Power Generation

Operator Manual

Generator Set

QSX15-G8 or QSX15-G9 Engine with PowerCommand® 3201 Controller

DFEG (Spec K-L)
DFEH (Spec K-L)
DFEJ (Spec K-M)
DFEK (Spec K-M)

English
Original Instructions
8-2014
A040Z650 (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

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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

Coolant under pressure.
Hot coolants under pressure can cause severe scalding.
Do not open a radiator or heat exchanger pressure cap while the engine is running. Let the engine cool down before removing the coolant pressure 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 or death.
Make sure all protective guards are properly in place before starting the generator set.

⚠ WARNING

Toxicity.
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

Operation of equipment.
Operation of equipment is unsafe when mentally or physically fatigued.
Do not operate equipment in this condition, or after consuming any alcohol or drug.

⚠ WARNING

Exhaust 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

Fire or explosion.
Flammable liquids can cause fire or explosion leading to severe personal injury or death.
Do not store fuel, cleaners, oil, etc. near the generator set.

⚠ WARNING

Noise.
Generator sets in operation mode emit noise, which can cause hearing damage.
Wear appropriate ear protection at all times.

⚠ WARNING

Hot metal parts.
Exposed skin can suffer serious and permanent burns, depending on the temperature and contact time.
Avoid contact or wear protective gloves.

⚠ WARNING

Maintaining or installing a generator set.

Failure to carry out the correct procedures when maintaining or installing a generator set can cause severe personal injury or equipment damage.

Wear personal protective equipment such as safety glasses, protective gloves, hard hats, steel-toed boots, and protective clothing when working on equipment.

⚠ WARNING

Toxicity.

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

Clean up coolant spills and dispose of used antifreeze in accordance with local environmental regulations.

⚠ WARNING

Starting fluids, such as ether.

Starting fluids, such as ether, may cause explosion, which can result in severe personal injury and generator set engine damage.

Do not use.

⚠ WARNING

Accidental or remote starting.

Accidental or remote starting of the generator set while working on it can cause severe personal injury or death.

Prevent accidental or remote starting by disconnecting the starting battery cables (negative [–] first), using an insulated wrench and isolating all auxiliary supplies.

⚠ CAUTION

Fire hazard.

Loose cleaning materials can become entangled in moving parts, which may result in equipment damage or a fire hazard.

Make sure that all cleaning materials are removed from the generator set before operating the generator.

⚠ CAUTION

Fire hazard.

A build up of combustible materials under the generator set can present a fire hazard.

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

⚠ CAUTION

Fire hazard.

Accumulated grease and oil can cause overheating and engine damage presenting a potential fire hazard.

Keep the generator set clean and makes sure oil leaks are repaired promptly.

NOTICE

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

⚠ CAUTION

Fire hazard.

Articles left against or close by the generator set may obstruct and restrict the air flow causing over heating or a fire hazard.

Keep the generator set and the surrounding area clean and free from obstructions. Remove any debris from the set and keep the floor clean and dry.

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

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 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

Improper operation and maintenance.

Improper operation and maintenance can lead to severe personal injury, or loss of life and property, by fire, electrocution, mechanical breakdown, or exhaust gas asphyxiation.

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

⚠ WARNING

Lifting .

Incorrect lifting and repositioning of the generator set, can result in severe personal injury, death, and/or equipment damage.

Lifting must only be carried out using suitable lifting equipment, shackles, and spreader bars, in accordance with local guidelines and legislation, by suitably trained and experienced personnel. For more information, contact your authorized distributor.

1.3.1 Moving Parts Can Cause Severe Personal Injury Or Death

- Keep your 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
On an enclosed generator set, the canopy doors must be 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 +/– 20 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.

1.3.4 Moving the Generator Set

⚠ WARNING
Improper handling.
Improper handling of the generator set may cause serious damage to the generator set and its components and can result in personal injury or death.
Transportation and handling of generator sets must only be undertaken by suitably trained and experienced personnel.

It is essential that there are sufficient trained and experienced personnel in attendance to make sure the lifting and transportation of the generator set is undertaken in a safe and appropriate manner, and in accordance to local guidelines and legislation.

⚠ WARNING
Lifting.
Improper handling of the generator set may cause serious damage to the generator set and its components and can result in severe personal injury or death.
Do not lift the generator set by attaching to the engine or alternator lifting points.

Before lifting the generator set, lifting points, angle of slings, mass, access to intended site, and the distance of movement should all be taken into account when organizing a suitable crane/hoist. Consult the generator set information supplied with the generator set for details of dimensions and mass.

- Make sure that the crane operating area is able to support the mass of the crane and the generator set.

⚠ WARNING

Access.
Using the generator set as a means of access when attaching lifting shackles, chains, or other lifting aids, may damage the generator set, causing severe personal injury or death
Do not use the skid (bedframe) or any part of the generator set as a means of access.

NOTICE

On an enclosed generator set, the canopy doors must be locked before repositioning, and they must remain locked during transportation and siting.

- Make sure the equipment used for lifting is adequate to support the weight of the generator set.
- Attach the lifting device to the lifting points only using suitable shackles, chains, and spreader bars.
- Slowly tighten the slings. Inspect the lifting attachments before commencing a full lift to make sure they are attached correctly.
- Hoist the generator set slowly using the indicated lifting points only.

⚠ DANGER

Raised Load.
Contact with a lifted generator set can result in severe personal injury or death.
Never stand underneath a lifted generator set.

- Guide the generator set with ropes at a safe distance to prevent uncontrolled rotation when positioning the generator set.
- Move the generator set to the desired location and place in position, bringing the set down slowly.
- Loosen the slings; unhook and remove the shackles.

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

- Only qualified service personnel certified and authorized to work on power circuits should work on exposed energized power circuits.
- All relevant service material must be available for any electrical work performed by certified service personnel.
- Exposure to energized power circuits with potentials of 50 VAC or 75 VDC or higher poses a significant risk of 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 safety requirements.

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. Safety*) 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 pipes.

Hot exhaust pipes and charge air pipes can cause severe personal injury or death from direct contact, or from fire hazard.

Wear appropriate PPE when working on hot equipment and avoid physical contact where possible.

⚠ WARNING

Exhaust gases.

Hot exhaust gases can cause burns resulting in severe personal injury.

Wear personal protective equipment when working on equipment.

⚠ WARNING

Exhaust gases.
Inhalation of exhaust fumes can result in serious personal injury or death.
Be sure deadly exhaust gas is piped outside and away from windows, doors, or other inlets to buildings. Do not allow to accumulate in habitable areas.

⚠ WARNING

Fire hazard.
Contaminated insulation is a fire risk which can result in severe personal injury and equipment damage.
Remove any contaminated insulation and dispose of 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.

1.8 Distribution Panel Door

NOTICE
Opening the distribution panel door while the generator set is running will trip the generator set circuit breaker and abruptly shut off power to all loads. Make sure that the generator set is not running and is in off mode before you open the distribution panel door.

2 Introduction

⚠ WARNING

Hazardous voltage.

Hazardous voltages can cause severe personal injury or death and equipment damage.

Generator electrical output connections must be made by a trained and experienced electrician in accordance with the installation instructions and all applicable codes.

⚠ WARNING

Electrical generating equipment.

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://qsol.cummins.com/info/index.html).

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.

ABBR.	DESCRIPTION	ABBR.	DESCRIPTION
AC	Alternating Current	LCT	Low Coolant Temperature
AMP	AMP, Inc., part of Tyco Electronics	LED	Light-emitting Diode

ABBR.	DESCRIPTION	ABBR.	DESCRIPTION
ANSI	American National Standards Institute	MFM	Multifunction Monitor
ASOV	Automatic Shut Off Valve	Mil Std	Military Standard
ASTM	American Society for Testing and Materials (ASTM International)	NC	Normally Closed
ATS	Automatic Transfer Switch	NC	Not Connected
AVR	Automatic Voltage Regulator	NFPA	National Fire Protection Agency
AWG	American Wire Gauge	NO	Normally Open
CAN	Controlled Area Network	NWF	Network Failure
CB	Circuit Breaker	OEM	Original Equipment Manufacturer
CE	Conformité Européenne	OOR	Out of Range
CFM	Cubic Feet per Minute	OORH / ORH	Out of Range High
CGT	Cummins Generator Technologies	OORL / ORL	Out of Range Low
CMM	Cubic Meters per Minute	PB	Push Button
CT	Current Transformer	PCC	PowerCommand® Control
DC	Direct Current	PGI	Power Generation Interface
DEF	Diesel Exhaust Fluid	PGN	Parameter Group Number
DPF	Diesel Particulate Filter	PI	Proportional/Integral
ECM	Engine Control Module	PID	Proportional/Integral/Derivative
ECS	Engine Control System	PLC	Programmable Logic Controller
EMI	Electromagnetic interference	PMG	Permanent Magnet Generator
EN	European Standard	PPE	Personal Protective Equipment
EPS	Engine Protection System	PT	Potential Transformer
E-Stop	Emergency Stop	PTC	Power Transfer Control
FAE	Full Authority Electronic	PWM	Pulse-width Modulation
FMI	Failure Mode Identifier	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
HMI	Human-machine Interface	SCR	Selective Catalytic Reduction
IC	Integrated Circuit	SPN	Suspect Parameter Number
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 DFEG, DFEH, DFEJ, and DFEK Generator Set with PowerCommand® 3201 Controller (A040Z650)
- Installation Manual for DFEG, DFEH, DFEJ, and DFEK Generator Set with PowerCommand® 3201 Controller (A040Z648)
- Service Manual for DFEG, DFEH, DFEJ, and DFEK Generator Set with PowerCommand® 3201 Controller (A040Z652)
- Controller Service Manual for PowerCommand® 3201 Controller (A034T572)
- Engine Operation & Maintenance Manual for QSX15 Engine (3666423)
- Alternator Service Manual for HC Alternator (0900-9904)
- *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 DFEG, DFEH, DFEJ, and DFEK Generator Set with QSX15 engine, PowerCommand® 2100 Controller or PowerCommand® 3201 Controller (A040G238)
- Standard Repair Times - CH Family (A034H045)
- 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 service or parts replacement can result in severe personal injury, death, and/or equipment damage.
Service personnel must be trained and experienced to 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.

Extended warranty coverage is also available. 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.

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 your nearest Cummins Power Generation distributor. To locate your local Cummins Power Generation distributor, refer to **www.cumminspower.com** and select Distributor Locator. When contacting your distributor, always supply the complete model, specification, and serial number as shown on the nameplate.

2.4.3.1 Locating Your Distributor

In North America

Telephone +1 800 888 6626 (this is an automated service for touch-tone phones only) to contact the nearest Cummins Power Generation distributor in the United States or Canada. By selecting Option 1 (press 1), you will be automatically connected to the distributor nearest you.

If you are unable to contact a distributor using the automated service, consult the Yellow Pages. Typically, our distributors are listed under:

GENERATORS – ELECTRIC or

ENGINES – GASOLINE OR DIESEL

If you have difficulty arranging service or resolving an issue, please contact the Service Manager at the nearest Cummins Power Generation distributor for assistance.

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

Outside North America

If you are outside North America, refer to **www.cumminspower.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

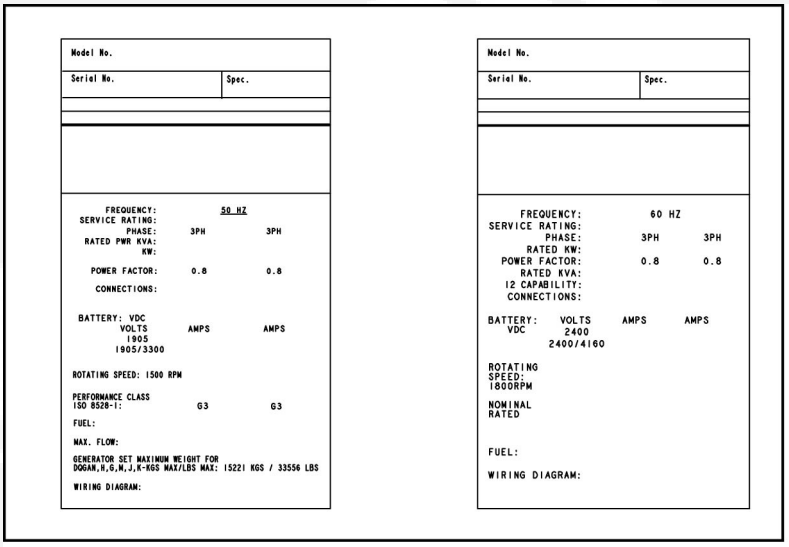
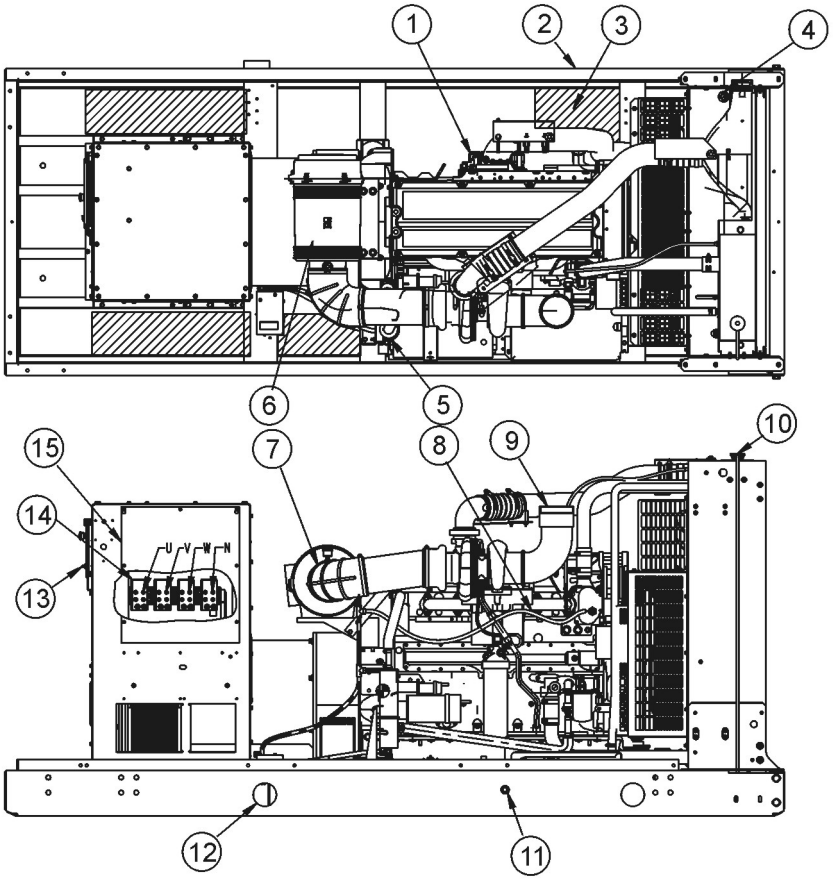


FIGURE 1. TYPICAL GENERATOR SET NAMEPLATE

3.2 DFEG, DFEH, DFEJ, and DFEK Generator Set Components

The main components of a DFEG, DFEH, DFEJ, and DFEK 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	Fuel Connections	9	Exhaust Connector
2	Fuel Stub Up Area A	10	Radiator Fill
3	Oil Fill	11	Oil Drain Extension Access Hole
4	Fuel Return	12	Lifting Holes
5	Optional Coolant Heater	13	Control Interface
6	Fuel Stub Up Area B	14	Generator Electrical Load Connections
7	Air Cleaner	15	Electrical Connection Access Removable Panel (Both Sides)
8	Fuel Supply		

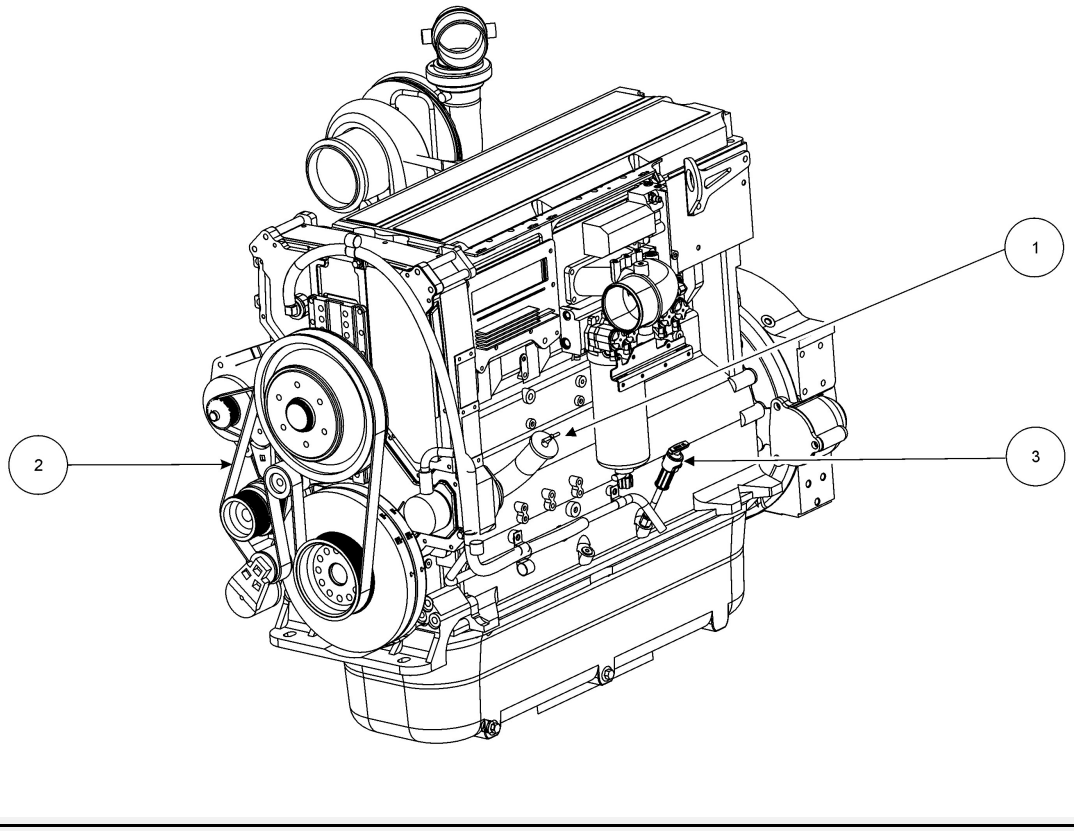
FIGURE 2. 0500-4227 REVISION C GENERATOR SET

