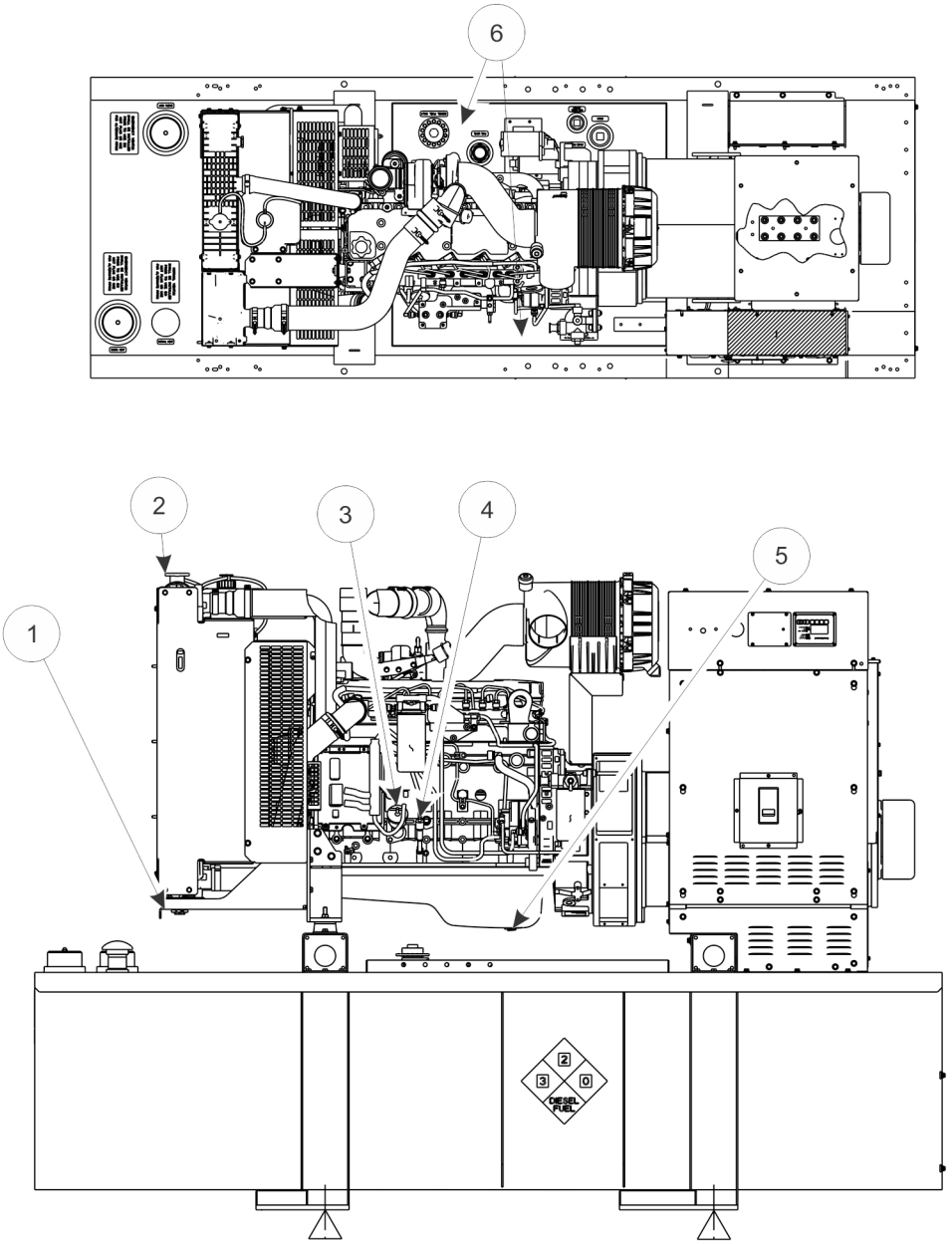


FIGURE 28. DRAINING THE FUEL/WATER SEPARATOR

6.7 Fluid Containment

The bedframe fluid containment area (if applicable) must be inspected at regular intervals and any liquid should be drained off and disposed of in accordance with local health and safety regulations. Failure to perform this action may result in spillage of liquids likely to contaminate the surrounding area.



1	Coolant Drain
2	Radiator Fill
3	Oil Fill
4	Oil Check
5	Oil Drain Plug
6	Containment Area

FIGURE 29. FLUID CONTAINMENT INSPECTION

Any other fluid containment area must also be checked and emptied, as above.

6.8 Hoses and Fuel Lines - Check

⚠ WARNING

Moving Parts

Moving parts can cause severe personal injury.

Use extreme caution around moving parts. All guards must be properly fastened to prevent unintended contact.

⚠ WARNING

Hot Surfaces

Contact with the hot surfaces can cause severe burns.

Avoid contact with hot parts. Allow hot parts to completely cool.

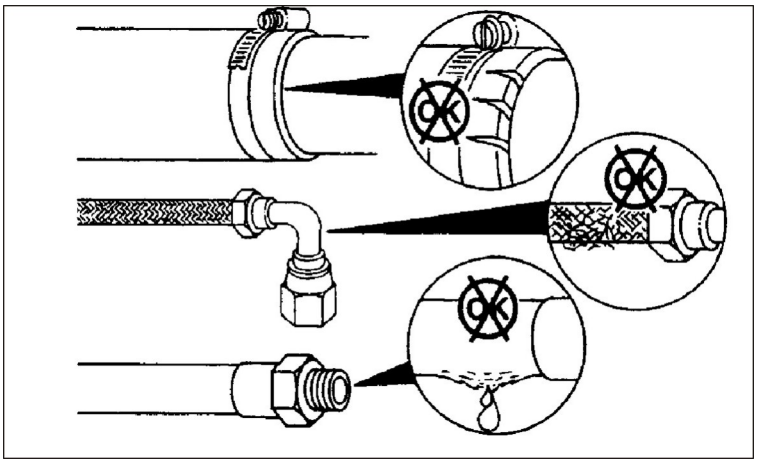


FIGURE 30. HOSES AND FUEL LINE INSPECTION

While the generator set is in operation, visually inspect the fuel lines, filters, and fittings for leaks. Check any flexible sections for cuts, cracks and abrasions and make sure they are not rubbing against anything that could cause breakage. If any leaks are detected, shut down the generator set (if possible). Contact your authorized distributor and have the leaks repaired immediately.

6.9 Air Intake System

The direct flow air cleaner consists of a primary filter and a secondary filter within the air cleaner housing. The air cleaner has been designed for a maximum restriction at 635 mm of H20 (25 in of H20), at which point the filter elements should be changed.

6.9.1 Air Cleaner Service Indicator

Check the air cleaner service indicator. If the gauge has crossed the red mark, replace the filter.

⚠ WARNING

Exhaust components become very hot when the generator set is in use and remain hot for a period of time after the generator set has been shut down. These components can cause severe personal injury or death from contact. Allow these components to cool completely before performing any maintenance tasks.

⚠ WARNING

Moving parts can cause severe personal injury or death. Use extreme caution around hot manifolds, moving parts, etc.

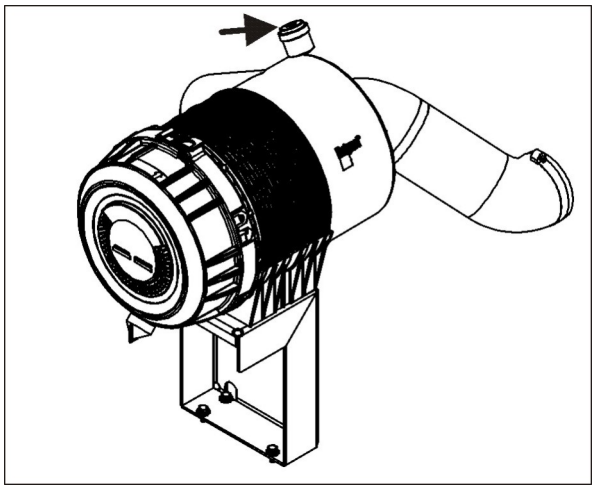


FIGURE 31. AIR CLEANER SERVICE INDICATOR

6.10 Exhaust System

⚠ WARNING

Hot Surfaces

Contact with the hot surfaces can cause severe burns.

Avoid contact with hot parts. Allow hot parts to completely cool.

⚠ WARNING

Moving Parts

Moving parts can cause severe personal injury.

Use extreme caution around moving parts. All guards must be properly fastened to prevent unintended contact.

⚠ WARNING

Toxic Gases

Substances in exhaust gases have been identified by some state and federal agencies to cause cancer or reproductive toxicity.

Do not breathe in or come into contact with exhaust gases.

While the generator set is in operation, inspect the entire exhaust system visually and audibly including the exhaust manifold, muffler, and exhaust pipe without removing guarding and panels. Check for leaks at all connections, welds, gaskets and joints, and make sure that exhaust pipes are not heating surrounding areas excessively. If any leaks are detected, shut down the generator set (if possible). Contact your authorized distributor and have the leaks repaired immediately.

6.11 Generator Set Output - AC Electric System

Check the following while the generator set is operating:

- Frequency: The generator set frequency should be stable and the reading should be the same as the generator set nameplate rating (50 Hz / 1500 RPM or 60 Hz / 1800 RPM).
- AC Voltage: At no load, the line-to-line voltage, or voltages, should be the same as the generator set nameplate rating.
- AC Ammeter: At no load, the current readings should be zero. With a load applied, each line current should be similar.
- Panel Lamps: When the Operating Panel is first connected to the DC supply, the system runs a check, illuminating each of the indicator lamps in turn.