3.3 Generator Set Rating

Refer to the generator set nameplate for generator set rating. Refer to **Section 5.8 on page 69** 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 Engine Data

3.4.1.1 Acoustic Information

3.4.1.1.1 Acoustic Information (1500 RPM)

TABLE 1. ACOUSTIC DATA (1500 RPM)

Model	DFEH	DFEJ	DFEK
Engine	QSX15	QSX15	QSX15

Standard Unhoused - Infinite Exhaust	116	118	118
F183 Weather with Residential Muffler - Mounted Muffler	118	118	118

2. Sound data with remote-cooled generator sets are based on ratged loads without cooling fan noise
3. Sound levels for aluminum enclosures are approximately 2 dB(A)s higher than listed sound levels for steel enclosures
4. Sound data for generator set with infinite exhaust do not include exhaust noise
5. Data is based on full rated load with standard radiator-cooling fan package
6. Sound Power Levels per ISO 3744 and ISO 8528-10, as applicable
7. Reference power = 1 pw (10^{-12}W)

3.4.1.1.2 Acoustic Information (1800 RPM)

TABLE 2. ACOUSTIC DATA (1800 RPM)

Model	DFEG	DFEH	DFEJ	DFEK
Engine	QSX15	QSX15	QSX15	QSX15
Standard, Unhoused[2] - Infinite Exhaust	117	117	118	119
F183 Residential Muffler - Mounted Muffler	118	118	119	119
F200 Weatgher - Mounted Muffler	114	116	116	118
F201 Quiet Site II First Stage - Mounted Muffler	113	114	115	116
F202 Quiet Site II Second Stage - Mounted Muffler	102	104	104	104

1. Sound levels are subject to instrumentation, measurement, installation, and manufacturing variability
2. Sound data with remote-cooled generator sets are based on ratged loads without cooling fan noise
3. Sound levels for aluminum enclosures are approximately 2 dB(A)s higher than listed sound levels for steel enclosures
4. Sound data for generator set with infinite exhaust do not include exhaust noise
5. Data is based on full rated load with standard radiator-cooling fan package
6. Sound Power Levels per ISO 3744 and ISO 8528-10, as applicable
7. Reference power = 1 pw (10^{-12}W)

3.4.1.2 Engine Fuel Consumption

TABLE 3. FUEL CONSUMPTION (L/HR) AT 1500 RPM (50 HZ)

Model	DFEH	DFEJ	DFEK
Engine	QSX15-G8	QSX15-G8	QSX15-G8
Engine Performance Data at 50Hz[1]	91	101	115

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.

TABLE 4. FUEL CONSUMPTION (L/HR) AT 1800 RPM (60 HZ)

Model	DFEG	DFEH	DFEJ	DFEK
Engine	QSX15-G9	QSX15-G9	QSX15-G9	QSX15-G9
Engine Performance Data at 60Hz[1]	91	103	114	130

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.

TABLE 5. FUEL CONSUMPTION (GAL/HR) AT 1500 RPM (50 HZ)

Model	DFEH	DFEJ	DFEK
Engine	QSX15-G8	QSX15-G8	QSX15-G8
Engine Performance Data at 50Hz[1]	24.1	26.8	30.5

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.

TABLE 6. FUEL CONSUMPTION (GAL/HR) AT 1800 RPM (60 HZ)

Model	DFEG	DFEH	DFEJ	DFEK
Engine	QSX15-G9	QSX15-G9	QSX15-G9	QSX15-G9
Engine Performance Data at 60Hz[1]	24.1	27.3	30.1	34.4

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.

3.4.2 Fuel Changeover System

NOTICE

Generator sets with the valves set to external tank supply and with the blanking plugs fitted will cause damage to the engine's fuel system.
Do not attempt to operate the generator set with the valves set to external tank supply and with the blanking plugs fitted.

NOTICE

Consult your authorized distributor to establish the maximum head of fuel allowable at the generator set fuel pump.

A 3-way fuel valve system is provided to enable the generator set to be fuelled directly from an external tank.

Where the system comprises two valves it is essential that both valves are in the same position to prevent the following:

- Fuel spillage from the generator set tank vent when fuel is drawn from the external tank and spill returned to the generator set tank.
- Fuel shortage when fuel is drawn from the generator set tank and spill returned to the external tank.

3.5 Sensors

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

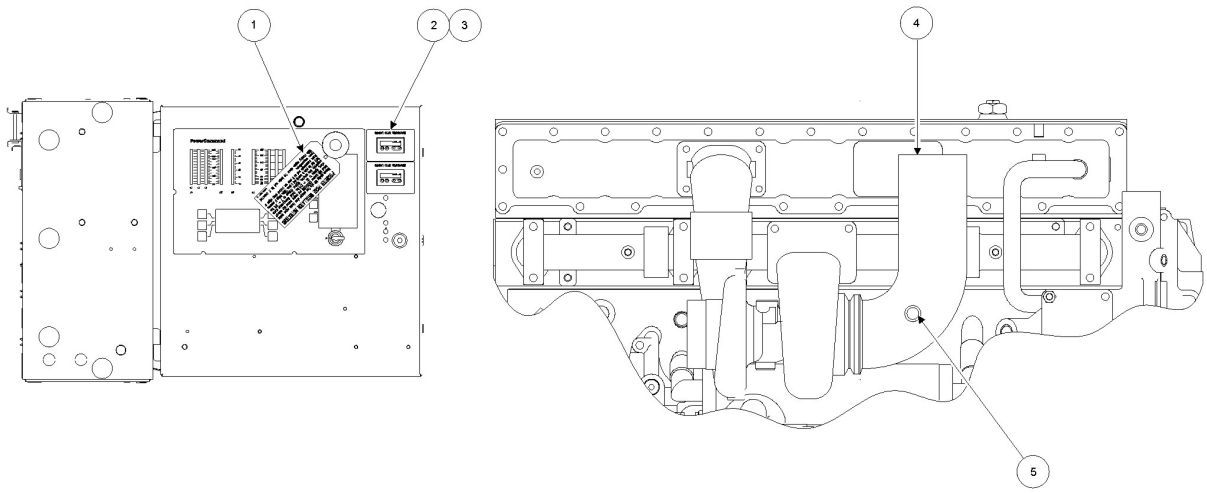
Engine-mounted sensors monitor a number of different systems, such as:

- Lube Oil Pressure
- Cooling System Temperature

3.6 Pyrometers - Engine Exhaust

A pyrometer measures engine exhaust gas temperature. A separate temperature meter is used to monitor each exhaust outlet elbow.

3.6.1 Pyrometer Position



No.	Description	No	Description
1	Instruction Label	4	Exhaust Outlet Elbow
2	Exhaust Pyrometer Label	5	Temperature Sender Location
3	Temperature Meter		

FIGURE 4. PYROMETER LOCATION AND METER(S)

3.7 Heaters

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.**

3.7.1 Heater Supply and Isolation

A heater 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.

3.8 Mains (Utility) Powered Battery Charger

⚠ CAUTION
Battery Isolation. ***Failure to disconnect the battery charger before isolating the battery can result in voltage spikes high enough to cause equipment damage and personal injury.*** ***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.

For more information on Battery Chargers see **Chapter 8 on page 121**.

3.9 Air Cleaner

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

3.9.1 Normal Duty Air Cleaner

This shows the normal duty air cleaner.

See **Section 3.11 on page 24** for optional air cleaners.

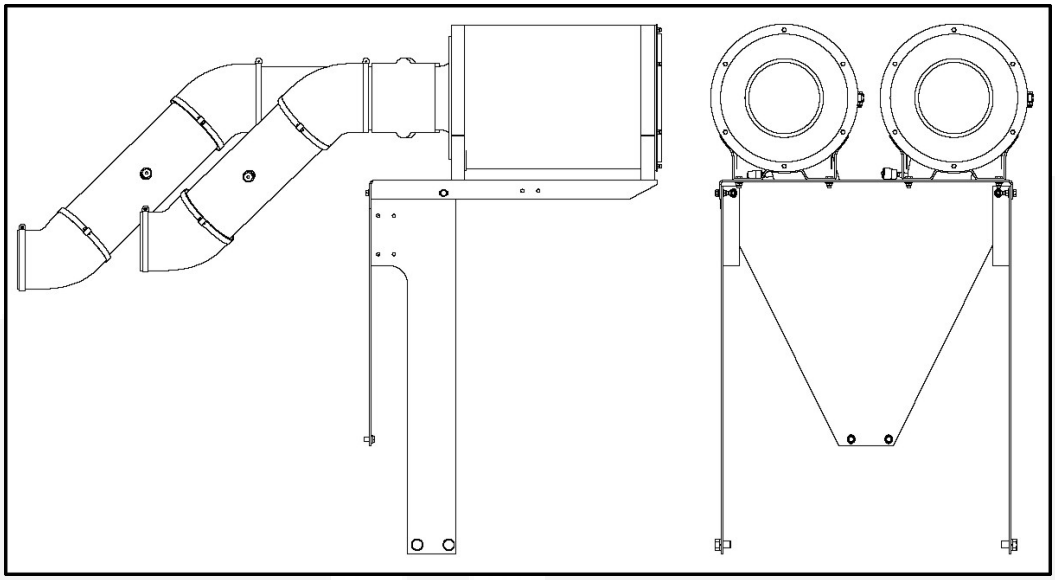


FIGURE 5. NORMAL AIR CLEANER ASSEMBLY

3.10 Coolant Heater

NOTICE
Oerating 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.

Make sure the coolant heater is plugged into a grounded outlet. If an extension cord is used, it must be a grounded type.

3.11 System Options

3.11.1 Heavy Duty Air Cleaner

A heavy duty air cleaner is used in dusty environments. This shows the heavy duty air cleaner.

See **Section 3.11 on page 24** for optional air cleaners.

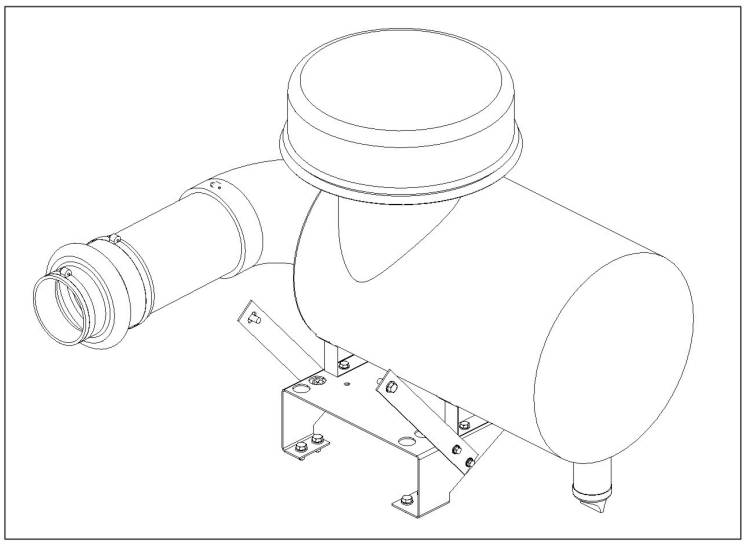


FIGURE 6. HEAVY DUTY AIR CLEANER ASSEMBLY

3.11.2 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.

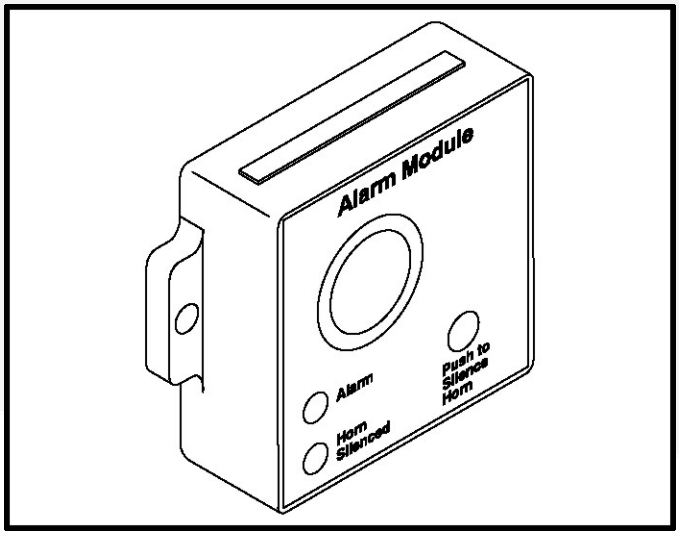


FIGURE 7. ALARM MODULE

3.11.3 PowerCommand Universal Annunciator

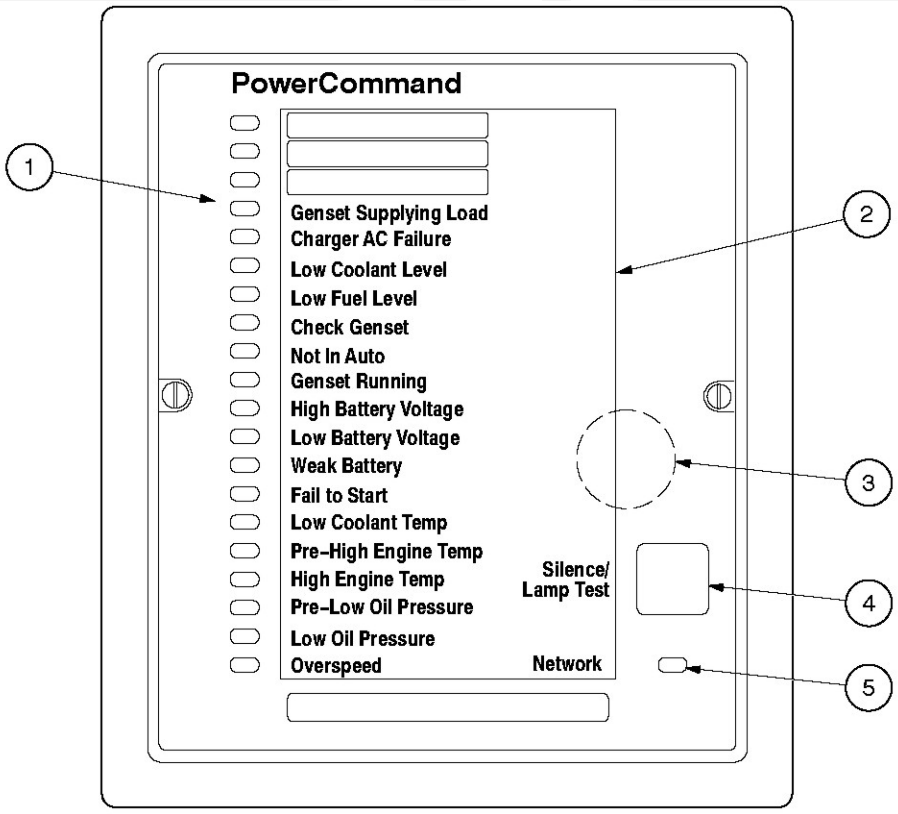
A universal annunciator provides lamps and a horn to annunciate the operating status and fault conditions of an emergency power system. It is designed for connection to either a 12 VDC or a 24 VDC control system. It can be configured to be either a positive or negative signal device.

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 8. ANNUNCIATOR COMPONENTS

3.11.4 Mains (Utility) Powered Battery Charger

⚠ CAUTION

Battery Isolation.
Failure to disconnect the battery charger before isolating the battery can result in voltage spikes high enough to cause equipment damage and personal injury.
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.

For more information on Battery Chargers see **Chapter 8 on page 121**.

3.11.5 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.

3.11.6 Coolant Heater

NOTICE

Oerating 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.

Make sure the coolant heater is plugged into a grounded outlet. If an extension cord is used, it must be a grounded type.

3.11.7 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.

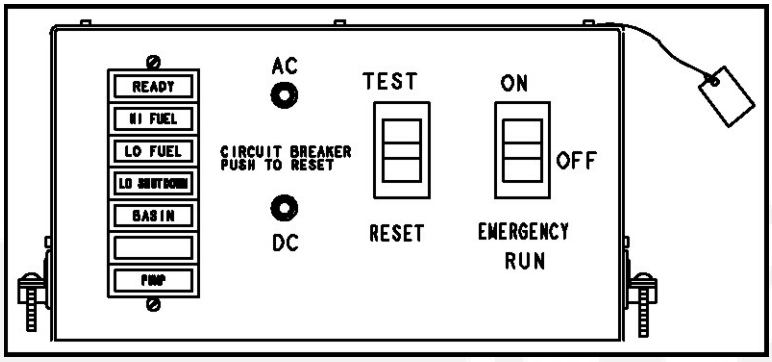
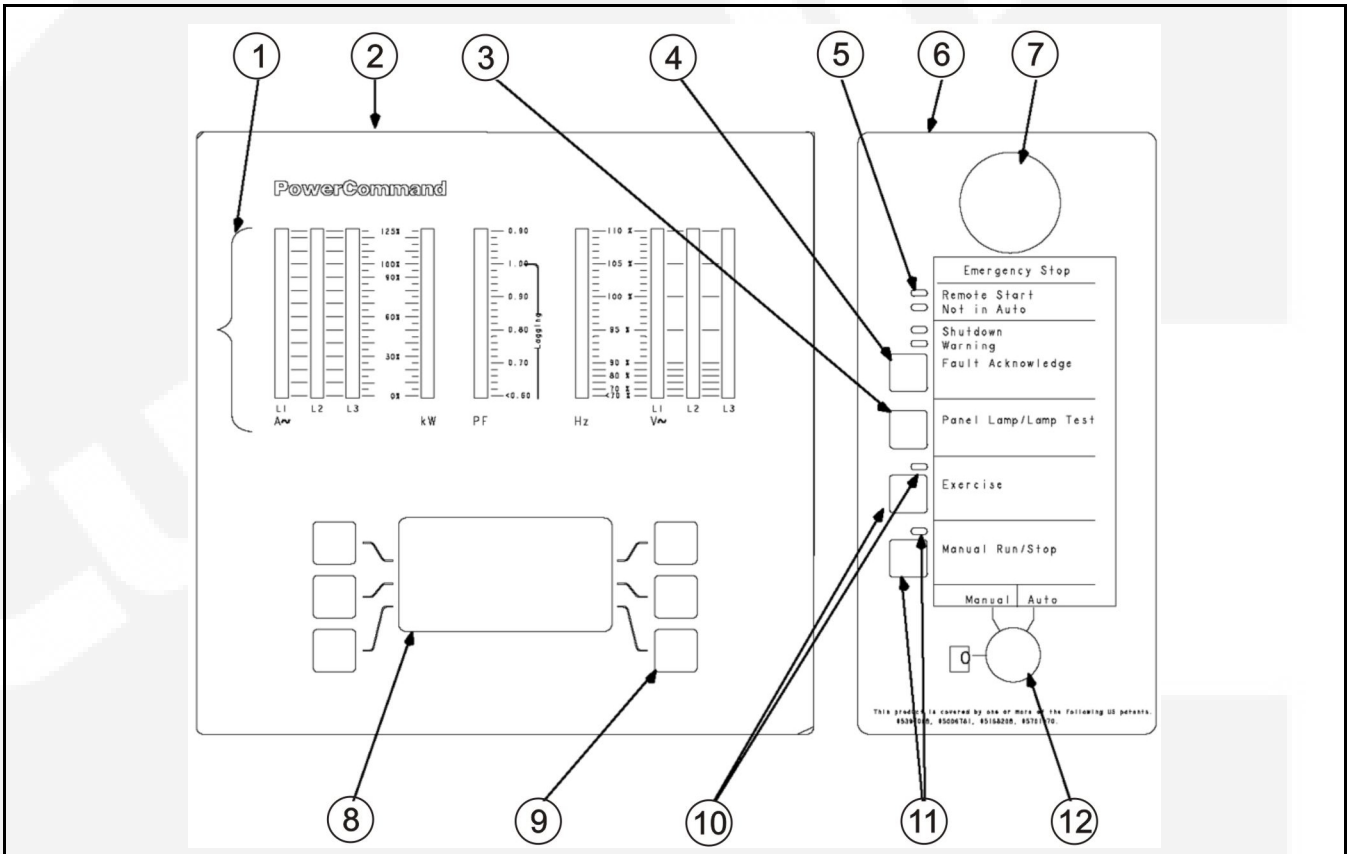


FIGURE 9. TYPICAL DAY TANK CONTROL

4 Control System - PCC 3201

4.1 Control System Description

The following describes the function and operation of the PCC 3201. All indicators, control switches/buttons, and graphical display are located on the face of the control panel as illustrated in Figure 10 on page 29.



No.	Description	No.	Description
1	Analog AC Metering Panel	7	Emergency Stop Push Button
2	Operator Panel	8	Graphical Display
3	Panel Lamp/Lamp Test Button	9	Display Menu Selection Button (1 of 6)
4	Fault Acknowledgement Button	10	Exercise Button and Indicator
5	Remote Start, Not in Auto, Shutdown Warning Status Indicators	11	Manual Run/Stop Button and Indicator
6	Switch Panel	12	O/Manual/Auto Switch

FIGURE 10. CONTROL PANEL ASSEMBLY (FULL-FEATURED)

Normally, generator set configuration options are set at the factory. When a new control is installed on a generator set or when parts are replaced, the control must be configured for that generator set. Setup and calibration procedures are described in later sections.

The control system is used to start and stop the generator set from the display screen in either Manual or Auto mode. It is suitable for stand alone or paralleling generator sets in both standby and prime-power applications, providing full generator set monitoring capability and protection. It monitors the engine for temperature, oil pressure and speed, and provides voltage and current metering. In the event of a fault the unit indicates the fault type and automatically shuts down the generator set on critical faults.

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 immediately takes the engine off-load and automatically shuts it down.

The standard control system operates on 12 or 24 VDC battery power. The auxiliary equipment operates on low voltage AC power. The history data is stored in non-volatile memory and is not deleted if battery power is lost.

The control panel assembly consists of two panels, the Operator Panel and the Switch Panel. Dependent on the site requirements, the Operator Panel is either mounted on the control panel assembly (full-featured) or contained in a separate enclosure and mounted remotely of the control panel assembly.

NOTICE
The function of several buttons on the control panel will vary dependent on the location of the control panel (remote or local of the control panel assembly). If the function differs, it is noted as either "remote" or "local operator panel" in the button description.

4.2 Control Panel Power On/Off Modes

The power on/off modes of the control panel and operating software are Power On, Screen Saver, and Sleep/Awake.

4.2.1 Power On Mode

In this mode, power is continuously supplied to the control panel. The control's operating software and control panel LEDs/graphical display will remain active until the Screen Saver mode is activated.

4.2.2 Screen Saver Mode

Power to the graphical display will be removed after 10 minutes (generator set not running or running). The 10 minute timer resets and begins after each control panel action (any button or switch selection) or signal received by the operating software. The bottom LEDs of the Analog AC Metering Panel (bar graphs) may stay On during Screen Saver mode, indicating that the operating software is active (Awake mode).

When a "Warning" signal (for example, low coolant temp) is sensed by the control will display the warning message. The control will remain active until the Fault Acknowledge button is pressed to clear the warning message and start the 10 minute timer.

4.2.3 Sleep/Awake Mode

In the Sleep mode, the control's operating software is inactive and the LEDs and the digital display on the control panel are all off. Sleep mode is a feature used to reduce battery power consumption when the control is not being used and the O/Manual/Auto switch is in the O position.

When all conditions are met (i.e., no unacknowledged faults and O/Manual/Auto switch is in the O position), the Sleep mode is activated.

The operating software is initialized and the digital display and control panel LEDs are turned on in response to moving/pressing the following control panel switch/buttons:

- Off/Manual/Auto switch
- Emergency Stop button
- Fault Acknowledge/Reset button
- Panel Lamp/Lamp Test button

To activate the control and view the menu display without starting the generator set, press the Fault Acknowledge or Panel Lamp button or move the mode switch from O to Manual.

The InPower™ service tool is required to enable or disable the Sleep mode. When shipped from the factory, Sleep mode is disabled. When disabled, the operating software will always remain active (Awake mode). If network and/or power transfer control (PTC) feature is installed, the sleep mode is not available.

NOTICE
The InPower service tool is required to select the desired mode. Contact an authorized service center for assistance.

4.3 Switch Panel

The Switch Panel contains the following items:

4.3.1 Manual Run/Stop Button

This button starts and stops the generator set locally and will bypass the Time Delay to Start and Stop sequences. The O/Manual/Auto switch must be in the Manual position to enable this button.

4.3.2 O/Manual/Auto Switch

Manual position enables the use of the switch panel Manual Run/Stop button.

Auto position enables start/stop control of the engine from a remote location. (Disable the use of the switch panel Manual Run/Stop button.)

O (off) position prevents the starting of the set (local or remote).

NOTICE

If moved to the O position during set operation, this will cause an immediate engine shutdown (bypasses cooldown timers). Hot shutdowns should be avoided to prolong the reliability of the generator set. Hot shutdowns are logged by the system software.

NOTICE

When the generator set is operating in Auto, removing the Remote Start Command does not shut off the engine if the load is more than 10 percent, the cooldown timer is set to zero, and the control is configured for a single unit (not in parallel). The generator set continues to operate until it runs out of fuel, the E-stop button is used, or the load is removed.

4.3.3 Emergency Stop Buttons

There are three Emergency Stop buttons: two on the outside wall of the container and one on the control panel.

Push the button in for emergency shutdown of the engine. If the engine is not running, pushing the button in will prevent the starting of the engine, regardless of the start signal source (local or remote).

To reset:

1. Pull the button out.
2. Move the O/Manual/Auto switch to O.
3. Press the front panel Fault Acknowledge/Reset button.
4. Return O/Manual/Auto switch to the desired position.

4.3.4 Exercise Button

Press this button to initiate a pre-programmed exercise sequence. The O/Manual/Auto switch is used in conjunction with this button to enable this function.

4.3.5 Lamp (LED) Test Button

Press this button to turn on or off the panel lamp (LED). Press and hold down this button for three seconds or more to turn all control panel LEDs on to make sure all lamps illuminate. The illumination will shut off after releasing button.

4.3.6 Fault Acknowledgement

Press this button to acknowledge warning and shutdown messages after the fault has been corrected.

To acknowledge a Warning message, the O/Manual/Auto switch can be in any position. (It is not necessary to stop the generator set to acknowledge an inactive Warning condition.) To acknowledge a shutdown message with this button, the O/Manual/Auto switch must be in the O (off) position.

This button is also used to blink a fault code if the Shutdown or Warning Status Indicator is lit. (This function is used when the control does not contain a graphical display.) Refer to Section 7.5.2 on page 109 which describes how to use this button for interpreting fault codes.

4.3.7 Lamp Indicators

The following are the lamp indicators on the switch panel.

4.3.7.1 Warning Status Indicator

This yellow lamp is lit whenever the control detects a warning condition. After the condition is corrected, warning indicators can be reset by pressing the Fault Acknowledge button. (It is **not** necessary to stop the generator set if the fault becomes inactive during generator set operation.) In auto mode, warning indicators can also be reset by cycling the remote reset input after the condition is corrected.

Some warnings remain active after the condition is corrected and the control reset button is pressed. This will require the generator set to be shut down to reset the warning indicator.

4.3.7.2 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 turning the O/Manual/Auto switch to the O position, and pressing the Fault Acknowledge button. The generator set cannot be started when this lamp is on.

Dependent upon the specific fault that occurs, the engine may or may not shut down immediately. A fault that could cause engine damage, causes an immediate engine shutdown (bypasses engine cooldown sequence). All other faults would allow the engine to run during the cooldown sequence before engine shutdown. In this case, the Shutdown Status indicator blinks during the cooldown period.

4.3.7.3 Not in Auto

This red lamp flashes continuously when the O/Manual/Auto switch is not in the Auto position.

NOTICE
If the switch is in the Auto position and the lamp is still flashing, service is required.

4.3.7.4 Remote Start Indicator

This green lamp indicates the control is receiving a remote run signal. When flashing, it indicates a load demand stop mode.

4.4 Operator Panel

The operator panel contains the following components:

4.4.1 Analog AC Metering Panel

This panel simultaneously displays 3-phase line to line AC volts and current, kW, power factor and frequency.

The meter panel is composed of a series of LEDs, that are configured in bar graphs for each function. The LEDs are color coded, with green indicating normal range values, amber for warning levels, and red for shutdown conditions.

Scales for each function are in % of nominal values. Resolution is 1% for values close to nominal, and increases at values further from nominal.

4.4.2 Graphical Display

The graphical display is capable of displaying up to 9-lines of data with approximately 27 characters per line. The display is used to view the menus of the menu-driven operating system, as well as display warning and shutdown messages/error codes; modes of operation and system actions such as: Warning, Derate, Shutdown, etc. Refer to the menu trees later in this section.

The display is also used to the following system information:

- **State Line** - modes of operation, such as: Stopped, Time Delay To Start, Warm Up At Idle, etc.; and paralleling operations, such as: Standby, Dead BUS Close, Synchonize, etc.
- **Action Line** - system actions, such as: Warning, Derate, Cooldown, Shutdown, and fault codes.
- **Description Line** - Fault code/status messages.

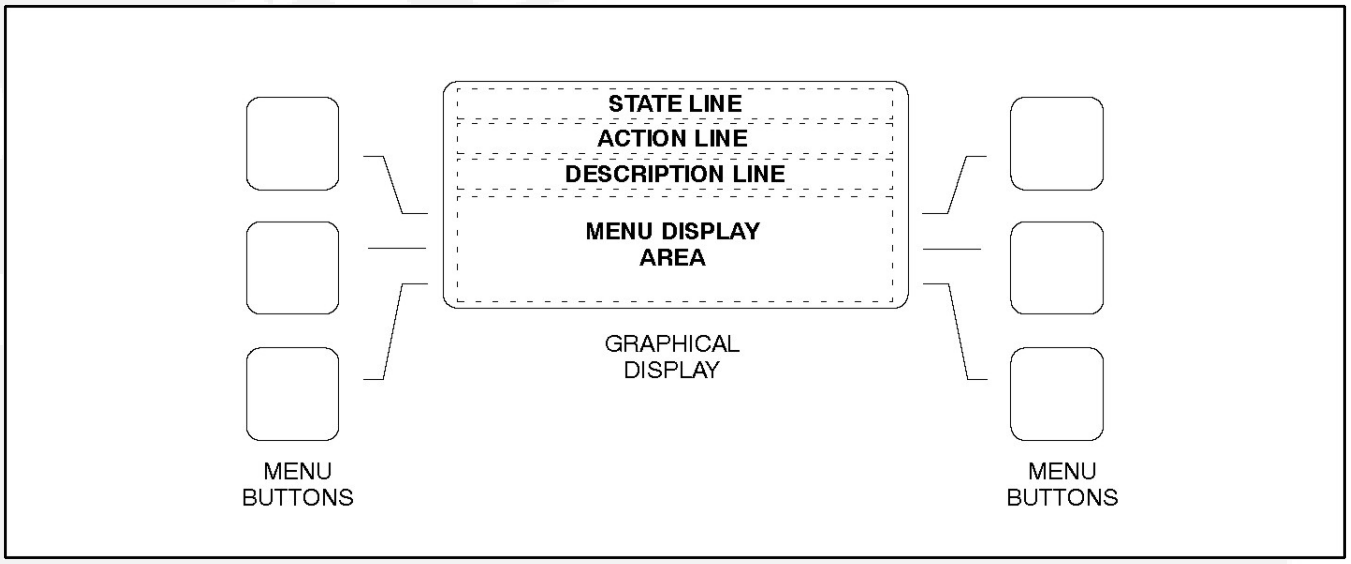


FIGURE 11. GRAPHICAL DISPLAY AND MENU SELECTION BUTTONS

4.4.3 Display Menu Selection Button

Six momentary buttons–three on each side of the graphical display window (Figure 11)–are used to navigate through the system control menus and to adjust generator set parameters. The button is active when the message adjacent to the button is highlighted (displayed in inverse video). The displayed message or symbol indicates the function of the button.

In the graphical display, the "▼" symbol indicates that selecting the adjacent button causes the operating program to go to the next menu display- as shown in the menu diagrams.

In the graphical display, the "▲" symbol indicates that selecting the adjacent button causes the operating program to go back to the previous menu display.

In the graphical display, the "⇑" symbol indicates that selecting the adjacent button causes the operating program to go back to Main Menu A.

4.5 Control Menus

4.5.1 Language/Units Selection Menu

During any control panel operation, you can select one of three languages and change how units are displayed by pressing the two lower menu buttons (one on each side of the display). When pressing these two buttons simultaneously, the language/units menu will appear (see Figure 12 on page 35). After making desired selections, press the ENTER button in this menu to change and save the selections.

Use the + buttons to select the desired option for each field. Use the arrow button to move to the next field. Selected field is highlighted.