6.12 DC Electrical System

⚠ WARNING

Combustible Gases

Ignition of battery gases is a fire and explosion hazard which can cause severe personal injury or death.

Do not smoke, or switch the trouble light ON or OFF near a battery. Touch a grounded metal surface first before touching batteries to discharge static electricity. Stop the generator set and disconnect the battery charger before disconnecting battery cables. Using an insulated wrench, disconnect the negative (–) cable first and reconnect it last.

1. Check the harness connections. If any harness connections are damaged, contact your service representative.

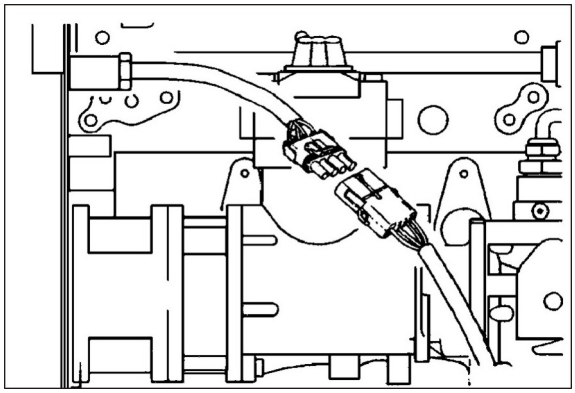


FIGURE 32. CHECK HARNESS CONNECTIONS

2. Check the terminals on the batteries for clean and tight connections. Loose or corroded connections create resistance, which can hinder starting. Clean and reconnect the battery cables if loose, using an insulated wrench. Always disconnect both ends of the negative battery cable. Reconnect one end of the cable to the negative battery terminal and the other end to ground. This will make sure that any arcing will be away from the battery and least likely to ignite explosive battery gases.
3. Check connections at the battery charging alternator.
4. Visually inspect the alternator belt to make sure it is not loose or cracked.

6.13 Batteries

Batteries are an essential part of any standby generator system. Roughly 90% of all generator failures are due to batteries.

It is important that batteries are stored, commissioned, and maintained as detailed here. Refer also to the Battery Manufacturer's instructions.

Always use correct handling techniques when moving or lifting batteries. Batteries can be heavy and may require more than one person to lift and a suitable trolley for transportation.

Batteries are usually supplied with the generator in 'dry-charged' form. In order to commission dry-charged lead-acid batteries, pre-mixed electrolyte of the correct type and specific gravity must be added to the cells of the battery.

Maintenance free batteries supplied with the generator need no maintenance for commissioning.

6.13.1 Storage

Batteries must be stored in a cool, dry, well-ventilated place, in the upright position, and with the vent caps securely in place.

Batteries must never be stacked on top of each other and must be protected from the floor by a wooden pallet or suitably thick cardboard sheet.

6.13.2 Safety Precautions

Handling and proper use of batteries is not hazardous if the correct precautions are observed and personnel are trained in their use.

6.13.2.1 General Precautions

⚠ WARNING

Combustible Gases

Ignition of battery gases is a fire and explosion hazard which can cause severe personal injury or death.

Laying tools or metal objects across the battery can cause arcing. Never lay tools or metal objects across the top of the battery.

- Use proper PPE. Do not wear jewelry. Remove any conductive items from pockets. These items can fall into equipment and result in a short circuit, which can cause shock or burning. Refer to local standards for PPE details (in the U.S: see NFPA 70).
- Keep batteries upright to prevent spillage. Electrolyte is a dilute sulphuric acid that is harmful to the skin and eyes.
- Use tools with insulated handles to prevent the risk of electric shock.

6.13.2.2 Fire Hazard

NOTICE

During the charging of a battery, explosive gases are given off. Keep the battery area well ventilated and away from naked flames and sparks. Do not smoke.

- Before disconnecting a battery, isolate the utility powered battery charger (where fitted).
- To disconnect the battery, use an insulated wrench to disconnect the negative cable first.
- To connect the battery, use an insulated wrench to connect the negative cable last.

6.13.2.3 Fluid Hazard

⚠ WARNING

Toxic Hazard

Contact with electrolyte can cause severe personal injury.

Wear appropriate PPE when handling electrolyte: acid-proof protective apron, goggles and gloves. If electrolyte is splashed on the skin or in the eyes, flush the affected areas immediately with water and seek medical attention.

⚠ WARNING

Hazardous Liquid

Uncontrolled chemical reactions can cause severe chemical burns or death.

Never add undiluted sulfuric acid to a battery.

6.13.3 Battery Commissioning

NOTICE

Commissioning is to be undertaken by suitably trained and qualified service personnel only.

Lead-acid batteries supplied in dry-charged form are commissioned as follows:

- Pre-Commissioning Procedure
- Filling the Battery with Electrolyte
- Charging
- Fitting the Battery to the Generator Set

6.13.3.1 Pre-Commissioning Procedure

1. Check for any damage to the battery case or terminals, and make sure that the battery is clean and dry.
2. Remove the vent plugs and break any seals (if present), taking care not to damage the plates or separators. The broken seal will fall into the bottom of the chamber and do no harm.

6.13.3.2 Filling the Battery with Electrolyte

1. Fill each cell of the battery with dilute sulphuric acid (electrolyte) of the correct specific gravity (SG) according to the levels on the battery label. (8.2 liters (2.2 gallons) per standard battery).

2. Filling must be completed in one step.
3. Allow the battery to soak for ten to fifteen minutes. If the electrolyte level has fallen, it should be restored by adding electrolyte of the correct SG to the levels given on the battery label.
4. After filling, place the battery on a commissioning charge within one hour. Charging must take place before any load is placed on the battery.

NOTICE

Failure to give a commissioning charge may impair the charge capacity and life of the battery.

6.13.3.3 Charging - Commissioning

1. Charge the battery for a minimum of four hours to ensure the acid is sufficiently mixed within the battery. If the battery has been in storage, check the manufacturer's instructions; the charging period may need extending.
2. When the generator set is running, check the charge alternator output using an induction ammeter.

6.13.3.4 Connecting the Battery to the Generator Set

NOTICE

A battery must not be fitted to a generator set without charge if the specific charge of the electrolyte has fallen below 1.240 during storage.

1. Secure the battery. Battery hold-down bolts must be tight, but not over-tight.
2. Smear the terminals with petroleum jelly, if necessary.
3. Fit the vents firmly in position and ensure that the battery is clean and dry.
4. Verify correct polarity when connecting the battery to the set. Even momentary incorrect connection can cause damage to the electrical system.
5. Use an insulated wrench connect the positive generator cable first, followed by the negative cable. Terminal connections must be tight, but not over-tight.

6.13.4 Battery Maintenance

⚠ WARNING

Combustible Gases

Ignition of battery gases is a fire and explosion hazard which can cause severe personal injury or death.

Do not smoke, or switch the trouble light ON or OFF near a battery. Touch a grounded metal surface first before touching batteries to discharge static electricity. Stop the generator set and disconnect the battery charger before disconnecting battery cables. Using an insulated wrench, disconnect the negative (–) cable first and reconnect it last.

NOTICE

To prevent dangerous arcing, always disconnect the negative (–) ground cable from the battery using an insulated wrench before working on any parts of the electrical system or the engine. Before touching batteries, discharge static electricity from body by first touching a grounded metal surface.

NOTICE

Always disconnect a battery charger from its AC source before disconnecting the battery leads. Failure to do so can result in voltage spikes high enough to damage the DC control circuits of the generator set.

NOTICE

Maintenance-free batteries are sealed and do not require the addition of electrolyte. Some manufacturers of maintenance-free batteries provide an 'eye' or some visible means of telling when the battery is discharged or approaching the end of its useful life.

Batteries require attention at all times, even when not working. A battery will not last if it is neglected. Maintenance is carried out as follows:

1. Keep the battery and the battery area clean and dry. If fitted, make sure that the vent caps are securely screwed down, or pushed home.
2. To avoid contamination of the battery, clean it only when the vent plugs (if fitted) are in place.
3. Keep the battery terminals and connections free from corrosion by lightly coating them with petroleum jelly.
4. Secure the battery(s) to prevent movement and internal damage to plates.
5. Check the condition of the starting batteries. Refer to the Generator Set Maintenance table in Section 6.2 on page 61 for the maintenance interval.

6.13.4.1 Cleaning Batteries

⚠ WARNING

Toxic Hazard

Contact with electrolyte can cause severe personal injury.

Wear appropriate PPE when handling electrolyte: acid-proof protective apron, goggles and gloves. If electrolyte is splashed on the skin or in the eyes, flush the affected areas immediately with water and seek medical attention.

Prevent a build up of dirt or corrosion by wiping the batteries with a damp cloth. Use a solution consisting of 0.11 kg (1/4 lb) of baking soda added to 0.96 liters (1 quart) of water to neutralize any possible acid. Be sure the vent plugs (if fitted) are tight to prevent any cleaning solution from entering the cells.

After cleaning, make sure the battery and surrounding areas are dry.

After making connections, coat the terminals with a light application of petroleum jelly to retard corrosion. Keep the battery terminals clean and tight. A loose connection can reduce battery standby time and cause battery fires.

6.13.4.2 Charging

When generator sets are used infrequently, batteries must be re-charged monthly to maintain a fully-charged condition.

NOTICE

Never allow a battery to become completely flat (fully discharged), or to stand in a discharged condition, or damage will result.

1. Do not put a filled battery into storage without first giving the battery a commissioning charge.

2. Batteries must be given a further charge every six months at the normal initial charge rate until the voltage ceases to rise.