- **Language:** Used to select desired language (default = English).
- **Location:** This selection must be set to Local when the graphical display is mounted on the generator set front control panel or Remote when mounted remotely from the generator set.

  The Local/Remote selection determines which buttons in the Control submenu are active (displayed).
- **Temp:** Used to select °F or °C for temperature readings.
- **Pressure Fluid:** Used to select PSI, KPA, BAR or IN for pressure readings.
- **Pressure Gas:** Used to select INHG or MMHG for pressure readings.
- **Flow Air:** Used to select CFM or CMM for air flow readings.

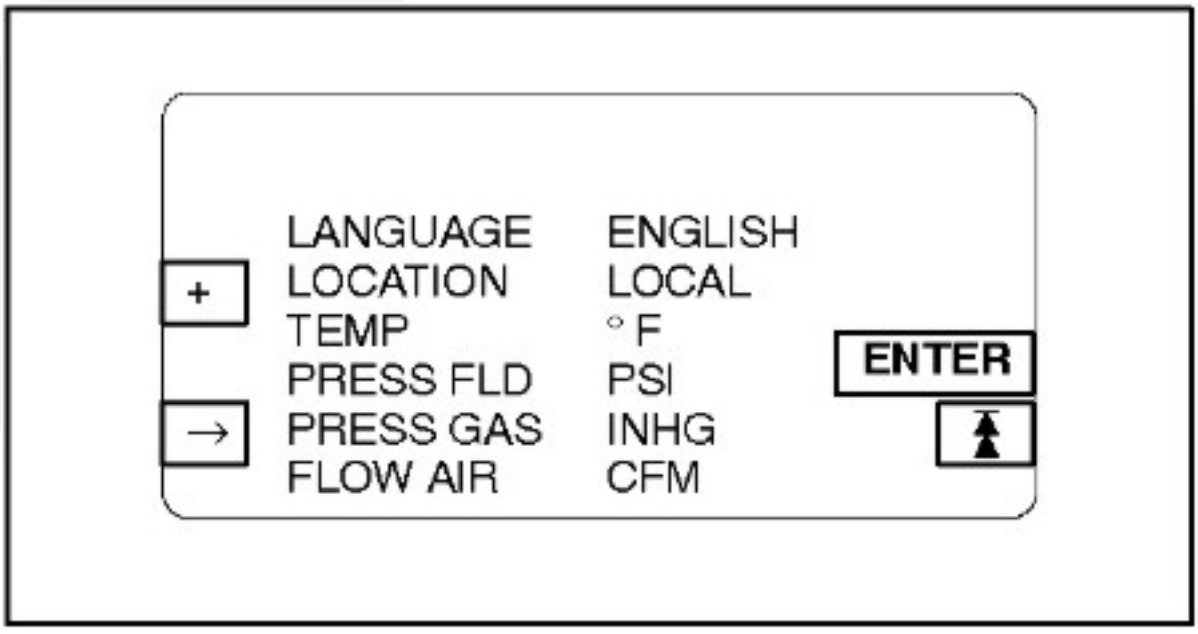


FIGURE 12. LANGUAGE/UNITS MENU

4.5.2 Main Menu

Figure 13 on page 36 shows the main menus (Menu A and Menu B) of the system control. The two main menus are used to divide the system submenus into major categories, such as, Engine Data, Alternator Data, Control, etc.

To view system data, simply press the appropriate menu button to select the category. Look in this chapter for detailed information related to the selected category.

In the following figure, the boxed/highlighted field indicates that the adjacent menu button is active. Also, the submenus are shown in the order in which they are displayed when scrolling up ▲ or down ▼.

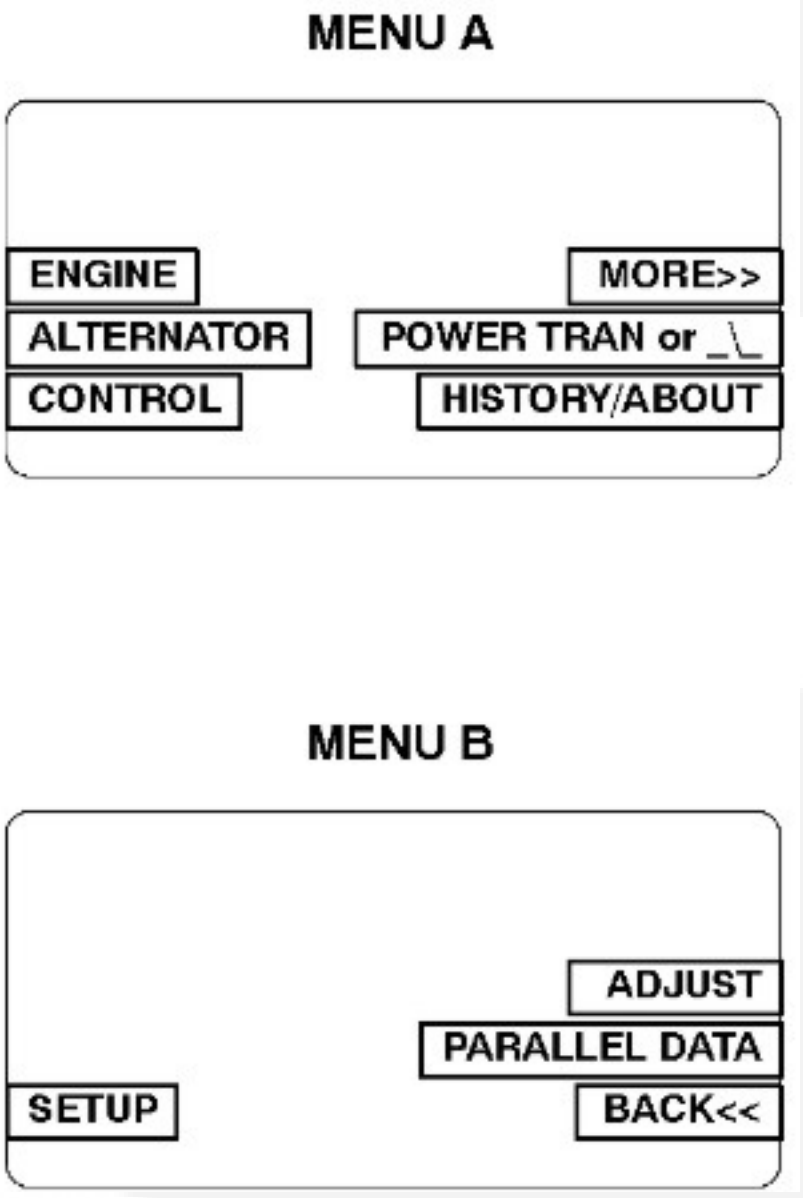


FIGURE 13. SYSTEM CONTROL MAIN MENUS A AND B

4.5.3 Engine Submenus

If you press the "ENGINE" button in Menu A, the Engine submenus will appear. See **Figure 14 on page 38**.

The first submenu displays general information that applies to all generator sets (coolant temp, oil pressure, etc.) The data in the remaining submenu(s) will vary according to the type and number of sensors provided with the engine.

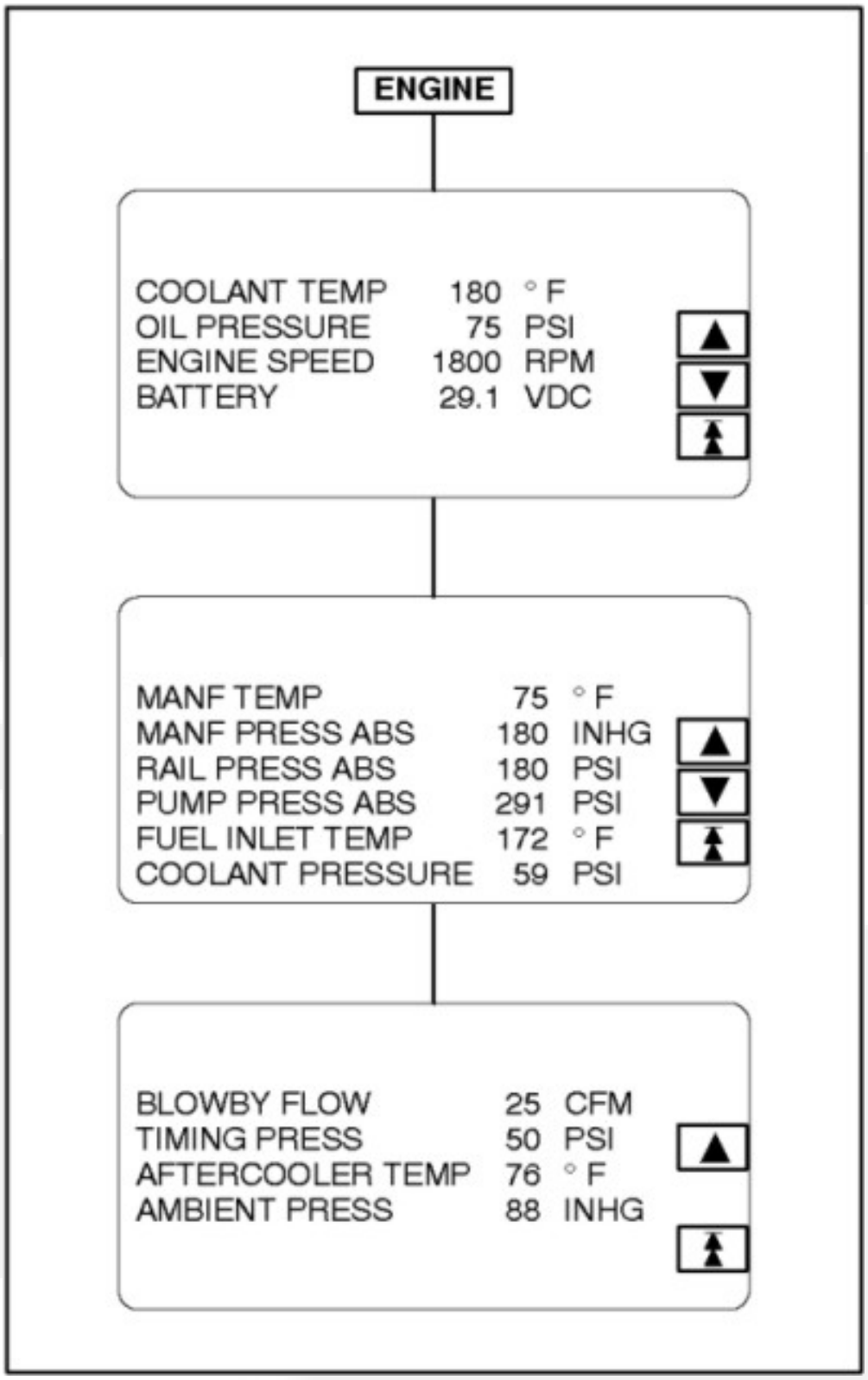


FIGURE 14. ENGINE SUBMENUS

4.5.4 Alternator Submenus

If you press the "ALTERNATOR" button in Menu A, the Alternator Data submenus will appear (**Figure 15 on page 40**).

- **Voltage L-L and L-N:** Indicates voltage Line-to Line and Line-to-Neutral. Note that the Line-to-Neutral column will not be displayed for a 3 phase/3 wire system. Accuracy 1%.

  The voltage Line-to-Line (L1, L2 and L3) are measured between L1 to L2, L2 to L3 and L3 to L1, respectively.
- **Amps:** All phases. Accuracy 1%.
- **Frequency:** Generator set output frequency.
- **AVR Duty Cycle:** Displays voltage regulator (drive) level in percentage of maximum.
- **kW, kVA and PF:** Displays generator set kW and kVA output (average and individual phase, and direction of flow) and power factor with leading/lagging indication. Accuracy 5%.

  The PF reading will contain an asterisk if the power factor is leading (for example, *.30).

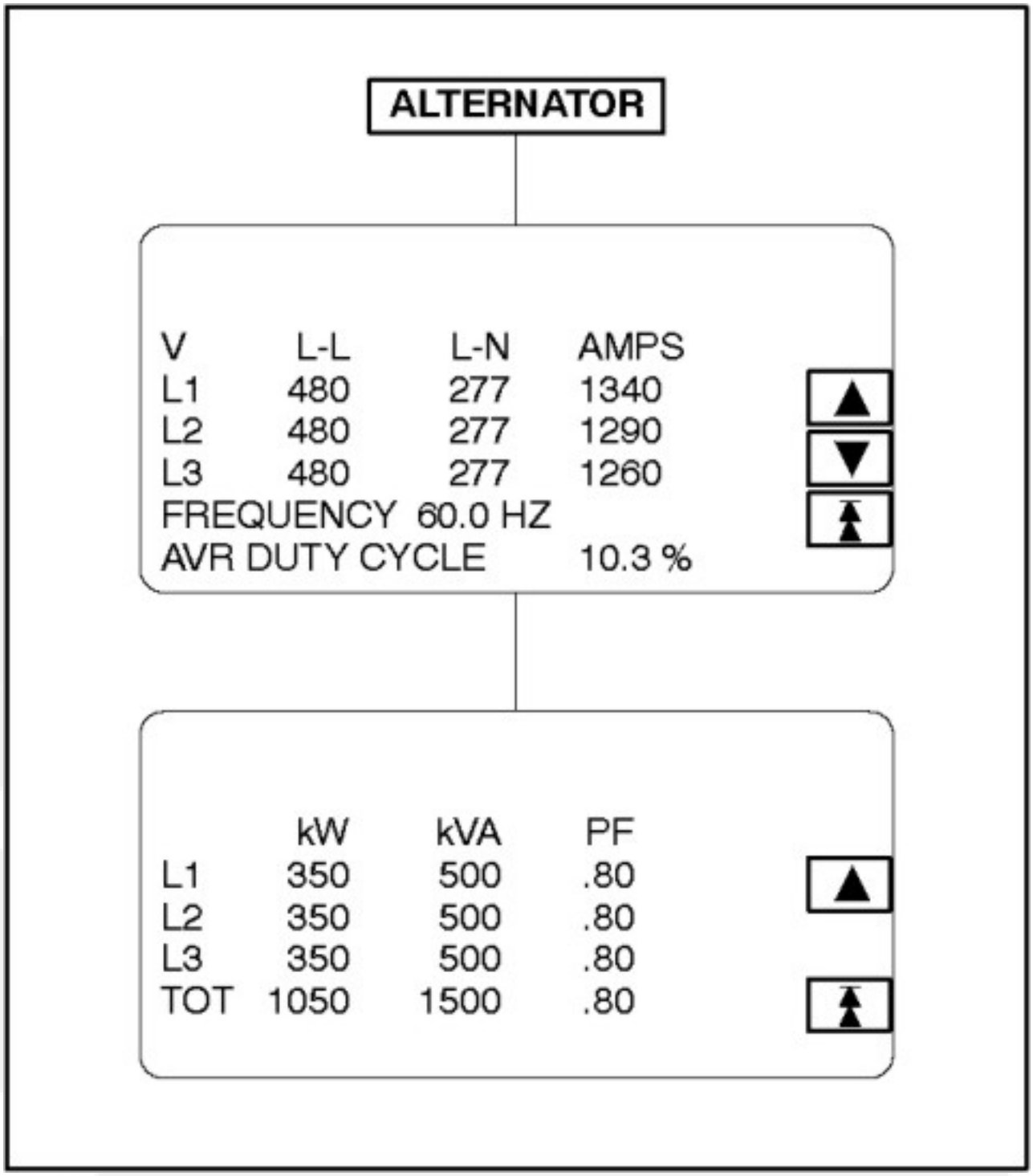


FIGURE 15. ALTERNATOR SUBMENUS

4.5.5 Control Submenu

If you press the "CONTROL" button in Menu A, the Control submenu will appear (**Figure 16 on page 41**).

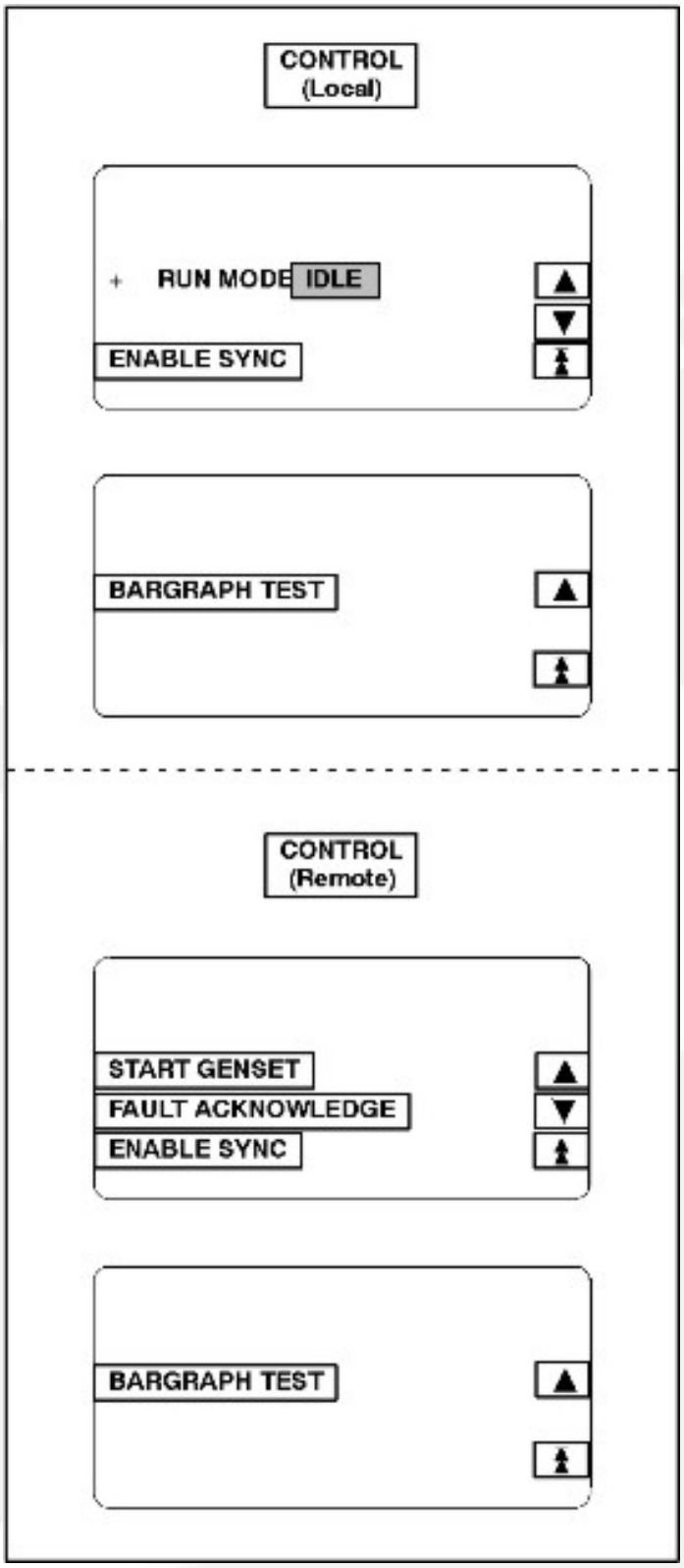


FIGURE 16. CONTROL SUBMENU

4.5.5.1 Local Control Submenu Function

When the operator panel is mounted on the control panel assembly, the Run Mode Idle/Rated button is active (displayed). Note in Figure 16 on page 41 that this button is not displayed in remote applications.

The shaded area in Figure 16 on page 41 displays the selected/active mode of operation, either IDLE or RATED.

4.5.5.2 Remote Control Submenu Functions

When the operator panel is mounted remotely of the control panel assembly, the menu buttons in the Control submenu are used to perform the following remote operations.

NOTICE
The O/Manual/Auto switch must be in the Auto position to activate the Remote Menu Buttons of the Control submenu.

- **Remote START or STOP Button:** This button is used to start and stop the generator set when the operator panel is mounted in a remote location.

  When the generator set is operating, Stop will be displayed for this button and Start will be displayed when not operating.
- **Fault Acknowledge Button:** This button is used to reset inactive Warning messages, not Shutdown messages.

4.5.5.3 Local/Remote Control Submenu Function

Bargraph Test: The function of this button remains the same and is not dependent on operator panel location. This button sequentially lights the LEDs to test the bar graph display.

Enable Sync: Displayed in paralleling applications only. This feature is intended for service personnel to turn off the synchronizer for troubleshooting/testing purposes.

4.5.6 History/About Submenu

If you press the "HISTORY/ABOUT" button in Menu A, the History/About submenus will appear (Figure 17 on page 43).

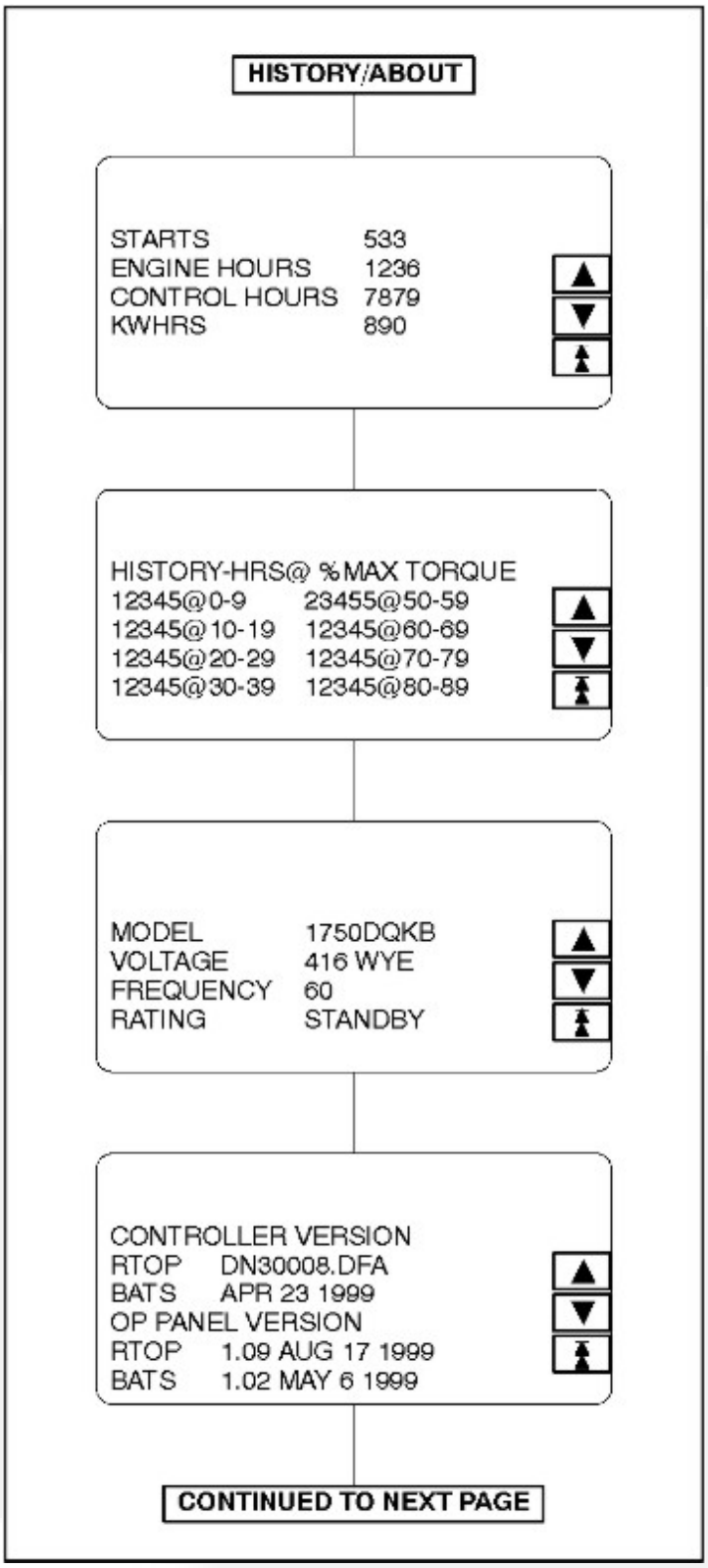


FIGURE 17. HISTORY/ABOUT SUBMENUS

4.5.6.1 History Submenu

The control maintains a data log of the number of engine starts and operating hours for the engine and control, the megawatt, and maximum torque hours of the generator set. This information is stored in non-volatile memory and will not be deleted due to loss of battery power.

4.5.6.2 About Submenu

The About submenus provide the following generator set information.

- Generator set model and wattage (kW/MW)
- Output voltage and WYE, DELTA, or SINGLE
- Frequency: 50 or 60 Hz
- Rating: Standby, Prime, or Base
- Version level of the controller and panel operating software.

4.5.6.3 Fault History

The control maintains a data log of all fault conditions as they occur, and time stamps them with the control and engine operating hours.

Up to 32 (unacknowledged) fault codes can be stored in control panel memory. After the fault is acknowledged and corrected, the recorded fault will be deleted from the control panel memory, but will remain in a data log that maintains a fault code history. (The InPower service tool is required to view this data log.)

- **The Fault History display line:** 1 of 24 indicates that 24 faults are recorded and that the most recent fault (1) detected by the controller is displayed.
- **The Occurrences display line:** In this example, 5 indicates that this is the fifth occurrence of this fault. (The InPower service tool is required to review the last four faults of this code.)

  The Occurrences number is incremented for each new occurrence of the same fault. The controller must detect that the original sensed fault is corrected before it will increment the occurrence number for that fault.

  For example, when a Low Oil Pressure fault is detected, the controller will increment the Occurrences number by 1. This fault will remain active until the fault is acknowledged and the controller detects that the fault is corrected. An active fault will prevent the controller from incrementing the Occurrences number each time the engine is started. When the controller detects that the oil pressure is normal, the fault will become inactive, allowing the occurrences number to be incremented for the next detected Low Oil Pressure fault.

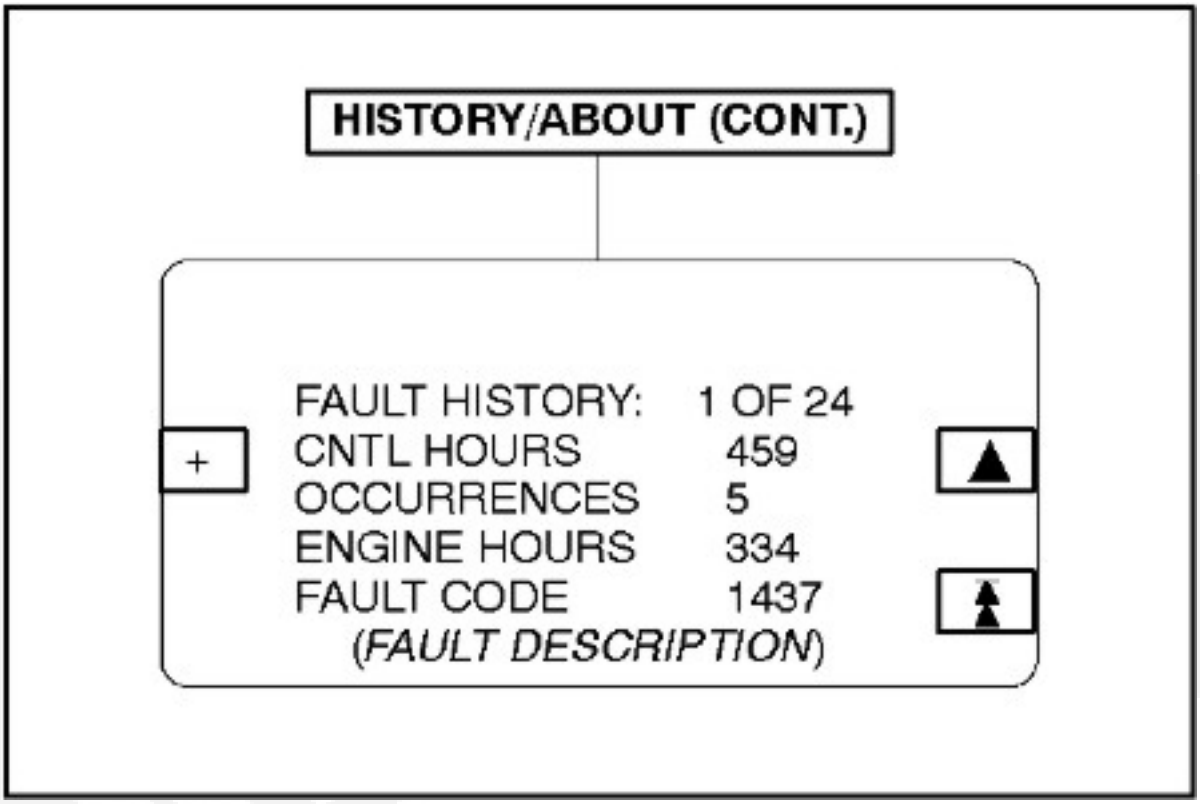


FIGURE 18. HISTORY/ABOUT SUBMENUS (CONT.)

4.5.7 Parallel Data Submenu

If you press the "PARALLEL DATA" button in Menu B, the Parallel Data submenu will appear (Figure 19 on page 46). This menu is displayed in paralleling applications only.

- **Parallel Data Status Line:** The top line of the graphical display is used to indicate the following Parallel Data status:
  - *STANDBY:* Indicates no paralleling activity is occurring at present.
  - *DEAD BUS CLOSE:* Indicates the first generator set in the system to close to bus.
  - *SYNCHRONIZE:* Generator set is synchronizing to bus.
  - *LOAD SHARE:* Generator set has closed to bus and is sharing load with other generator sets in the system.
  - *LOAD GOVERN:* Generator set closed to bus in parallel with utility (mains).
- **Bus Voltage L-L:** The BUS voltage Line-to-Line (L1, L2, and L3) are measured between L1 to L2, L2 to L3 and L3 to L1, respectively.
- **BUS GEN HZ:** BUS/GEN hertz.
- **BUS/GEN Status:** The bottom line of the graphical display is used to indicate the following BUS/GEN Sync status:
  - *NOT SYNCHRONIZING:* Generator set is in service mode that does not allow auto sync feature. (Selected via InPower service tool- deactivate to allow synchronization.)
  - *SYNCHRONIZING:* Generator set is synchronizing to bus.

- *READY TO CLOSE:* In manual mode, push circuit breaker close button to close the breaker.

- **__ Button:** Used to open and close the generator set circuit breaker (CB). The symbol indicates if the CB is opened or closed. Opened __, push to close. Closed _-_ push to open.

  When the control panel O/Manual/Auto switch is in the **AUTO** position, the opening and closing of the CB is controlled by the control system software. The CB symbol will indicate an open or closed CB, but the button will be inactive when the control is in **AUTO**.

  In the **Manual** position, the CB must be closed by this button. When manually closed and the CB opens, it must be closed again by using this button. To close the CB, press and hold the button until the symbol indicates a closed CB. (CB close will occur only when setup conditions allow - dead bus or generator synchronized with bus).

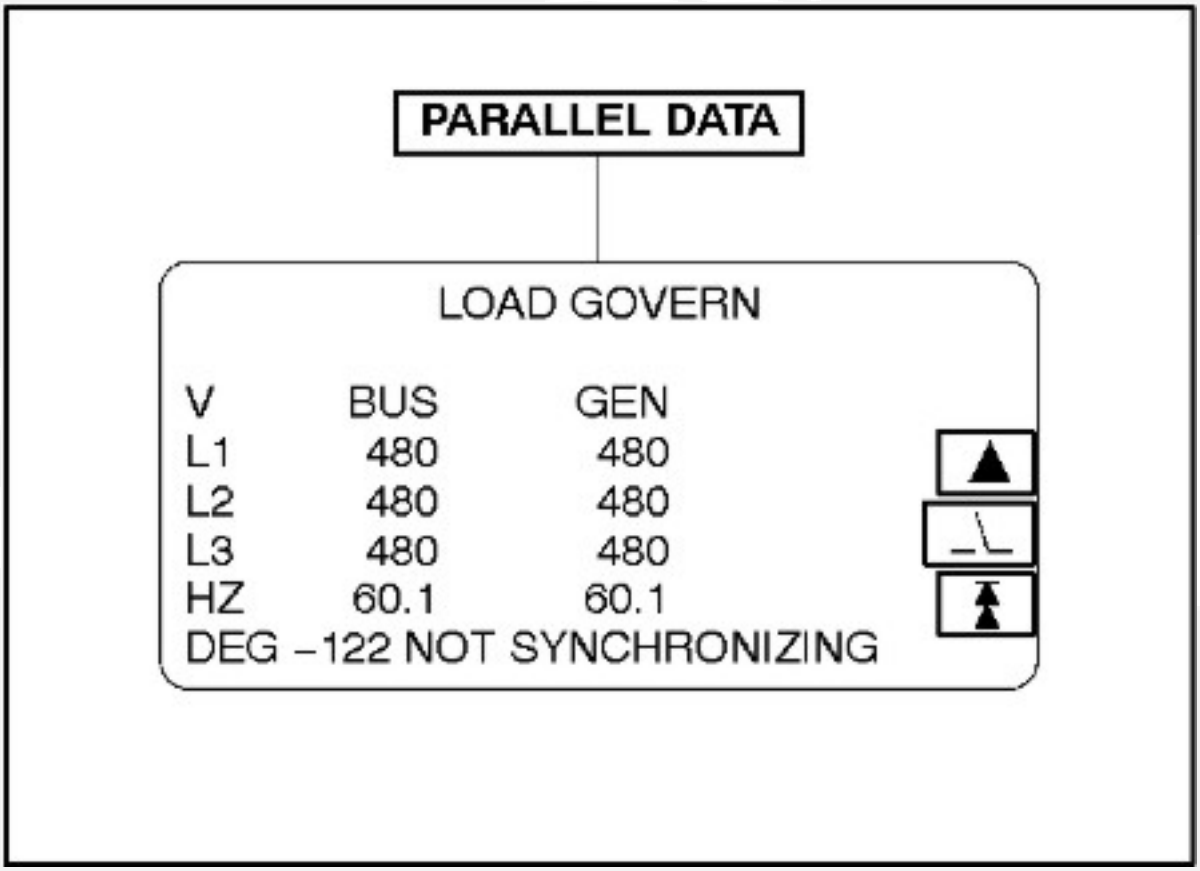


FIGURE 19. BUS DATA SUBMENU

4.5.8 Adjust Submenu

Figure 20 on page 48 shows the main menus (Menu A and Menu B) of the system control and the Adjust submenu.