6.13.4.3 Trickle/Boost Charging (Option)

The battery will automatically receive a trickle-charge from the battery charger (when switched ON) to prevent the battery from becoming discharged below its optimum charge level.

During trickle-charging, not all cells in the battery receive the same charge. Over a period of several months, this may affect battery performance. It is, therefore, good practice to give batteries a regular charge at their full rate to return all cells to full capacity. This is referred to as boost-charging, or equalize-charging.

If the charger is fitted with a **Boost Charge** switch, the **Boost** position should be selected at intervals detailed by the battery manufacturer (normally around every 6 months).

NOTICE
Batteries should not be left on Boost Charge for extended periods as this results in excessive water consumption and gassing, and may impair battery performance.

A boost charge not exceeding twice the bench charge rate may be used, providing that:

- The electrolyte temperature does not exceed 43 °C (109 °F).
- The battery volts do not reach 15 V (for a 12 V battery).

If either of these situations arises, reduce the charge rate to the normal bench rate. For tropical climates the temperature must not exceed 49 °C (120 °F).

NOTICE
The charge period should be extended: • **To 8 hours if the battery has been in storage for three months or more at temperatures in excess of 30 °C (86 °F), or if humidity is above 80%.** • **To 12 hours if the battery has been in storage for twelve months or more.**

At the end of the charging process, the electrolyte levels must be checked and restored if necessary by the addition of electrolyte of the correct SG. The vent caps must then be replaced.

NOTICE
Any further topping-up of the electrolyte must be made using distilled or de-ionized water.

6.13.5 Electrolyte - Specific Gravity and Temperature

Maintenance-free batteries are sealed and do not require the addition of electrolyte. Some manufacturers of maintenance-free batteries provide an ‘eye’ or other visible means of telling when the battery is discharged or approaching the end of its useful life.

6.13.5.1 Checking Electrolyte Level

NOTICE
Never add tap or well water and never allow the battery electrolyte to drop below the top of the plates, otherwise damage will occur.

NOTICE

Do not add water in freezing weather unless the engine will run long enough (2 to 3 hours) to make sure that water and electrolyte are thoroughly mixed.

Check the level of the electrolyte (acid and water solution) in the batteries at least every month or 100 hours of operation, whichever occurs first. Maintain the electrolyte to the levels indicated on the battery label. Add distilled water only and recharge. Replace the vent plugs once filling is completed.

If a cell level is low, check the case for leaks.

Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

6.13.5.2 Checking Specific Gravity Using a Hydrometer

Use a hydrometer to check the specific gravity (SG) of the electrolyte in each battery cell.

Hold the hydrometer vertically and take the reading.

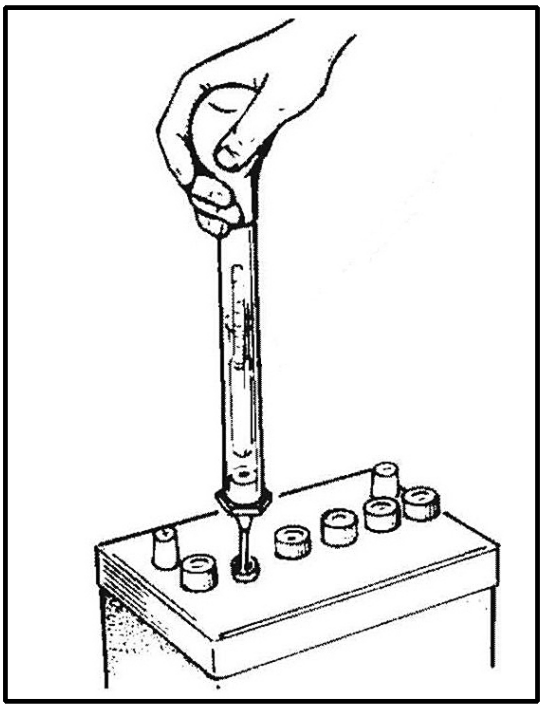


FIGURE 33. CHECKING SPECIFIC GRAVITY

6.13.5.3 Checking Specific Gravity Using an Acid Refractometer

Follow the instructions included with the refractometer. Obtain a small drop of liquid and place it under the clear plastic cover to check the specific gravity (SG) of the electrolyte in each battery cell.

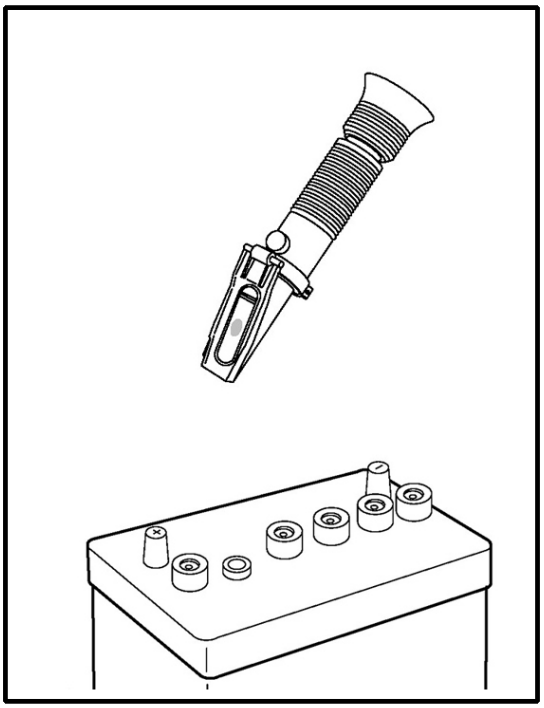


FIGURE 34. TYPICAL BATTERY ACID REFRACTOMETER

6.13.5.4 Specific Gravity Values for Batteries

A fully charged battery will have a corrected specific gravity (SG) of 1.260 at 25 °C (77 °F). Hold the hydrometer vertically and take the reading. Charge the battery if the reading is below 1.215.

TABLE 5. SPECIFIC GRAVITY

Temperature	For Filling New Cells	At End of Charge
Ambient temperature normally below 32 °C (90 °F)	1.270	1.270 – 1.290
Ambient Temperature frequently above 32 °C (90 °F)	1.240	1.240 – 1.260
Maximum permissible temperature of electrolyte during charge	45 °C (113 °F)	45 °C (113 °F)

Table 5 shows the specific gravity of electrolyte, corrected to 25 °C (77 °F). Correct the specific gravity reading for other temperatures by subtracting seven gravity points (0.007) for every 10 °C (18 °F) the electrolyte temperature is above 27 °C (80 °F). Apply the correction formula as follows:

1. For every 10 °C (18 °F) above 25 °C (77 °F), subtract 0.007 (7 points)
2. For every 10 °C (18 °F) below 25 °C (77 °F), add 0.007 (7 points)

For example: if the specific gravity at 25 °C (77 °F) is 1.260, then the specific gravity at 15 °C (59 °F) is 1.267.

6.13.6 Battery Replacement

⚠ WARNING

Combustible Liquid

Burning the battery may cause an explosion. Damage to the casing will release electrolytes which is harmful to the skin and eyes.

When disposing of a battery, do not mutilate or burn it. Comply with all local health and safety regulations/codes during handling or disposal.

Always replace the starting battery with the same number and type (e.g., vented, lead acid, maintenance free). Properly dispose of battery in accordance with local environment agency requirements.

Always use correct handling techniques to lift and move a battery.

6.13.7 Electrolyte Levels and Bench Charging Rates

The following table shows the electrolyte level expected at a range of bench charging rates.

TABLE 6. ELECTROLYTE LEVELS

Battery Type	Electrolyte Level Above Plates (mm)	Bench Charging Rate (A/hour)		Battery Type	Electrolyte Level Above Plates (mm)	Bench Charging Rate (A/hour)
1	8	3		325	8	20
7	8	3.5		327	8	11
15	8	4		328	8	20
16	8	4		329	8	20
17	8	9		332	8	25
35	8	3.5		333	8	11
36	8	3.5		386	8	6
37	8	4		404	8	7
38	8	4		414	8	20
46	8	6		415	8	20
47	8	3		471	8	15
48	8	4		484	8	25
49	8	4		501	8	9
63	8	4		511	8	10
65	8	5		521	8	12
67	8	7		531	8	13
68	8	7		541	8	15
69	8	7		543	8	15
70	8	7		591	8	14

Battery Type	Electrolyte Level Above Plates (mm)	Bench Charging Rate (A/hour)		Battery Type	Electrolyte Level Above Plates (mm)	Bench Charging Rate (A/hour)
71	8	6		602	8	8
72	8	8		612	8	9
73	8	6		635	16	12
74	8	7		643	16	9
75	8	7		644	16	12
77	8	4		645	16	9
78	12	5		646	16	8
83	8	3.5		647	16	12
84	8	4		648	16	12
85	8	5		649	16	9
90	12	7		655	16	12
91	8	6		656	16	12
92	12	5		663	16	9
93	8	6		664	16	9
97	8	6		665	16	9
154	4	3.5		678	8	6
175	8	7		679	16	9
191	6	6		701	8	16
221	8	8		702	8	20
222	8	12		703	8	25
279	8	6		711	8	16
312	8	14		712	8	20
313	8	14		713	8	25
315	8	14		721	8	15
319	8	14		722	8	20
320	8	14		732	8	15
321	8	14		733	8	20
322	8	14		769	8	45
324	8	20				

NOTICE

If not listed in the above table use the bench rate given in the catalog, or charge at a current equal to 10% of the nominal capacity at the twenty hour rate (Amperes/hour), or 5% of the reserve capacity in minutes.