To display the Adjust submenu, press the **MORE>>** button in Menu A and then the **ADJUST** button in Menu B.

The Adjust submenus are intended for trained and experienced service personnel and site personnel only, and may require a **USER** password. If a password is required, the **USER** password menu will appear when you try to modify the Adjust submenus. (Contact a person authorized to enter the password.)

Changes are automatically saved when you exit this menu.

If the generator set is operating in parallel with a system bus, the voltage and frequency adjustments are disabled to prevent inadvertent misadjustment of the paralleling load sharing functions.

NOTICE
Use the + and – buttons to increase or decrease the values in the following fields. Use the arrow button to move the cursor within a field or to the next field. Exit the menu to save changes.

- **START DELAY:** This delay applies only to remote starting in the Auto mode. The Start Delay adjustment range is 0 to 300 seconds.
- **STOP DELAY:** This delay applies only to remote stopping in the Auto mode. The Stop Delay adjustment range is 0 to 600 seconds.
- **VOLTAGE:** Used to adjust the output voltage +5%.
- **FREQUENCY:** Used to adjust the frequency +3 Hz.
- **VOLTAGE/SPEED DROOP:** These two submenus apply to a generator set that has the paralleling option and is configured to operate in droop mode.

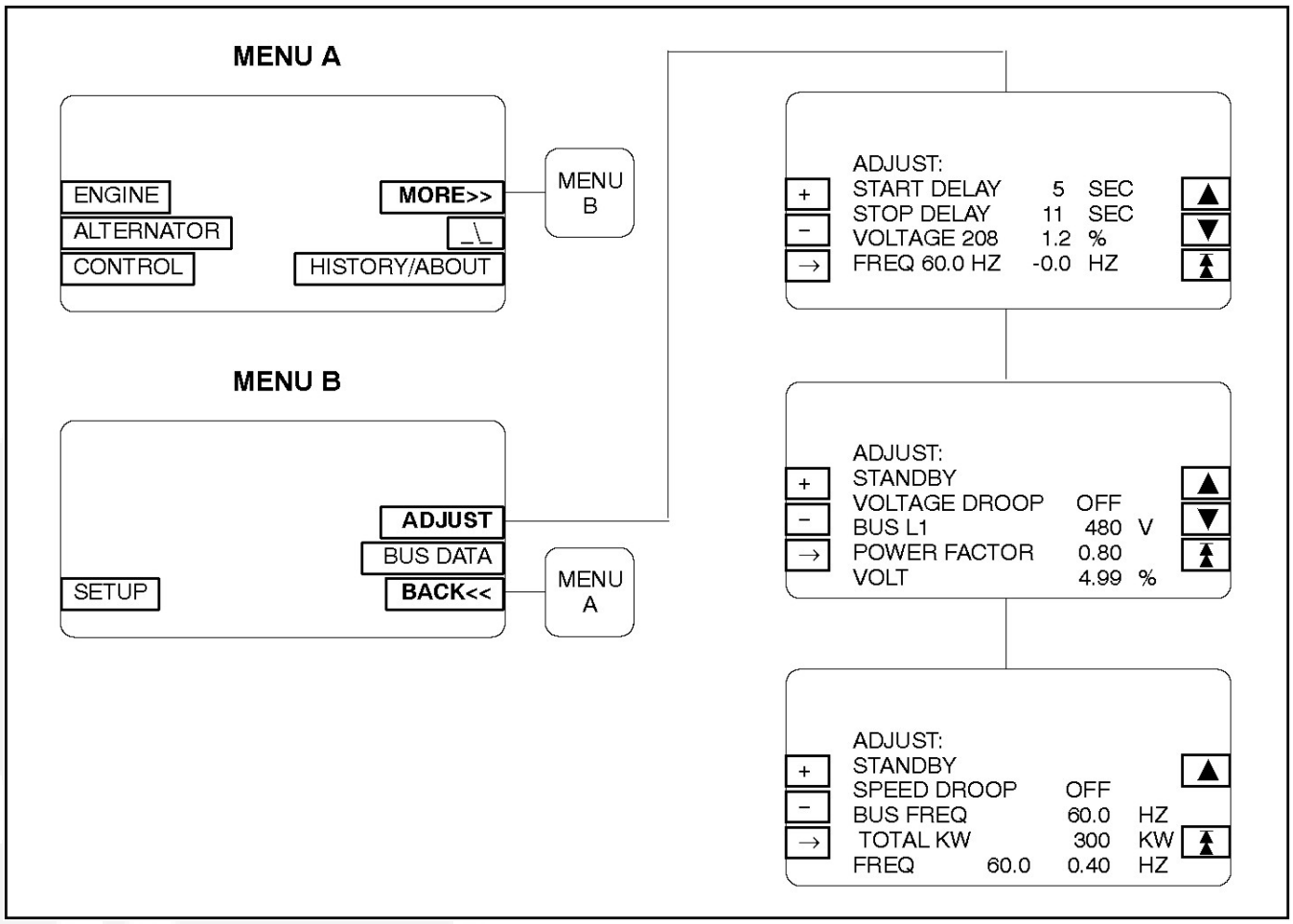


FIGURE 20. ADJUST MENU

4.5.9 Power Transfer Main/Submenus

If you press the "POWER TRAN" button in Menu A, the Power Transfer main menu will appear (**Figure 21 on page 49**). The Power Transfer Control (PTC) feature must be installed to display this menu.

The PTC feature enables the PCC to monitor the utility voltage (mains) and frequency for failure and control the opening and closing of the contacts (circuit breaker) for the utility (S1) and the generator set (S2).

If the utility fails, the control will initiate the generator set starting sequence, open S1 and S2 to the load. When utility returns, the load is retransferred to the utility (S1 closes/S2 opens) and the control initiates the generator set shutdown sequence.

The symbol displayed in the middle of the Power Transfer main menu indicates which breaker (utility or generator set) is closed/opened to the load. The symbol presently shown indicates that the utility breaker is closed and supplying power to the load.

The Power Transfer main menu also indicates if the utility and the generator set are available to accept load. When the control detects that either source is ready to accept load, UTILITY and/or GENSET will be displayed in inverse video.

The Power Transfer main menu has four submenu groups.

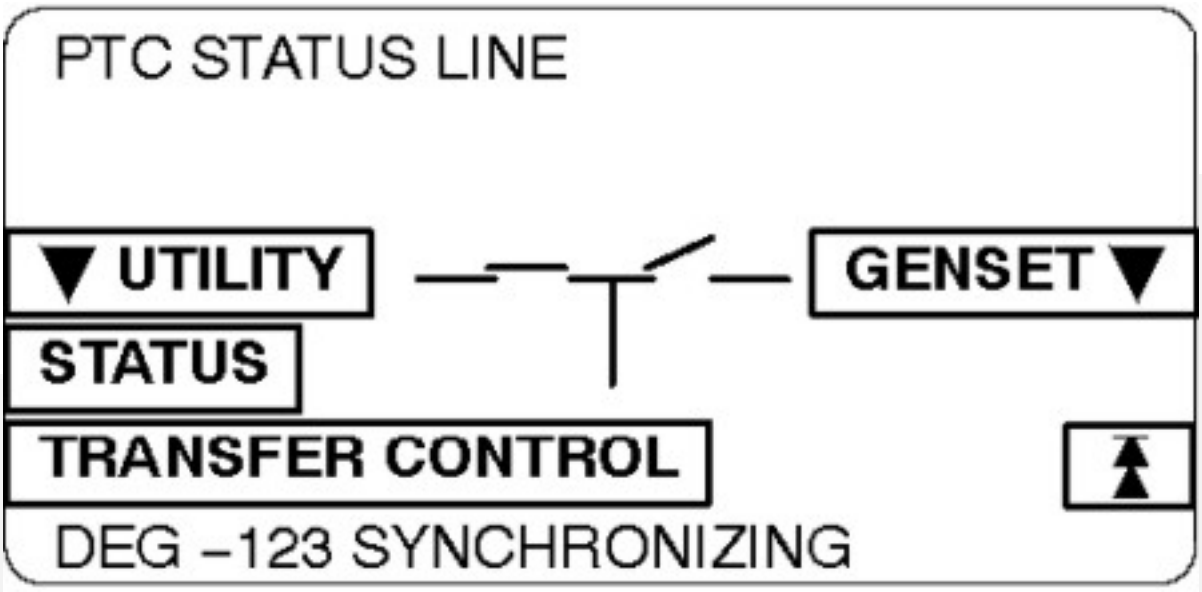


FIGURE 21. POWER TRANSFER MAIN MENU

4.5.9.1 PTC Status Line

The top line of the graphical display is used to indicate the following PTC status:

- **NOT ENABLED:** PTC is not enabled. Control panel switch in O (Off) position.
- **MANUAL:** Control panel switch is in Manual position. All PTC actions or generator set start/stop actions are manually controlled.
- **NORMAL UTIL:** Load connected to the utility.
- **RETRAN:** Retransfer of load to the utility
- **RETRAN OVRD:** Immediate retransfer of load to the utility due to generator set fault (e.g., warning, derate, or shutdown w/cooldown fault). The retransfer timer is ignored as is the retransfer inhibit.
- **EMERG TEST:** Emergency Test sequence initiated through Remote Start switch with emergency start sequence enabled (TB8-3 terminal opened). Emergency test mode means that the generator set will continue to run even if a generator set warning or derate fault occurs. This test can be performed with or without load.
- **TEST:** Test sequence initiated through Remote Start switch with emergency start sequence disabled (TB8-3 terminal closed). Test mode is non-emergency, which means that a retransfer to the utility will occur if any problems occur with the generator set while testing with load. This test can be performed with or without load.
- **EXERCISE:** Exercise sequence initiated through the control panel. This test can be performed with or without load. A retransfer to the utility will occur if any problems occur with the generator set during the exercise sequence.
- **UTILITY FAIL:** Utility has failed. (Initiates transfer of load to the generator set if O/MANUAL/AUTO switch is AUTO.)

4.5.10 Utility (PWR TRN) Submenus

If you press the "Utility" button in the Power Transfer Main Menu, the Utility Submenus will appear (Figure 22).

- **Voltage L-L and L-N:** Indicates utility voltage Line-to Line and Line-to-Neutral. Note that the Line-to-Neutral column will not be displayed for a 3 phase/3 wire system. Accuracy 1%.

  The voltage Line-to-Line (L1, L2 and L3) are measured between L1 to L2, L2 to L3 and L3 to L1, respectively.
- **Amps:** L2 only. Accuracy 1%.
- **Frequency:** Utility frequency.
- **kW, kVA and PF:** Displays (L2 only) utility kW and kVA output (average and direction of flow) and power factor with leading/lagging indication. Accuracy 5%.

  The PF reading will contain an asterisk if the power factor is leading (for example, *.30).

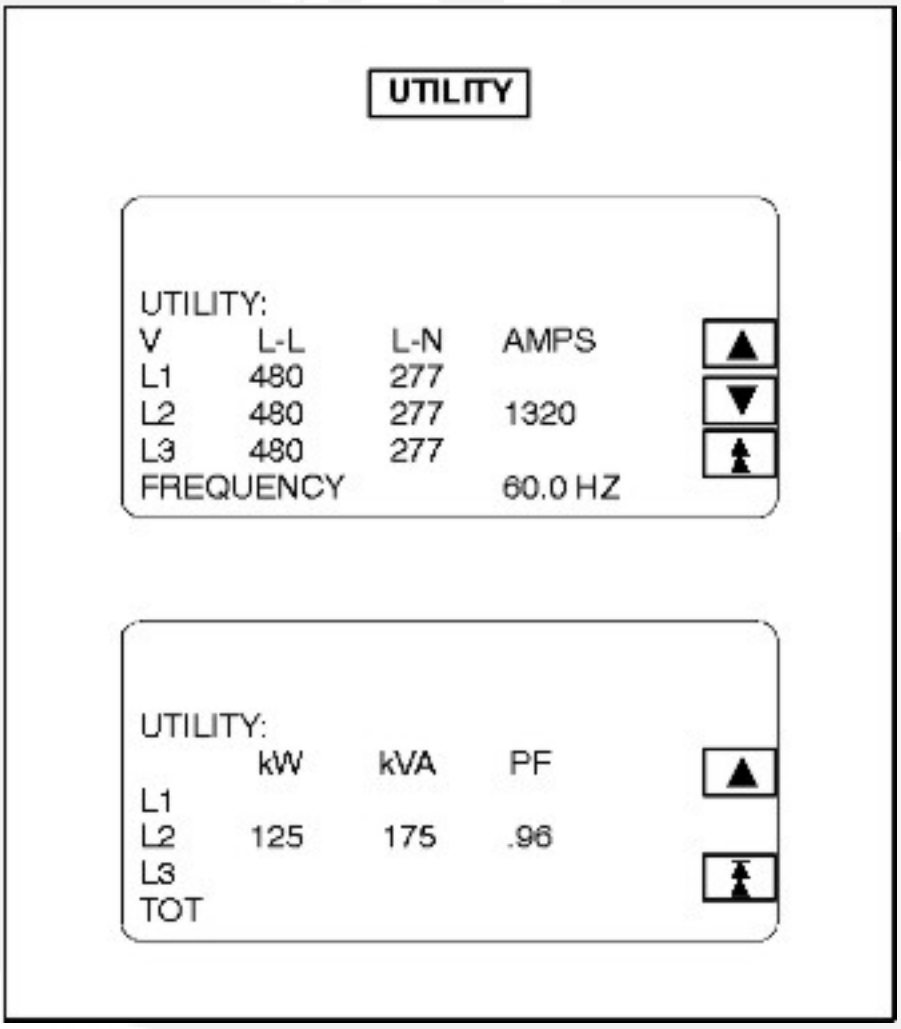


FIGURE 22. UTILITY SUBMENU

4.5.11 Transfer Control (PWR TRAN) Submenu

If you press the **TRANSFER CONTROL** button in the Power Transfer Main Menu, the Transfer Control Submenu will appear (Figure 23 on page 52).

The symbol displayed in the middle of the Transfer Control submenu indicates which breaker (utility or generator set) is closed/opened to the load. The symbol presently shown indicates that the utility breaker is closed and supplying power to the load.

During generator set operation in the manual mode, you can manually transfer/retransfer load between the utility and the generator set.

To transfer load, press the appropriate **CB ENABLE** button (Utility or Genset).

EXAMPLE Figure 23 on page 52

In the example, the **CB ENABLE** button for "Utility" was pressed. (If the **CB ENABLE** button for the "Genset" was pressed, **ENABLE GEN CB** would be displayed in the second submenu, allowing you to open or close the generator set circuit breaker.)

After pressing the Utility **CB ENABLE** button, the second submenu will be displayed allowing you to either **CANCEL** or **ENABLE** the entered selection.

Pressing the **CANCEL** button will return the display to the previous menu.

Pressing the **ENABLE** button will display the third submenu. With this submenu displayed you can return to the second submenu without opening the utility circuit breaker (press **<<BACK**) or you can press the **OPEN UTIL** button.

Pressing the **OPEN UTIL** button will display the fourth submenu, indicating that the utility circuit breaker is now opened.

NOTICE
The fourth submenu displays CLOSE UTIL. Pressing this button will close the utility circuit breaker and redisplay the third submenu.

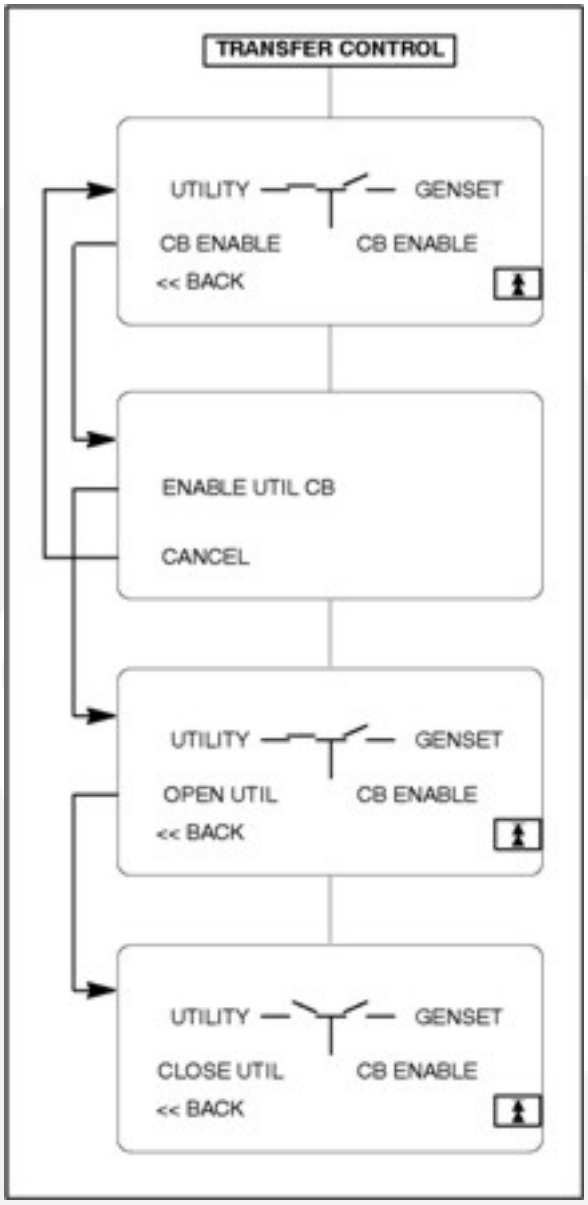


FIGURE 23. TRANSFER CONTROL SUBMENUS

4.5.12 Genset (PWR TRAN) Submenus

If you press the "Genset" button in the Power Transfer Main Menu, the Genset Submenus will appear (Figure 24 on page 53).

- **Voltage L-L and L-N:** Indicates voltage Line-to Line and Line-to-Neutral. Note that the Line-to-Neutral column will not be displayed for a 3 phase/3 wire system. Accuracy 1%.

The voltage Line-to-Line (L1, L2 and L3) are measured between L1 to L2, L2 to L3 and L3 to L1, respectively.

- **Amps:** All phases. Accuracy 1%.
- **Frequency:** Generator set output frequency.
- **kW, kVA and PF:** Displays generator set kW and kVA output (average and individual phase, and direction of flow) and power factor with leading/lagging indication. Accuracy 5%.

  The *PF* reading will contain an asterisk if the power factor is leading (for example, *.30).

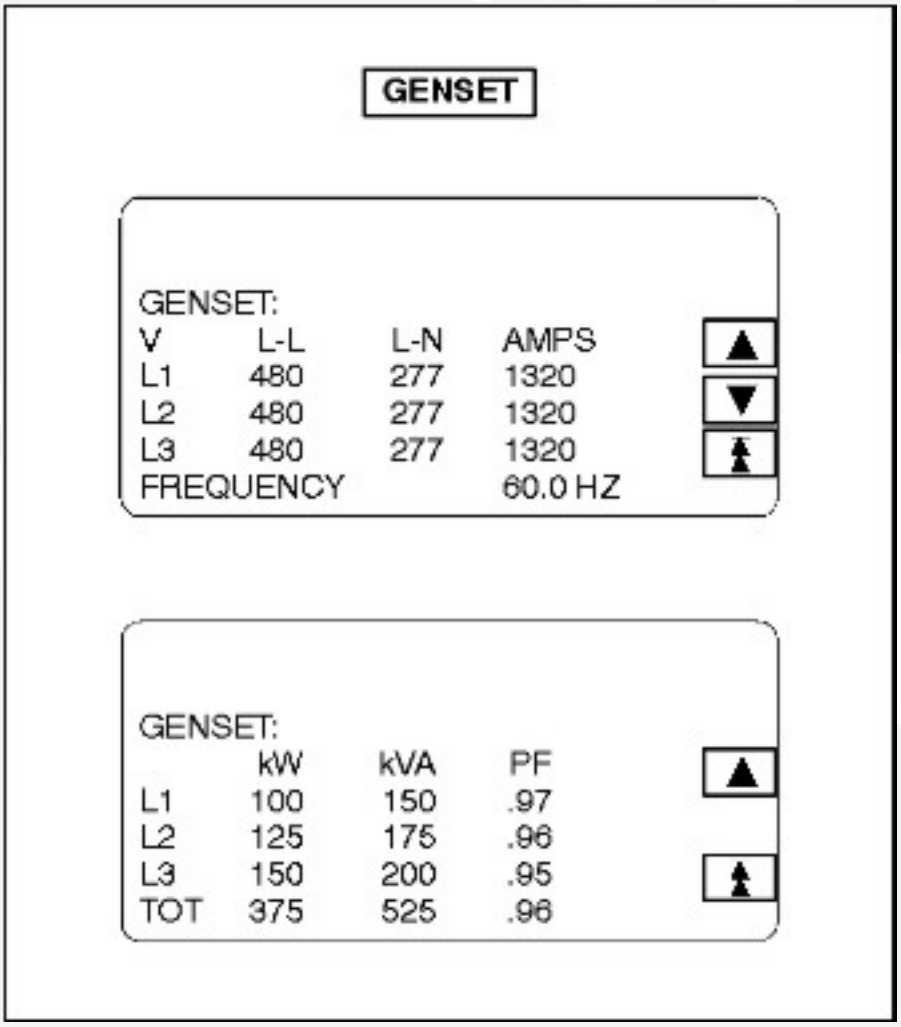


FIGURE 24. GENSET SUBMENUS

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5 Operation - PCC 3201

5.1 Safety

Only trained and experienced personnel should carry out generator set operations. Before operating the system, the operator should become familiar with all the safety instructions, see Chapter 1 on page 1, together with the Health and Safety manual. Observe all of the WARNINGS and CAUTIONS at all times.

⚠ WARNING

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 plant is operated correctly.

⚠ WARNING

Contacting high voltage components can cause severe personal injury or death by electrocution. Do not open the generator output box while the generator set is running. Read and observe all warnings and cautions in your generator set manuals.

⚠ CAUTION

Only technically qualified personnel should open the control housing. Voltages are present which can cause electrical shock, resulting in personal injury. Even with the power removed, improper handling of components can cause electrostatic discharge and damage circuit board components.

⚠ WARNING

Exhaust gases contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning include:

- ***Dizziness***
- ***Nausea***
- ***Headache***
- ***Weakness and sleepiness***
- ***Throbbing in temples***
- ***Muscular twitching***
- ***Vomiting***
- ***Inability to think coherently***

IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Protection against carbon monoxide inhalation includes proper installation and regular, frequent visual and audible inspections of the complete exhaust system.

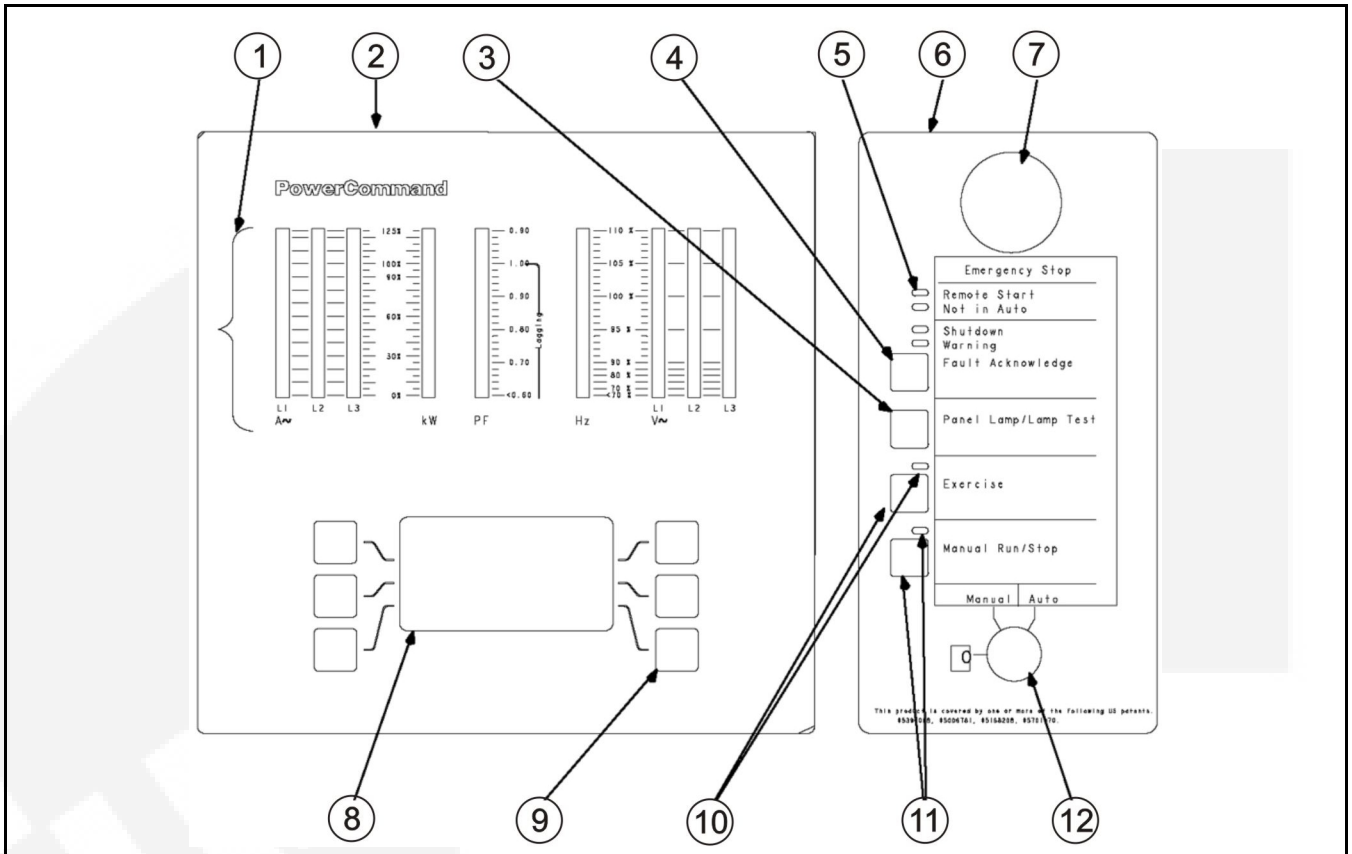
5.2 Overview

This section describes the function and operation of the PowerCommand® Control 3201 (PCC) and generator set for the rental unit.

This section covers prestart checks, starting and stopping and operating the generator set. Each operator should read through this entire section before they attempt to start the generator set. It is essential that the operator be completely familiar with the generator set and the PCC control.

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 25 on page 57**.



No.	Description	No.	Description
1	Analog AC Metering Panel	7	Emergency Stop Push Button
2	Operator Panel	8	Graphical Display
3	Panel Lamp/Lamp Test Button	9	Display Menu Selection Button (1 of 6)
4	Fault Acknowledgement Button	10	Exercise Button & Indicator
5	Remote Start, Not in Auto, Shutdown Warning Status Indicators	11	Manual Run/Stop Button & Indicator
6	Switch Panel	12	O/Manual/Auto Switch

FIGURE 25. CONTROL PANEL ASSEMBLY

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 73**.

5.4 Starting

5.4.1 Starting - Safety Consideration

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 switch to shut down an engine unless a serious fault develops. The Emergency Stop push-switch 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. 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 shut down as soon as possible after the appropriate functions have been checked.

5.4.2 Starting - Overview

Before attempting to start the generator set, the operator should read through this entire manual, together with specific engine manual 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® 3201 control.

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

NOTICE
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® 3201 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.

5.4.3 Operator's Pre-start Checks

⚠ WARNING

Hazardous voltage.
Electrical short circuit may result in catastrophic failure, severe personal injury and death.
Generator windings must be dry before the generator set is operated.

⚠ WARNING

Coolant under pressure.
Hot coolant under pressure can cause severe scalding.
Do not attempt to remove a radiator pressure cap while the generator set is running, or is stationary but hot. Hot coolant is under pressure in the radiator system. Always allow it to cool before releasing the pressure and removing the cap.

- Fuel Supply - Make sure that the fuel tank is filled to the normal level and that the fuel system is primed and all the valves required for operation are open. Make sure that there are no leaks and that all fittings are tight.
- Lubrication - Check the engine lubrication oil level and ensure that the correct level is always maintained.
- Coolant - Check the engine coolant level and ensure 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.

NOTICE

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

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

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(s) before initial start.

- 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, that the electrolyte is at the correct level and that all connections are correct.
- Auxiliary AC Supplies - Make sure that all auxiliary equipment is receiving power from the customer's supply.
- Emergency Stop/Fire Detection Equipment - Make sure that all related equipment is fully operational.

5.4.4 Starting at Switch Panel (Manual Mode)

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.

To start the generator set in the Manual Run mode, move the O/Manual/Auto switch to the Manual position and press the Manual Run/Stop button. This will activate the engine control system and the starting system. The starter will begin cranking, and after a few seconds the engine will start and the starter will disconnect.

In the Manual position, the control will not complete the time delay to start or time delay to stop but will complete the Warm-up at Idle and Cooldown at Rated/Idle.

When the coolant reaches operating temperature or the Warm-up At Idle time delay (0 to 300 seconds) is reached, whichever occurs first, the generator set will ramp to rated speed and voltage.

NOTICE
PTC- To manually transfer load between the utility and the generator set during generator set operation, refer to Transfer Control (PWR TRAN) Submenu in this section.

If the engine does not start, the starter will disengage after a specified period of time and the control will not indicate an overcrank shutdown.

The generator set can be configured for a number of starting cycles (1 to 7) with set times for crank and rest periods for all starting modes (manual/remote). Default setting is for 3 start cycles composed of 15 seconds of cranking, and 15 seconds of rest.

NOTICE
The InPower Service tool is required to change the number of crank cycles, and the crank and rest times. Contact an authorized service center for assistance.

To clear a Fail To Start shutdown, place the O/Manual/Auto switch in the 0 position and press the Fault Acknowledge button. Before attempting to restart, wait two or more 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 the Troubleshooting chapter (**Chapter 7 on page 105**).

5.4.5 Starting at Remote Operator Panel (Auto Mode)

When the operator panel is mounted remotely of the control panel assembly, the Start button of the Control submenu can also be used to start the generator set. The function of this Start button is identical to the following description (Section 5.4.6 on page 61).

NOTICE
The O/Manual/Auto switch must be in the Auto position to activate the Remote Menu Buttons of the Control submenu.

5.4.6 Starting from Remote Location (Auto Mode)

Place the O/Manual/Auto switch in the Auto position. This allows the generator set to be started from a remote switch or device (e.g., transfer switch or the optional Power Transfer Control feature).

NOTICE
With the PTC feature installed, the Remote Start input (TB8-4/5) will function as a Test mode switch for the PTC. The PTC Test sequence is shown in Table 9 on page 68.

There are two start modes that are selectable for the remote start input, one for non-emergency start and the other for emergency start. In the non-emergency mode, the control will complete the Warm-up At Idle. In the Emergency mode, the generator set will skip the warm-up and go directly to rated speed and voltage.

The emergency start feature is controlled by connecting a remote contact between TB8-3 and TB8-5. Open the contact for emergency start and close the contact for non-emergency start.

In response to receiving the remote run signal or the control receiving the loss of utility voltage detected through the PTC, the control lights the Remote Start indicator and initiates the starting sequence described in Section 5.4.4 on page 60, except for the following:

- In the Auto position, the control will complete the Time Delay To Start (0 to 300 seconds) and the Time Delay To Stop (0 to 600 seconds).

NOTICE
Refer to Section 4.5.8 on page 46 (Adjust menu) to change the time delay settings.

5.4.7 Exercise Start

Move the O/Manual/Auto switch to the Auto position and press and hold the Exercise button. Move the control switch from Auto to Manual and back to Auto.

This will activate the engine control system to complete a pre-programmed exercise sequence. The sequence (Figure 26 on page 64) will vary accordingly to the settings/selections of the system control parameters.

NOTICE

The InPower service tool is required to modify the following exercise parameters. Contact an authorized service center for assistance.

The exercise sequence may include running at idle speed, ramping to rated speed, running for a predetermined period of timed shutdown. During the exercise operation, the LED lamp adjacent to the Exercise button will light. To manually stop the exercise operation before completion, press the Exercise button. The set will complete its normal cooldown sequence. The control will indicate that the set is in a cooldown mode by flashing the exercise LED.

NOTICE

PTC - If exercising with load, cooldown mode is activated after retransfer of load to utility. (See Table 9 on page 68 for PTC Exercise sequence).

All exercise functions are disabled when a remote start signal is received by the control.

5.4.8 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.

In accordance with NFPA 110, Cummins Power Generation recommends installing diesel standby generator sets (life safety systems) equipped with engine jacket water coolant heaters in locations where the minimum ambient temperature is below 40 °F (4 °C). NFPA also requires that the engine be heated as necessary to maintain the water jacket temperature determined by the manufacturer for cold start and load acceptance for the type of system. Although most Cummins Power Generation generator sets will start in temperatures down to -25 °F (-32 °C) when equipped with engine jacket water coolant heaters, it might take more than 10 seconds to warm the engine before a load can be applied when ambient temperatures are below 40 °F (4 °C).

Cummins Power Generation recommends equipping diesel 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.

To advise the Operator of a possible delay in accepting the load, the **Low Coolant Temp (Code 152)** message, in conjunction with illumination of the Warning LED, is provided to meet the requirements of NFPA 110. 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.

5.4.8.1 Checking Coolant Heater Operation

⚠ CAUTION
Hot surfaces. ***Contact with the cooling system or engine can cause serious burns.*** ***Do not touch the cooling system or engine until they are 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.

5.5 Running At Idle

NOTICE
The Run At Idle mode is selectable only when the operator panel is mounted on the control panel assembly.

The run mode can be set to Rated or Idle with the set running or not running. To manually select the engine idle function, the O/Manual/Auto switch must be in the Manual position. Once selected and the set is manually started, the control will limit the engine idle time to 10 minutes. When the 10 minute idle cycle is complete, the generator set will ramp to rated speed.