NOTICE
Batteries of the 800 series should be prepared in accordance with the instructions supplied with each battery.

6.13.8 Battery Fault Finding

The following table shows some typical faults and their possible causes and remedies .

TABLE 7. FAULT FINDING

Symptom	Possible Fault	Remedy
Battery completely discharged	Poor battery terminal connection	Clean connections, replace and tighten.
	Charge alternator/ alternator connection fault	Contact your nearest Cummins Power Generation distributor .
	Mains battery charger/ charger connections fault/ mains supply fault	Contact your nearest Cummins Power Generation distributor.
	Blown fuse	Contact your nearest Cummins Power Generation distributor.
	Battery fault	Contact your nearest Cummins Power Generation distributor.
	Newly installed battery shipped dry	Fill with electrolyte and give commissioning charge.
Battery low charge	Poor battery connection	Clean connections, reconnect and tighten securely .
	Charge alternator/ alternator connection fault	Contact your nearest Cummins Power Generation distributor.
	Mains battery charger/ charger connections fault	Contact your nearest Cummins Power Generation distributor.
	Inequality in cell charge	Contact your nearest Cummins Power Generation distributor.
	Battery fault	Contact your nearest Cummins Power Generation distributor.
Battery overcharged	Charge alternator fault	Contact your nearest Cummins Power Generation distributor.
	Mains battery charge fault	Contact your nearest Cummins Power Generation distributor.
	Low battery fluid level	Check the charger; it may not be shutting off when the charge is complete.
Battery terminals getting hot	Poor battery connection	Clean connections, reconnect and tighten securely.
		Contact your nearest Cummins Power Generation distributor.

7 Troubleshooting

Fault code information, together with warning and shutdown information, is provided in this section to assist in locating and identifying the possible causes of faults in the generator set system.

Refer also to the Operator's engine specific manual. The engine manual contains additional information regarding the running and care of the generator set as well as specific equipment instructions that may differ from the standard generator set.

7.1 Control System

The generator set control system continuously monitors engine sensors for abnormal conditions, such as low oil pressure and high coolant temperature. If any of these conditions occur, the control will light a yellow Warning lamp or a red Shutdown lamp and will display a message on the graphical display panel. In the event of an engine shutdown fault (red Shutdown LED), the control will stop the engine immediately.

7.2 Safety Considerations

⚠ WARNING

Hazardous Voltage

Contact with high voltages can cause severe electrical shock, burns, or death.

Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.

⚠ WARNING

Automated Machinery

Accidental or remote starting of the generator set can cause severe personal injury or death.

Make sure that the generator set can not be started accidentally or remotely before starting work on the generator.

⚠ WARNING

Combustible Gases

Ignition of battery gases is a fire and explosion hazard which can cause severe personal injury or death.

Do not smoke, or switch the trouble light ON or OFF near a battery. Touch a grounded metal surface first before touching batteries to discharge static electricity. Stop the generator set and disconnect the battery charger before disconnecting battery cables. Using an insulated wrench, disconnect the negative (–) cable first and reconnect it last.

⚠ CAUTION

Hazardous Voltage

Contact with high voltages can cause severe electrical shock, burns, or death.

Isolate all external electrical supplies prior to access of the control panel. Internal components have live exposed terminations even when the generator set is not running.

NOTICE

Do not open the output box while the generator set is running as the isolator switch will cause the generator set to shut down. Keep the output box covers in place during troubleshooting.

NOTICE

Always disconnect a battery charger from its AC source before disconnecting the battery cables. Failure to do so can result in voltage spikes high enough to damage the DC control circuits of the generator set.

NOTICE

Ventilate the battery area before working on or near the battery. Wear goggles. Stop the generator set and disconnect the battery charger before disconnecting the battery cables using an insulated wrench. Disconnect the negative (–) cable first and reconnect it last.

All maintenance tasks must be assessed for health and safety risks, the preventative measures identified must be actioned. Accompaniment is required for tasks where the presence of someone else will add significantly to the safety of the task.

The installation of a generator set can be designed for remote starting. When troubleshooting a generator set that is shut down, make sure that the generator set cannot be accidentally re-started. Refer to the Locking the Generator Set Out of Service section.

7.3 Fault Finding

⚠ WARNING

Electrical Generating Equipment

Incorrect operation and maintenance can result in severe personal injury or death

Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service.

NOTICE

Review safety precautions listed within Chapter 1 on page 1 of this manual together with the documentation supplied with the generator set.

Should a fault condition occur during operation, follow the procedures in the following tables to locate and correct the problem. For any symptom not listed, contact your authorized distributor for assistance.

Before starting any fault finding, ensure that the following basic checks are carried out:

- All switches and controls are in their correct positions
- Fuel system is connected and fuel is available
- The lubricating oil level is correct
- The coolant level is correct
- The radiator matrix is free from obstruction
- The battery charge condition is satisfactory and the connections are secure
- The generator set electrics and alternator connections are secure
- The panel connections are secure

- The protection circuits have been reset
- Blown fuses have been replaced
- Tripped contactors or circuit breakers have been reset

7.4 Status Indicators - PowerCommand 1.1

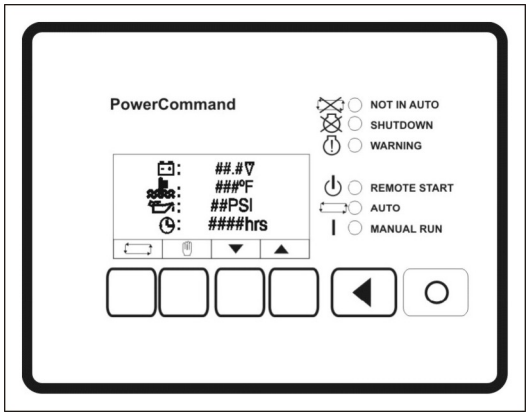


FIGURE 35. OPERATOR PANEL

7.4.1 Not in Auto

This red lamp is lit when the control is not in Auto.

7.4.2 Shutdown Status

This red lamp is lit when the control detects a Shutdown condition. The generator set cannot be started when this lamp is on. After the condition has been corrected, the lamp can be reset by pressing the **Off** button.

NOTICE
When Battle Short mode has been enabled and an overridden shutdown fault occurs, the Shutdown lamp will be lit even though the generator set will continue to run.

7.4.3 Warning

This yellow lamp is lit whenever the control detects a Warning condition. This lamp is automatically shut off when the Warning condition no longer exists.

7.4.4 Remote Start

This green lamp indicates the control is receiving a Remote Run signal.

7.4.5 Auto

This green lamp indicates the control is in **Auto** mode. **Auto** mode can be selected by pressing the selection button from any of the Operator menus.

7.4.6 Manual Run

This green lamp indicates the control is in the **Manual Run** mode. **Manual Run** can be selected by pressing the  selection button from any of the Operator menus.

7.5 Fault/Status Codes - PowerCommand 1.1

7.5.1 Fault/Status Codes

⚠ WARNING

Electrical Generating Equipment

Incorrect operation and maintenance can result in severe personal injury or death

Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service.

⚠ WARNING

Automated Machinery

Accidental or remote starting of the generator set can cause severe personal injury or death.

Make sure that the generator set can not be started accidentally or remotely before starting work on the generator.

The fault codes have been divided into five categories to help you determine what corrective action to take for safe operation of the generator set. Use the Fault Codes table to find the category (CTG) and fault description for all codes.

NOTICE

Gaps in the code numbers are for codes that do not apply to this generator set. Some of the codes listed are feature dependent and will not be displayed by this control.

7.5.2 Fault Messages

A Fault message is an indicator of a Warning or Shutdown condition. It includes the fault type (Warning or Shutdown), fault number, and a short description. It also includes where the fault occurred if the generator set control did not detect the fault and is simply reporting the fault.

Active and acknowledged faults may be viewed in the Faults menu.

7.5.3 Fault Acknowledgement

Shutdown faults must be acknowledged after the fault condition has been corrected. Shutdown faults are acknowledged by pressing the **Off** button on the display panel.

Shutdown faults can also be acknowledged when in Auto mode by using an external customer-supplied remote fault reset switch. This ability must be enabled using InPower (default condition is disabled). To reset the fault using the remote fault reset switch, the remote start command must be removed prior to the remote fault reset switch being activated.

Faults are removed from the display when they are cleared.

NOTICE

Faults are cleared from the control panel display by pressing the ▲, or ▼ button.

NOTICE

Faults are re-announced if they are detected again after being acknowledged.

7.5.4 Category A Fault Codes

This category pertains to engine or alternator shutdown faults that require immediate repair by trained and experienced service personnel (generator set non-operational). The control prevents the generator set from being re-started if a shutdown fault has not been corrected.

7.5.5 Category B Fault Codes

This category consists of faults that can affect generator set performance or can cause engine, alternator, or connected equipment damage. Operate the generator set only when it is powering critical loads and cannot be shut down. These faults require repair by trained and experienced service personnel.

7.5.6 Category C Fault Codes

NOTICE

Continued operation may void the generator set warranty if damage occurs that relates to this type of fault condition.

This category consists of faults that do not affect generator set performance, but require repair by trained and experienced service personnel. These codes indicate a defective harness or wiring problem.

These codes can also indicate a defective engine sensor, leaving no engine protection. (Without this protection, engine damage can occur without detection).

7.5.7 Category D Fault Codes

This category consists of faults that are repairable by site personnel. Service will be required by trained and experienced service personnel if site personnel cannot resolve the problem.

7.5.8 Category E Fault Codes

This category indicates non-critical operational status of the generator set, external faults, or customer fault inputs. These faults require repair by trained and experienced service personnel.

7.5.9 Fault Codes - PowerCommand 1.1

NOTICE

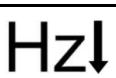
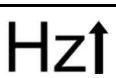
In the displayed message, the fault code number always follows the symbol.

TABLE 8. FAULT CODES

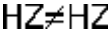
CTG	CODE	LAMP	DISPLAYED MESSAGE/SYMBOLS		DESCRIPTION
			TEXT VERSION	SYMBOLIC VERSION	
A	121	Shutdown	SPEED SIGNAL LOST		Indicates that no magnetic pickup pulses were sensed for a Loss of Speed delay. If a magnetic pickup is disabled, this fault is not activated.
B	135	Warning	OIL PRESS SENSOR OOR HIGH		Indicates the oil pressure sensor output is out of range (OOR), high.
C	141	Warning	OIL PRESS SENSOR OOR LOW		Indicates the oil pressure sensor output is out of range (OOR), low.
B	143**	Warning	PRE-LOW OIL PRESSURE		Indicates the engine oil pressure is approaching an unacceptable level.
C	144	Warning	COOLANT SENSOR OOR LOW		Indicates the coolant temperature sensor output is out of range (OOR), low.
C	145	Warning	COOLANT SENSOR OOR HIGH		Indicates the coolant temperature sensor output is out of range (OOR), high.
C	146**	Warning	PRE-HIGH COOLANT TEMP		Indicates that the engine is operating near cooling system capacity. Increase in load or higher ambient temperature may cause High Coolant Temp (code 151) shutdown.
D	151**	Shutdown	HIGH COOLANT TEMP		Indicates that the engine coolant temperature is above normal and has reached the Shutdown trip point.
C	153	Warning	INTAKE MANIFOLD TEMP OOR HIGH		Indicates that the intake manifold temperature sensor is out of range (OOR), high.
C	154	Warning	INTAKE MANIFOLD TEMP OOR LOW		Indicates that the intake manifold temperature sensor is out of range (OOR), low.
D	155	Shutdown	INTAKE MANIFOLD TEMP HIGH		Indicates that the intake manifold temperature sensor is above normal and has reached the shutdown trip point.
C	195	Warning	COOLANT LEVEL OOR HIGH		Indicates that a sensor on the radiator has detected that the coolant level is out of range (OOR), high.
C	196	Warning	COOLANT LEVEL OOR LOW		Indicates that a sensor on the radiator has detected that the coolant level is out of range (OOR), low.

CTG	CODE	LAMP	DISPLAYED MESSAGE/SYMBOLS		DESCRIPTION
			TEXT VERSION	SYMBOLIC VERSION	
D	197	Warning	COOLANT LEVEL LOW		Indicates that a sensor on the radiator has detected that the coolant level is below normal.
A	234**	Shutdown	OVERSPEED		Indicates that the engine has exceeded normal operating speed. The default thresholds are 1725 RPM (50 Hz) or 2075 RPM (60 Hz).
A	285	Shutdown	ECM PGN TIMEOUT		Datalink failure. PowerCommand® 1.1 control not responding to the engine control module.
A	286	Shutdown	ECM CONFIGURABLE ERROR		Indicates an engine control module configuration error - out of calibration,
D	359	Shutdown	FAIL TO START		The system has failed to start after a set number of crank attempts. This indicates a possible fuel system or air induction problem (engine cranks but fails to start).
A	415**	Shutdown	LOW OIL PRESSURE		Indicates the engine oil pressure has dropped below normal and has reached the shutdown trip point.
C	421^	Shutdown	OIL TEMP HIGH		Indicates the engine oil temperature is above normal and has reached the shutdown trip point. (I/O Module option).
B	425^	Shutdown	OIL TEMP OOR		Indicates the engine oil temperature output is out of range (OOR). High or low. (I/O Module option).
A	426	Shutdown	DATA LINK ERROR		Datalink failure. No communications between the PowerCommand® 1.1 control and the engine control module.
A	427**	Warning	CAN LINK LOST		Datalink fault. Indicates that important data was lost between the PowerCommand® 1.1 control and the engine control module.
D	441**	Warning	LOW BATTERY		Indicates battery voltage supply to the control is approaching a low level at which unpredictable operation can occur.
D	442**	Warning	HIGH BATTERY		Indicates battery voltage supply to the control is approaching a high level at which damage to the control can occur.

CTG	CODE	LAMP	DISPLAYED MESSAGE/SYMBOLS		DESCRIPTION
			TEXT VERSION	SYMBOLIC VERSION	
D	488^	Shutdown	INTAKE MANIFOLD TEMP HIGH		Indicates that the intake manifold temperature is above normal and has reached the shutdown trip point. (I/O Module option).
A	689	Shutdown	ENGINE SPEED ERRATIC		Indicates a fault condition in the engine crankshaft sensor circuit.
A	781	Shutdown	CAN LINK LOST		Datalink failure. No communications between the PowerCommand® 1.1 control and the engine control module
D	1117	Warning	ECM POWER LOST		Indicates battery voltage supply to the engine control module was lost.
B	1123*	Shutdown	SHUTDOWN AFTER BS		A shutdown fault occurred while the Battle Short mode was enabled.
D	1131*	Warning	BATTLE SHORT ACTIVE		Indicates that the control is in Battle Short mode - used to bypass several fault shutdowns for generator set operation during emergencies.
C	1246	Warning	GENERIC ENGINE FAULT		Engine control fault code not recognized by the PowerCommand® 1.1 control.
E	1311	Configurable	Customer Fault Input 1		The nature of the fault is an optional customer selection.
E	1312	Configurable	Customer Fault Input 2		The nature of the fault is an optional customer selection.
E	1317	Configurable	Customer Fault Input 3		The nature of the fault is an optional customer selection.
E	1318	Configurable	Customer Fault Input 4		The nature of the fault is an optional generator set input.
B	1416*	Warning	FAIL TO SHUTDOWN		Indicates that a shutdown fault is active, but is being bypassed by Battle Short.
A	1417	Shutdown	FAILURE TO POWER DOWN		Indicates the control is powered up after attempting to go to sleep.
D	1433	Shutdown	LOCAL EMERGENCY STOP		Indicates a Local Emergency Stop has been activated.
D	1434	Shutdown	REMOTE EMERGENCY STOP		Indicates a Remote Emergency Stop has been activated.
D	1435**	Warning	LOW COOLANT TEMP		Indicates that the engine coolant temperature is below the adjusted setpoint. This may indicate that the coolant heater is not operating or is not circulating coolant.

CTG	CODE	LAMP	DISPLAYED MESSAGE/SYMBOLS		DESCRIPTION
			TEXT VERSION	SYMBOLIC VERSION	
D	1438	Shutdown	FAIL TO CRANK		The generator set has failed to sense rotation for two start attempts. This indicates a possible fault with the control, speed sensing, or the starting system.
D	1442**	Warning	WEAK BATTERY		Indicates that the generator set battery voltage is below battery thresholds during cranking.
A	1446**	Shutdown	HIGH AC VOLTAGE		Indicates that one or more measured AC output voltages have exceeded the threshold for longer than a specified time limit. The threshold and time limits are 130% of nominal for zero seconds or 110% of nominal for ten seconds.
A	1447**	Shutdown	LOW AC VOLTAGE		Indicates that the measured AC output voltage is below the threshold for longer than a specified time limit. The threshold and time limits are 85% of nominal for ten seconds.
A	1448**	Shutdown	UNDER FREQUENCY		Indicates that the alternator frequency is 6 Hertz under the nominal frequency.
A	1449**	Shutdown	OVER FREQUENCY		Indicates that the alternator frequency is 6 Hertz above the nominal frequency.
A	1469**	Shutdown	SPEED HZ MATCH		Indicates that measured engine speed and measured alternator AC output frequency do not agree.
B	1471**	Warning	HIGH AC CURRENT		Indicates that the alternator output current (one or more phases) has exceeded safe operating limits.
A	1472**	Shutdown	HIGH AC CURRENT		Indicates that the alternator output current (one or more phases) has exceeded the alternator's current rating.
C	1845	Warning	WATER IN FUEL OOR HIGH		Indicates the water in fuel sensor is out of range (OOR), high.
C	1846	Warning	WATER IN FUEL OOR LOW		Indicates the water in fuel sensor is out of range (OOR), low.
D	1852	Warning	WATER IN FUEL		Indicates that the water in fuel is above normal and has reached the warning trip point.
E	1853	Configurable	Annunciator Fault 2		The nature of the annunciator fault is an optional customer selection.

CTG	CODE	LAMP	DISPLAYED MESSAGE/SYMBOLS		DESCRIPTION
			TEXT VERSION	SYMBOLIC VERSION	
E	1854	Configurable	Annunciator Fault 3		The nature of the annunciator fault is an optional customer selection.
E	1855	Configurable	Annunciator Fault 1		The nature of the annunciator fault is an optional customer selection.
E	1944	Warning	ANNUNCIATOR OUTPUT CONFIGURATION ERROR		Indicates a mismatch in the configuration of one of the annunciator relay outputs.
D	1965^	Warning	EXHAUST TEMPERATURE OOR		Indicates the exhaust temperature sensor is out of range (OOR), high or low. (Aux 101 I/O option).
B	1992	Warning	ENGINE OVERSPEED		Indicates that the engine has exceeded normal operating speed. The default thresholds are 1725 RPM (50 Hz) or 2075 RPM (60 Hz). (ECM fault code).
C	2224^	Warning	FUEL LEVEL OOR		Indicates the fuel level sensor is out of range (OOR), high or low. (Aux 101 I/O option).
A	2335	Shutdown	EXCITATION FAULT		Indicates that a loss of voltage or frequency sensing from the generator has occurred.
C	2398^	Warning	AMBIENT TEMPERATURE OOR		Indicates the ambient temperature sensor is out of range (OOR), high or low. (Aux 101 I/O option).
C	2542^	Warning	VOLTAGE BIAS OOR		Indicates the voltage bias circuit output is out of range (OOR), high or low. (Aux 101 I/O option).
A	2545	Shutdown	KEYSWITCH RESET REQUIRED		Indicates a datalink failure. Communications are lost between the PowerCommand® 1.1 control and the engine control module.
E	2619^	Diagnostic	AUX 101 ANALOG INPUT 1		The nature of the Base I/O Module event is an optional customer selection. (Aux 101 I/O Module option). Each event function can be programmed (using InPower service tool or access to the Setup menu), as follows: 1. Change display name using up to 32 characters 2. Select active low or high input.

CTG	CODE	LAMP	DISPLAYED MESSAGE/SYMBOLS		DESCRIPTION
			TEXT VERSION	SYMBOLIC VERSION	
E	2621^	Diagnostic	AUX 101 ANALOG INPUT 2		See code 2619
E	2622^	Diagnostic	AUX 101 ANALOG INPUT 3		See code 2619
E	2623^	Diagnostic	AUX 101 ANALOG INPUT 4		See code 2619
E	2624^	Diagnostic	AUX 101 ANALOG INPUT 5		See code 2619
E	2625^	Diagnostic	AUX 101 ANALOG INPUT 6		See code 2619
E	2626^	Diagnostic	AUX 101 ANALOG INPUT 7		See code 2619
E	2627^	Diagnostic	AUX 101 ANALOG INPUT 8		See code 2619
E	2628^	Diagnostic	AUX 102 DIGITAL INPUT 9		The nature of the Aux I/O Module event is an optional customer selection. (Aux 102 I/O Module option). Each event function can be programmed (using InPower service tool or access to the Setup menu), as follows: 1. Change display name using up to 32 characters 2. Select active low or high input.
E	2629^	Diagnostic	AUX 102 DIGITAL INPUT 10		See code 2628
E	2631^	Diagnostic	AUX 102 DIGITAL INPUT 11		See code 2628
E	2632^	Diagnostic	AUX 102 DIGITAL INPUT 12		See code 2628
A	2676	Shutdown	ALTERNATOR FREQUENCY CONFLICT		Indicates the measured alternator line frequency and measured alternator excitation frequency do not agree.
A	2677	Shutdown	FAIL TO STOP		The generator set continues to run after receiving a stop command from the controller.

CTG	CODE	LAMP	DISPLAYED MESSAGE/SYMBOLS		DESCRIPTION
			TEXT VERSION	SYMBOLIC VERSION	
B	2678**	Warning	CHARGER FAILURE		Indicates the battery charging alternator has not reached an acceptable voltage range within the selected time period (default is 120 seconds). This warning is also displayed if your alternator is a type that does not support the control's charging alternator logic functionality. If this occurs, this warning can be disabled if the Charging Alt. Enable setting is set to "No".
C	2693^	Warning	SPEED BIAS OOR		Indicates the speed bias circuit output is out of range (OOR), high or low. (Aux 101 I/O Module option).
C	2694^	Warning	ALTERNATOR RTD OOR		Indicates the alternator RTD sensor is out of range (OOR), high or low. (Aux 101 I/O Module option).
A	2696^	Shutdown	ALTERNATOR RTD TEMP HIGH		Indicates the alternator temperature is above normal and has reached the shutdown trip point. (I/O Module option).
C	2729^	Warning	I/O MODULE LOST		Indicates an intermittent datalink between the I/O module and the control board. (Aux 101 I/O Module option).
C	2731	Shutdown	I/O MODULE LOST		Indicates the datalink between the I/O module and the control board is lost. (Aux 101 I/O Module option).
A	2897	Shutdown	FACTORY BLOCK CORRUPT		Indicates a fatal software error occurred in the PowerCommand® 1.1 control.
A	2898	Warning	PERIODIC/FAULT CORRUPT		Indicates that either the periodic data file or the fault history file has been corrupted. Remove and re-apply power to the control to clear the fault. (Periodic and/or fault history data will be lost after re-setting the control).
A	2899	Shutdown	USER BLOCK CORRUPT		Indicates a fatal software error occurred in the PowerCommand® 1.1 control.
A	2911	Shutdown	TRIM BLOCK CORRUPT		Indicates a fatal software error occurred in the PowerCommand® 1.1 control.

CTG	CODE	LAMP	DISPLAYED MESSAGE/SYMBOLS		DESCRIPTION
			TEXT VERSION	SYMBOLIC VERSION	
D	2964	Warning	INTAKE MANIFOLD TEMPERATURE HIGH		Indicates engine has begun to overheat (intake manifold temperature has risen to an unacceptable level). Increase in load or higher ambient temperature may cause Intake Manifold Temp High (code 155) shutdown.
A	2972**	Shutdown	FIELD OVERLOAD		Indicates that the Field Voltage has been above 70 V for eight seconds.

* For more information on these events, refer to the Battle Short Mode description in Section 4.1.2.5 on page 26.
** Any values listed in the Description column for these faults are default values.
^ These faults are available only if your installation includes the optional I/O Module (Kit 541-1291)

7.5.10 Customer Input Faults - PowerCommand 1.1

Dependent on Customer Options specified, the Customer Input Faults may indicate the following:

ACTUAL TEXT SHOWN	TRANSLATION
Earth Fault	Earth Fault
Low Fuel	Low Fuel
High Fuel	High Fuel
High Alternator Temperature	High Alternator Temperature

Dependent on the number of Customer Options required, an adjacent display panel may be fitted where these Faults will be displayed.

TABLE 9. TROUBLESHOOTING PROCEDURES FOR FAULT CODES

FAULT CODE		CORRECTIVE ACTION – *(IF IN DOUBT, CALL YOUR AUTHORIZED SERVICE TECHNICIAN)
CODE:	**143**	Indicates the engine oil pressure has dropped below the warning trip point. If generator is powering critical loads and cannot be shut down, wait until the next shutdown period and then follow the fault code 415 procedure.
LAMP:	**Warning**	
MESSAGE:	**PRE-LOW OIL PRESSURE**	
CODE:	**146**	Indicates the engine is operating near cooling system capacity. An increase in load or higher ambient temperature may cause High Coolant Temp (151) shutdown. Review fault code 151 correction list for other possible causes.
LAMP:	**Warning**	
MESSAGE:	**PRE-HIGH COOL TEMP**	

FAULT CODE		CORRECTIVE ACTION – *(IF IN DOUBT, CALL YOUR AUTHORIZED SERVICE TECHNICIAN)
CODE:	**151**	Indicates the engine has overheated (coolant temperature has risen above the shutdown trip point). Allow the engine to cool down completely before proceeding with the following checks: 1. Look for possible coolant leakage points and repair if necessary. Check coolant level and replenish if low. 2. Check for obstructions to cooling airflow and correct as necessary. 3. Check fan belt and repair or tighten if necessary. 4. Check blower fan and circulation pumps on remote radiator installations. 5. Reset control and restart after locating and correcting problem.
LAMP:	**Shutdown**	
MESSAGE:	**HIGH COOLANT TEMP**	
CODE:	**155**	Indicates the engine has overheated (intake manifold temperature has risen above the shutdown trip point). Large load or high ambient temperature may be the cause. Review fault code 151 correction list for other possible causes.
LAMP:	**Shutdown**	
MESSAGE:	**INTAKE MANIFOLD TEMP HIGH**	
CODE:	**197**	Indicates the engine coolant level has fallen below the trip point. If the generator is powering critical loads and cannot be shut down, wait until the next shutdown period. If the engine can be stopped, allow the engine to cool down completely before proceeding: 1. Look for possible coolant leakage points and repair if necessary. Check coolant level and replenish if low. 2. Reset the control and restart after locating and correcting problem.
LAMP:	**Warning**	
MESSAGE:	**COOLANT LEVEL LOW**	
CODE:	**359**	Indicates a possible fuel system or air induction problem. (Engine cranks but fails to start). Allow the engine to cool down completely before proceeding with the following checks: 1. Check for empty fuel tank, fuel leaks, or blocked fuel lines and correct as required. 2. Check for dirty fuel filter and replace if necessary. 3. Check for dirty or blocked air filter and replace if necessary 4. Reset the control and restart after correcting the problem.
LAMP:	**Shutdown**	
MESSAGE:	**Fail to Start**	
CODE:	**415**	Indicates the engine oil pressure has dropped below the shutdown trip point. Allow the engine to cool down completely before proceeding with the following checks: 1. Check the oil level, lines and filters. 2. If the oil system is OK but the oil level is low, replenish. 3. Reset the control and restart after locating and correcting the problem.
LAMP:	**Shutdown**	
MESSAGE:	**LOW OIL PRESSURE**	

FAULT CODE		CORRECTIVE ACTION – *(IF IN DOUBT, CALL YOUR AUTHORIZED SERVICE TECHNICIAN)
CODE:	**441**	Indicates the battery voltage supply to the control is approaching a low level at which unpredictable operation will occur. If the engine can be stopped, allow the engine to cool down completely before proceeding: 1. Poor battery cable connections - Clean the battery cable terminals and tighten all connections. 2. Check the battery charge voltage float level, if applicable (raise float level). 3. Discharged or defective battery - Check the battery charger fuse. Recharge or replace the battery.
LAMP:	**Warning**	
MESSAGE:	**LOW BAT VOLTAGE**	
CODE:	**442**	Indicates the battery voltage supply to the control is approaching a high level at which damage to the control can occur. If the engine can be stopped, allow the engine to cool down completely before proceeding: 1. Poor battery cable connections - Clean the battery cable terminals and tighten all connections. 2. Check battery charge float level if applicable (lower float level).
LAMP:	**Warning**	
MESSAGE:	**HIGH BAT VOLTAGE**	
CODE:	**488**	Indicates the engine has overheated (intake manifold temperature has risen above the shutdown trip point). Large load or high ambient temperature may be the cause. Review fault code 151 correction list for other possible causes.
LAMP:	**Shutdown**	
MESSAGE:	**INTAKE MANIFOLD TEMP HIGH**	
CODE:	**1117**	Indicates that 'Keyswitch' to the ECM was NOT removed for 30 seconds before removing battery power to the ECM (removing battery cable). To reset: 1. Press the Off button and press the Emergency Stop button and wait for 30 seconds. 2. Remove the Emergency Stop and select an operating mode (manual or remote).
LAMP:	**Warning**	
MESSAGE:	**ECM POWER LOST**	
CODE:	**1131**	Indicates that the control is in Battle Short mode * (used to bypass several fault shutdowns; therefore, allowing generator set operation during emergencies).
LAMP:	**Warning**	
MESSAGE:	**BATTLE SHORT ACTIVE**	
CODE:	**1311, 1312, 1317, 1318**	The nature of the fault is an optional customer selection. Example inputs: Low Fuel Day Tank, Water In Fuel, Ground Fault, etc. Each of the fault functions can be programmed (using the InPower service tool or accessing the Setup menu), as follows: 1. Event , Warning, or Shutdown level, if Function Select = Fault Input 2. Change display name using up to 32 characters
LAMP:	**Configurable**	
MESSAGE:	**CONFIGURABLE INPUT 1, 2, 3, 4**	
CODE:	**1416**	The generator set continues to run after receiving a shutdown command from the controller. The Battle Short feature is enabled * (this is used to bypass several critical fault shutdowns; therefore, allowing generator set operation during emergencies).
LAMP:	**Warning**	
MESSAGE:	**FAIL TO SHUTDOWN**	

<table>
<tr><th colspan="2">FAULT CODE</th><th>CORRECTIVE ACTION – *(IF IN DOUBT, CALL YOUR AUTHORIZED SERVICE TECHNICIAN)</th></tr>
<tr><td>CODE:</td><td>1433/1434</td><td rowspan="3">Indicates local or remote Emergency Stop. Emergency Stop shutdown status can be reset only at the local control panel. After locating and correcting problem, reset the local/remote Emergency Stop button as follows:
1. De-activate (disable) emergency stop button
2. Press the O (Off) button
3. Select the desired operating mode (manual or remote).</td></tr>
<tr><td>LAMP:</td><td>Shutdown</td></tr>
<tr><td>MESSAGE:</td><td>E-STOP - LOCAL
E-STOP - REMOTE</td></tr>
<tr><td>CODE:</td><td>1435</td><td rowspan="3">Indicates the engine coolant heater is not operating or is not circulating coolant. If the engine can be stopped, allow the engine to cool down completely before proceeding with the following checks:
1. The coolant heater not connected to power supply - Check for blown fuse or disconnected heater cable and correct as required.
2. Look for possible coolant leaks and repair as required. Check for low coolant level and replenish if required.
Generator set is not operating. Warning occurs when engine coolant temperature is 21 °C (70 °F) or lower.
NOTICE
In applications where the ambient temperature falls below 4 °C (40 °F), Low Coolant Temp may be indicated even though the coolant heaters are operating.</td></tr>
<tr><td>LAMP:</td><td>Warning</td></tr>
<tr><td>MESSAGE:</td><td>LOW COOLANT TEMP</td></tr>
<tr><td>CODE:</td><td>1438</td><td rowspan="3">Indicates a possible fault with control, speed sensing, or starting system.
See code 441 for corrective action.</td></tr>
<tr><td>LAMP:</td><td>Shutdown</td></tr>
<tr><td>MESSAGE:</td><td>FAIL TO CRANK</td></tr>
<tr><td>CODE:</td><td>1442</td><td rowspan="3">Indicates that during cranking, the battery voltage is at, or below the weak battery warning trip point for a time greater than, or equal to the weak battery set time.
See code 441 for corrective action</td></tr>
<tr><td>LAMP:</td><td>Warning</td></tr>
<tr><td>MESSAGE:</td><td>WEAK BATTERY</td></tr>
<tr><td>CODE:</td><td>1448</td><td rowspan="3">Indicates that the generator set frequency has dropped below 90% of nominal for approximately ten seconds. Allow the engine to cool down completely before proceeding with the following checks:
1. Check the fuel supply.
2. Check the air intake supply.
3. Check the load and correct any overload.</td></tr>
<tr><td>LAMP:</td><td>Shutdown</td></tr>
<tr><td>MESSAGE:</td><td>UNDER FREQUENCY</td></tr>
</table>

CODE:	**1852**	Indicates that the water in the fuel is above normal and has reached the warning trip point. If the engine can be stopped, allow the engine to cool down completely before proceeding with the following checks: 1. Check fuel in the tank (local or remote). 2. Drain and re-fill if necessary. 3. Be aware of all Health and Safety, and environmental issues if draining tank.
LAMP:	**Warning**	
MESSAGE:	**WATER IN FUEL**	
CODE:	**2964**	Indicates the engine is operating near the system capacity. Increase in load or high ambient temperature may cause a High Intake Manifold Temperature (155) shutdown. If the engine can be stopped, allow the engine to cool down completely before proceeding with the following checks: Review fault code 151 correction list for possible causes.
LAMP:	**Warning**	
MESSAGE:	**HIGH INTAKE MANIFOLD TEMP**	

7.6 Line Circuit Breaker

A line circuit breaker is mounted in the generator output box. If the load exceeds the circuit breaker current rating, the line circuit breaker will open, preventing the generator from being overloaded. If the circuit breaker trips, locate the source of the overload and correct as necessary. Manually reset the breaker to reconnect the load to the generator.

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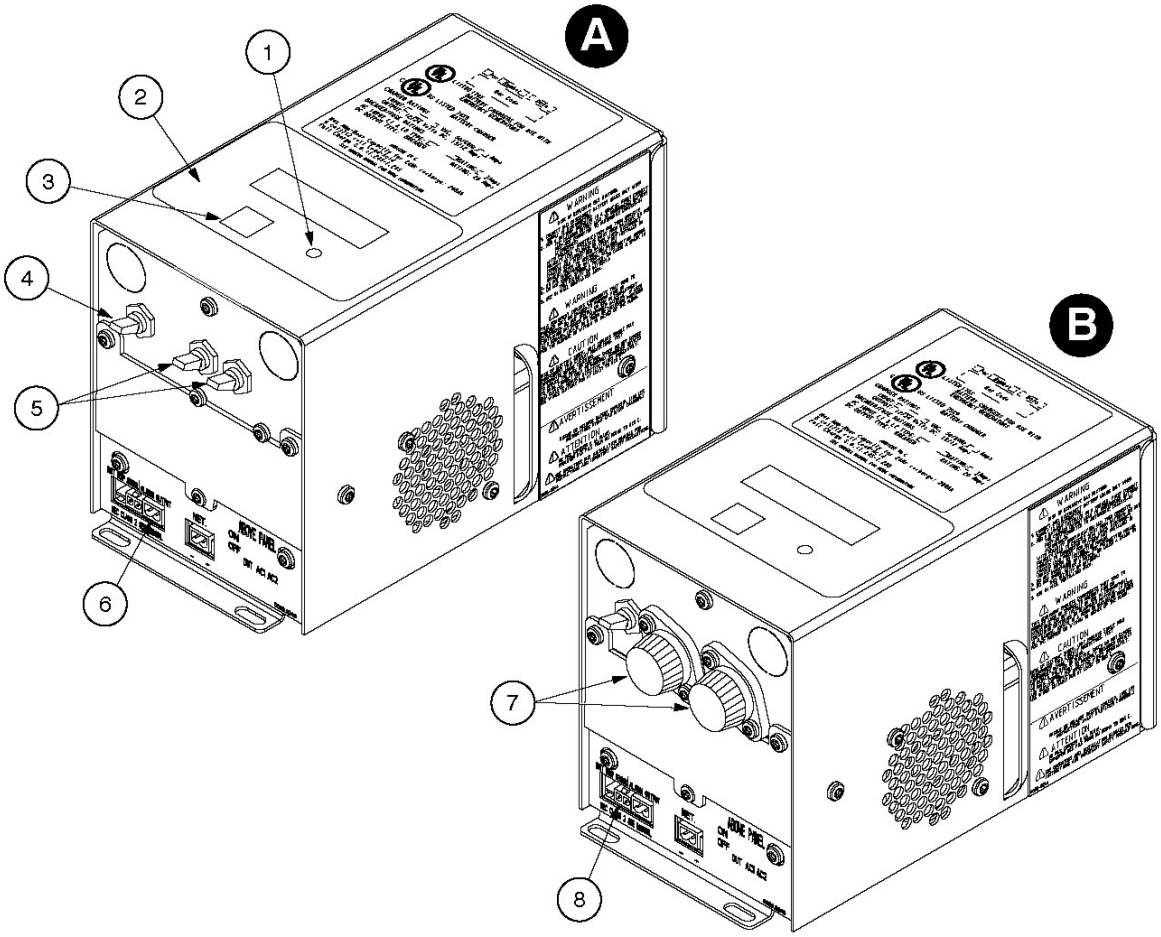
8 Battery Charger

8.1 Battery Charger - 15 Amp/12 Volt and 12 Amp/24 Volt

There are two types of 15/12-Amp PowerCommand battery chargers. All 15/12-Amp battery chargers have a 20 Amp DC circuit breaker switch on the front of the battery charger. The 120, 208, and 240 VAC battery chargers include two 10 Amp AC circuit breaker switches, all other models include two AC fuse holders.

Refer to the battery charger Owner Manual (901-0107) for more information.



No.	Description	No.	Description
A	120, 208, and 240 VAC Battery Charger	4	20 Amp DC Circuit Breaker Switch (Shown in the "On" position)
B	Battery Charger with Fuse Holders	5	10 Amp AC Circuit Breaker Switches (Shown in the "On" position)
1	Status LED	6	Fault Alarm Output Connector
2	Control Panel	7	10 Amp AC Fuse Holders
3	Reset Button	8	Connector for Optional Battery Temperature Sensor

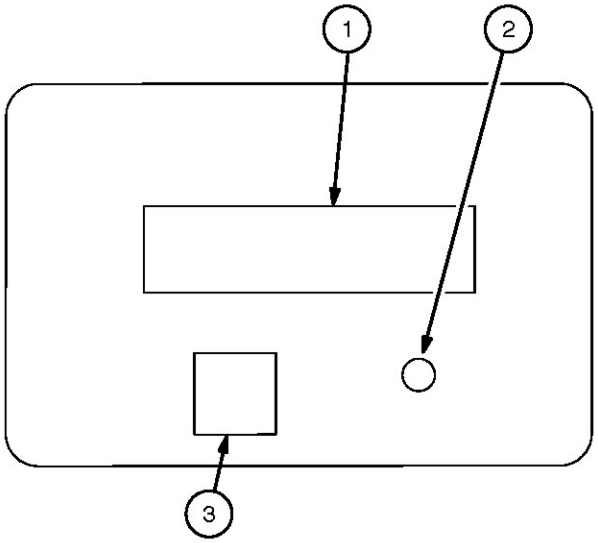
FIGURE 36. 15/12-AMP POWERCOMMAND BATTERY CHARGERS

8.1.1 Control Panel

The 15/12-amp charger control panel includes a digital display, a Reset button, and an LED status indicator.

- The 2-line x 16-character digital display displays menus and faults.
- The Reset button is used to select menu options and to clear fault messages.

- The status LED displays the appropriate color for the following conditions.
  - **Green** - On solid indicates unit is charging.
  - **Amber** - On solid indicates equalizing.
  - **Red** - On solid indicate a fault condition. The fault number is shown on the digital display.



No.	Description	No.	Description
1	Digital Display	3	Reset Button
2	LED/Status Indicator		

FIGURE 37. CONTROL PANEL

8.1.2 Battery Charger Configuration

The **RESET** button on the control panel is used to configure the battery charger. More information on the Setup menus is included in the Battery Charger Operator Manual (901-0107).

- **Battery Voltage and Type** - The battery charger must be correctly configured, using the Setup menus, for the correct battery voltage and type before it is connected to the battery. The battery voltage can be set for 12 or 24 VDC (default = 12 VDC). The battery type can be set for Lead-Acid, Gel, or AGM batteries (default = Lead-Acid).

NOTICE
A factory installed battery charger is set up for the proper DC battery voltage requested on the production order, with the Lead-Acid battery type selected as the default.

- **Float Voltage** - Various float voltages can be configured using the Setup menus. Consult your battery datasheet for the best possible choice.
- **Battery Equalization** - Battery equalization is available for Lead-Acid batteries that are completely charged, using the Equalize Battery screen in the Setup menus. When battery equalization is in process, the LED status indicator turns amber.

8.1.3 Battery Temperature Sensor

A connector for the battery temperature sensor option is located on the front of the battery charger. When used to monitor battery temperature, this sensor is connected from the battery charger to the positive terminal of the battery. A fault message (fault code 2263) is displayed if the battery temperature is too high (reaches 55 °C [131 °F]).

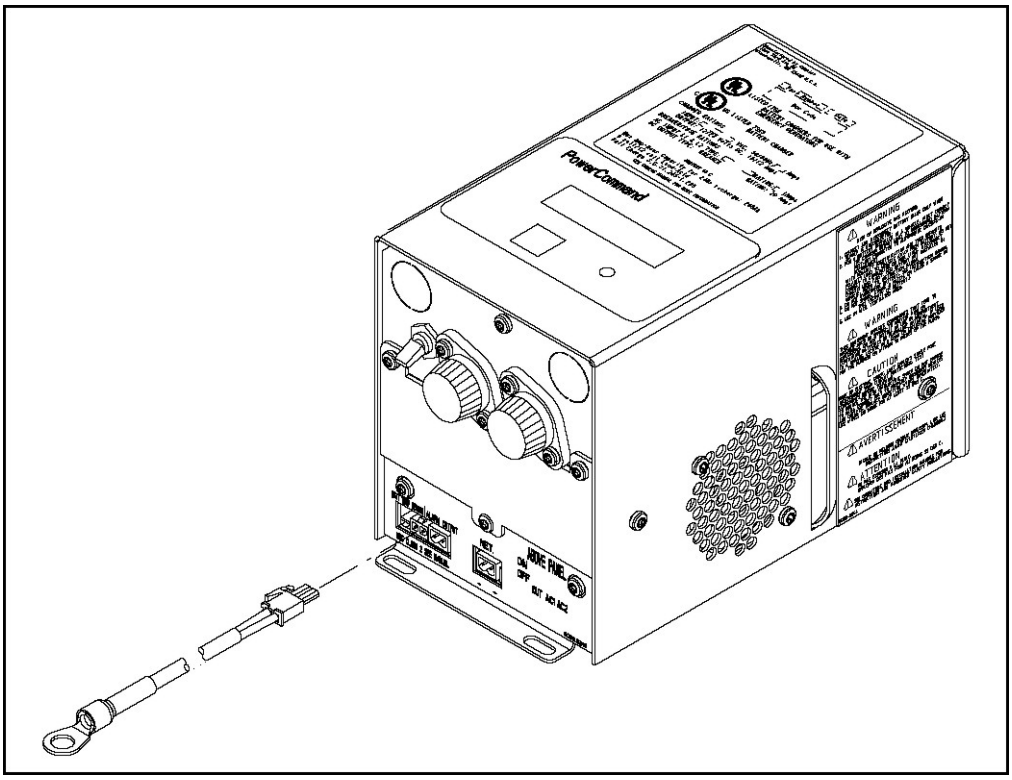


FIGURE 38. TEMPERATURE SENSOR

8.2 Circuits

For generator set specific information, refer to the drawings and circuit diagrams provided with your generator set.

9 Manufacturing Facilities

NORTH AMERICA	EMEA, CIS	ASIA PACIFIC
Cummins Power Generation Limited 1400 73rd Ave. NE Minneapolis, MN 55432 USA	Cummins Power Generation Limited Columbus Avenue Manston Park Manston, Ramsgate Kent CT12 5BF United Kingdom	Cummins Power Generation Limited 10 Toh Guan Road #07-01 TT International Tradepark Singapore 608838
Phone +1 763 574 5000 Toll Free +1 800 888 6626 Fax +1 763 574 5298	Phone +44 1843 255000 Fax +44 1843 255902	Phone +65 6417 2388 Fax +65 6417 2399
BRAZIL	**CHINA**	**INDIA**
Rua Jati, 310, Cumbica Guarulhos, SP 07180-900 Brazil	Cummins Power Generation 2 Rongchang East Street, Beijing Economic – Technological Development Area Beijing 100176, P.R.China	Cummins India Ltd, Power Generation Business Unit, Plot No B-2, SEZ Industrial Area, Village-Nandal & Surwadi, Taluka-Phaltan Dist- Satara, Maharashtra 415523 India
Phone +55 11 2186 4195 Fax +55 11 2186 4729	Phone 86 10 59023001 Fax +86 10 5902 3199	Phone +91 021 66305514
LATIN AMERICA	**MEXICO**	
3350 Southwest 148th Ave. Suite 205 Miramar, FL 33027 USA	Eje 122 No. 200 Zona Industrial San Luis Potosi, S.L.P. 78395 Mexico	
Phone +1 954 431 551 Fax +1 954 433 5797	Phone +52 444 870 6700 Fax +52 444 824 0082	

9.1 How to Obtain Service

When a product requires servicing, contact the nearest Cummins Power Generation distributor. To locate the distributor, refer to **power.cummins.com** and select Distributor Locator. When contacting the distributor, always supply the complete model, specification, and serial number as shown on the nameplate.

9.1.1 Locating a Distributor

In North America

To easily locate the nearest certified distributor/dealer for Cummins generator sets in your area, or for more information, contact us at 1-800-344-0039 or visit **power.cummins.com**.

If unable to contact a distributor using the automated service, consult the Internet.

If unable to arrange a service or resolve an issue, contact the Service Manager at the nearest Cummins Power Generation distributor for assistance.

When contacting the distributor, always supply the complete Model, Specification, and Serial Number as shown on the product nameplate.

Outside North America

Refer to **power.cummins.com** and select Distributor Locator, or send an email to ask.powergen@cummins.com.

power.cummins.com