To activate the idle functions, refer to **Section 4.5.5 on page 40**.

When the engine idle function is enabled, the control automatically sets lower oil pressure warning and shutdown trip points to reflect the lower operating speed. When the engine idle function is removed and the set reverts to normal operating speed, the control automatically rests oil pressure warning and shutdown trip points to the normal settings.

5.6 Stopping

NOTICE
The access code may be required before initiating the Off button sequence.

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.

5.6.1 Stopping at Switch Panel (Manual Mode)

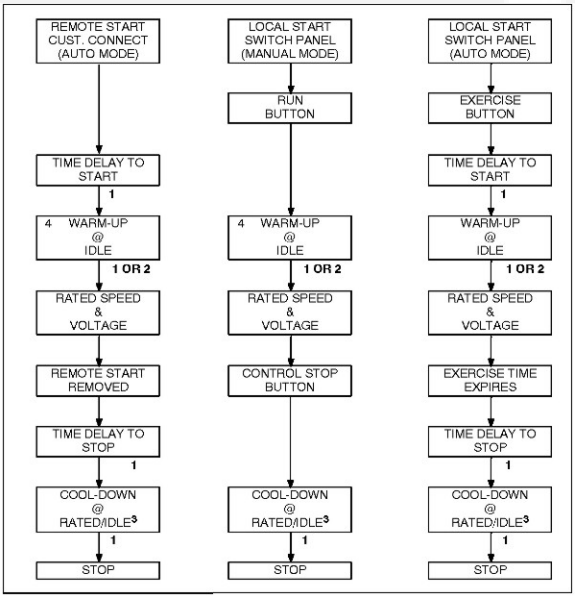
If the generator set was started at the Switch Panel in Manual mode, pressing the Manual Run/Stop button will cause the set to complete its normal (Local Start) shutdown sequence (See **Figure 26**).

The preset cooldown time (at rated speed) can vary dependent on the kW output. That is, if prior to shutdown, the kW is 10% or less of rated, the control software considers this output as cooldown and will subtract this time from the preset cooldown timer.

Moving the O/Manual/Auto switch to the O position will cause an immediate engine shutdown (bypass Cooldown At Idle) and display a Cooldown Interrupted Warning message.

NOTICE

If possible, hot shutdown under load should be avoided to help prolong the reliability of the set. A hot shutdown may result in a Hot Shutdown Warning and are logged in the system software.



NOTICE

1. **Timer expires.**
2. **Coolant temperature reaches operating level.**
3. **Cooldown can be at rated speed and/or idle with different time-outs for each.**
4. **Only when non-emergency feature enabled (TB8-3 closed).**

FIGURE 26. NORMAL START/RUN/STOP SEQUENCES

5.6.2 Stopping at Operator Panel (Manual Mode)

When the operator panel is mounted remotely of the control panel assembly, the Stop button of the Control submenu can also be used to stop the generator set (O/Manual/Auto position).

The function of this Stop button is identical to the Stopping from Remote Location (non-emergency sequence, **Figure 26**). Refer to **Section 4.5 on page 35** for control menu/submenu descriptions.

NOTICE

The O/Manual/Auto switch must be in the Auto position to activate the Remote Menu Buttons of the Control submenu.

5.6.3 Stopping from Remote Location (Switch or Device) (Auto Mode)

If the control receives a remote stop signal or the control detects the return of utility voltage through the PTC, the set will complete its normal shutdown sequence. (The remote stop signal is actually the removal of the remote start signal to the control).

The set will stop after completing the following cooldown sequence:

- The generator set stops after completing the Time Delay to Stop function (zero to 300 seconds).
- Cooldown At Idle (zero to 10 minutes, or longer if necessary to obtain normal operating temperature before shutdown)

The set will remain in the Auto mode, and subject to a remote start signal, unless the Stop button is pressed. If this button is pressed, the generator set will enter the Off mode.

NOTICE
Refer to Section 4.5.8 on page 46 to change the Time Delay To Stop setting. The InPower service tool is required to change the Cooldown At Idle setting. Contact your authorized distributor for assistance.

5.6.4 Emergency Stop (Code 1433 or 1434)

5.6.4.1 1433 Local Emergency Stop

The Local Emergency Stop button is situated on the front of the control panel.

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 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

5.6.4.2 1434 Remote Emergency Stop

A Remote Emergency Stop button may be incorporated within the installation. If this Remote Emergency 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. Move the O/Manual/Auto Switch to O.
3. Press the front panel Fault Acknowledge button.
4. Return the O/Manual/Auto Switch to the desired position.

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.

5.7 Optional Power Transfer Control (PTC) Operation

The following describes the function and operation of the PCC with the optional PTC feature installed. With the PTC feature installed, the PCC performs two functions: generator set operation and transfer of load between the utility and the generator set.

Table 7 describes how the generator set/PTC operates when the PCC control switch is in the Off, Manual, and Auto position.

TABLE 7. GENSET/PTC OPERATION - OFF/MANUAL/AUTO

Control Switch Position	Result
OFF	• PCC/PTC Not in Auto (1222) warning fault active • Generator set will not start • Loads will not transfer/retransfer
MANUAL (Sequence of Operation, Table 10 on page 69)	• PCC/PTC Not in Auto (1222) warning fault active • Generator set can only be started manually via the control panel Manual Run/Stop button. • Load must be retransferred manually • Synchronizing and load ramping will occur automatically • Enforcement of maximum parallel time will occur automatically
AUTO (Sequence of Operation, Table 8 on page 67)	• PCC/PTC in automatic mode. • Generator set will start automatically as required. • Loads will transfer/retransfer automatically as required

5.7.1 PCC/PTC - Normal Operation Sequences

The following tables show the normal operating sequence of events for each of the four possible running modes (utility power failure, exercise, test, or manual run). The sequences are further defined by what the Generator Set Application Type is (i.e., Open Transition, Closed Transition-Momentary, or Closed Transition-Soft Loading).

The previous Start, Exercise and Stop information also applies/remains the same, other than the addition of the PTC transfer and retransfer of load after the generator set or utility voltage/frequency stabilize.

NOTICE

The PCC/PTC Exercise With Load is shown in Table 9. The PCC/PTC Exercise Without Load is identical to the standard PCC Exercise sequence shown in Figure 26 on page 64.

NOTICE

Test Switch - With the PTC feature installed, the Remote Start input (TB8-4/5) will function as a Test mode switch for the PTC. The PTC Test sequence is identical to the Exercise sequence (with or without load), except that the generator set will continue to run until the Test switch is deactivated.

TABLE 8. UTILITY POWER FAIL

	Open Transition	Closed Transition- Momentary	Closed Transition - Soft Loading
1	Utility Failure	Utility Failure	Utility Failure
2	Time Delay to Start	Time Delay to Start	Time Delay to Start
3	Generator Set Starts	Generator Set Starts	
4	Generator Set Available	Generator Set Available	
5	Time Delay to Transfer	Time Delay to Transfer	
6	Utility Circuit Breaker Opens	Utility Circuit Breaker Opens	
7	Time Delay Programmed Transition	Time Delay Programmed Transition	
8	Generator Set Circuit Breaker Closes	Generator Set Circuit Breaker Closes	Generator Set Circuit Breaker Closes
9	Generator Set Supplying Load	Generator Set Supplying Load	Generator Set Supplying Load
10	Utility Available	Utility Available	Utility Available
11	Time Delay Retransfer	Time Delay Retransfer	Time Delay Retransfer
12		Synchronizes to Utility	Synchronizes to Utility
13		Utility Circuit Breaker Closes	Utility Circuit Breaker Closes
14		<100 msec Overlap	Generator Set Ramp Unloads
15			Generator Set Unloaded
16	Generator Set Circuit Breaker Opens	Generator Set Circuit Breaker Opens	Generator Set Circuit Breaker Opens

	Open Transition	Closed Transition- Momentary	Closed Transition - Soft Loading
17	Time Delay Programmed Transition		
18	Utility Circuit Breaker Closes		
19	Utility Supplying Load	Utility Supplying Load	Utility Supplying Load
20	Time Delay to Stop/Cooldown	Time Delay to Stop/Cooldown	Time Delay to Stop/Cooldown
21	Generator Set Stopped	Generator Set Stopped	Generator Set Stopped

TABLE 9. EXERCISE WITH LOAD (SWITCH PANEL)

	Open Transition	Closed Transition - Momentary	Closed Transition - Soft Loading
1	Exercise Start Activated	Exercise Start Activated	Exercise Start Activated
2	Time Delay to Start	Time Delay to Start	Time Delay to Start
3	Generator Set Starts	Generator Set Starts	Generator Set Starts
4	Warm-Up @ Idle	Warm-Up @ Idle	Warm-Up @ Idle
5	Generator Set Available	Generator Set Available	Generator Set Available
6	Time Delay to Transfer	Time Delay to Transfer	Time Delay to Transfer
7	Utility Circuit Breaker	Synchronizes to Utility	Synchronizes to Utility
8	Time Delay Programmed Transition		
9	Generator Set Circuit Breaker Closes	Generator Set Circuit Breaker Closes	Generator Set Circuit Breaker Closes
10		<100 msec Overlap	Generator Set Ramp Unloaded
11			Utility Unloaded
12		Utility Circuit Breaker Opens	Utility Circuit Breaker Opens
13	Generator Set Supplying Load	Generator Set Supplying Load	Generator Set Supplying Load
14	Exercise Timer Expires	Exercise Timer Expires	Exercise Timer Expires
15	Time Delay Retransfer	Time Delay Retransfer	Time Delay Retransfer
16	Generator Set Circuit Breaker Opens	Synchronizes to Utility	Synchronizes to Utility
17	Time Delay Programmed Transition		
18	Utility Circuit Breaker Closes	Utility Circuit Breaker Closes	Utility Circuit Breaker Closes
19		<100 msec Overlap	Generator Set Ramp Unloads
20			Generator Set Unloaded
21		Generator Set Circuit Breaker Opens	Generator Set Circuit Breaker Opens
22	Utility Supplying Load	UTILITY SUPPLYING LOAD	Utility Supplying Load
23	Time Delay to Stop/Cooldown	Time Delay to Stop/Cooldown	Time Delay to Stop/Cooldown
24	Generator Set Stopped	Generator Set Stopped	Generator Set Stopped

TABLE 10. MANUAL RUN (SWITCH PANEL)

	Open Transition	Closed Transition - Memory	Closed Transition - Soft Loading
1	Manual Run Switch Activated	Manual Run Switch Activated	Manual Run Switch Activated
2	Generator Set Starts	Generator Set Starts	Generator Set Starts
3	Warm-Up @ Idle	Warm-Up @ Idle	Warm-Up @ Idle
4	Generator Set Available	Generator Set Available	Generator Set Available
5		Synchronized to Utility	Synchronized to Utility
6	Open Utility CP (Operator)		
7	Time Delay Programmed Transition		
8	Close Generator Set CB (Operator)	Close Generator Set CB (Operator)	Close Generator Set CB (Operator)
9		<100 msec Overlap	Generator Set Ramp Loads
10			Utility Unloaded
11		Utility CB Opens (Auto by Control)	Open Utility CB (* Operator)
12	Generator Set Supplying Load	Generator Set Supplying Load	Generator Set Supplying Load
13	Open Generator Set CB (Operator)		
14	Time Delay Programmed Transition	Synchronizes to Utility	Synchronizes to Utility
15	Close Utility CB (Operator)	Close Utility CB (Operator)	Close Utility CB (Operator)
16		<100 msec Overlap	Generator Set Ramp Unloads
17			Generator Set Unloaded
18		Generator Set CB Opens (By Control)	Open Generator set CB (* Operator)
19	Utility Supplying Load	Utility Supplying Load	Utility Supplying Load
20	Manual Run Switch Deactivated	Manual Run Switch Deactivated	Manual Run Switch Deactivated
21	Cooldown	Cooldown	Cooldown
22	Generator Set Stopped	Generator Set Stopped	Generator Set Stopped

* Maximum Parallel Time is enforced in Manual mode. Breaker operation will be automatic if maximum parallel time is exceeded.

5.8 Operating Recommendations

5.8.1 Running-in

Refer to the Maintenance section of this manual Chapter 6 on page 73. 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.

5.8.2 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.

5.8.3 Exercise Period

Generator sets on standby duty 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 generator set at least once a month for a minimum of 30 minutes, under not less than 30 percent of the nameplate rating.

5.8.4 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. Be sure the voltage of the separate power source is correct for the heater element rating.

5.8.5 High Operating Temperatures

Refer to the Generator Set Name Plate for the maximum operating temperature, if applicable.

5.8.6 De-Rating Factors

For de-rating factors applicable at specific sites, contact your authorized distributor.

5.9 Generator Set Operation

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

⚠ WARNING

Do not operate a diesel engine where there are or can be combustible vapors. These vapors can be sucked through the air intake system and cause engine acceleration and overspeeding, which can result in a fire, an explosion, and extensive property damage and personal injury. Numerous safety devices are 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 Engine Company does not know how you will use your engine. 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.

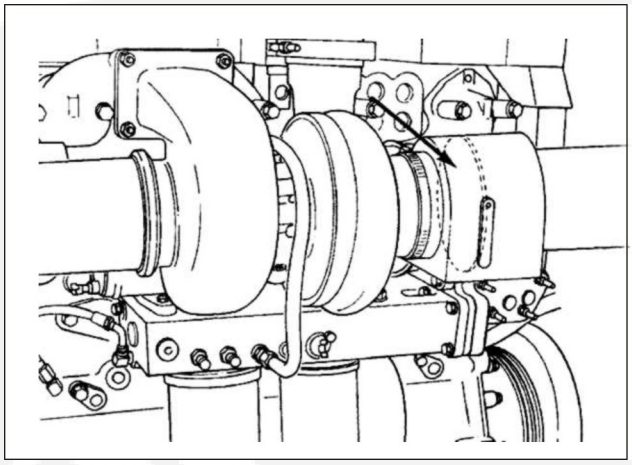


FIGURE 27. AIR INTAKE SHUTOFF DEVICE

⚠ CAUTION

Do not idle the engine for excessively long periods. Long periods of idling (more than ten minutes) can damage an engine because combustion chamber temperatures drop so low the fuel will not burn completely. This will cause carbon to clog the injector spray holes and piston rings, and can cause the valves to stick. If the engine coolant temperature becomes too low (60 °C [140 °F]), raw fuel will wash the lubricating oil off the cylinder walls and dilute the crankcase oil. This will result in the moving parts of the engine not receiving the correct quality of lubrication.

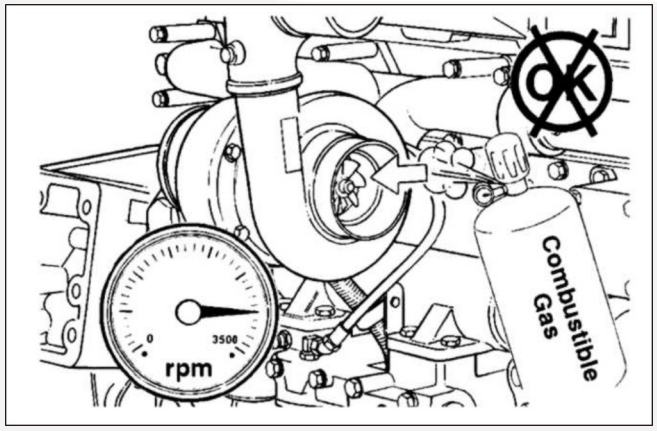


FIGURE 28. COMBUSTIBLE VAPORS CAN CAUSE ENGINE OVERSPEEDING

5.9.1 Sequence of Operation

When the PowerCommand® control is in the AUTO mode, it will cause the generator set to start on receiving a signal from a remote device. The control will initiate a starter cranking signal and verify that the engine is rotating. The control will provide sufficient fuel to the engine to accelerate to start disconnect speed. On reaching that speed, the control will ramp the generator set to rated speed and voltage. (In MANUAL mode, the control will ramp the generator set to idle mode, if needed for warm-up then ramp to rated speed and voltage).

On reaching rated speed and voltage, the control checks the system bus voltage. If no bus voltage is present, it will wait for a pulse from a remote Master First Start Sensor. On receiving that pulse, the control will signal the paralleling breaker to close.

If bus voltage is present, the control will check for proper phase rotation, adjust the generator set to the bus voltage and frequency level, and then synchronize the generator set to the system bus. When a synchronous condition is achieved, the control will send a signal to close the paralleling breaker.

When the paralleling breaker is closed, the generator set will assume it's proportional share of the total load on the system bus.

6 Maintenance

⚠ WARNING

Accidental or remote starting.

Accidental or remote starting of the generator set while working on it can cause severe personal injury or death.

Prevent accidental or remote starting by disconnecting the starting battery cables (negative [–] first), using an insulated wrench and isolating all auxiliary supplies.

⚠ WARNING

Hydrogen gas.

Arcing can ignite explosive hydrogen gas given off by batteries, causing severe personal injury or death. Arcing can occur when cables are removed or replaced, or when the negative (–) battery cable is connected and a tool used to connect or disconnect the positive (+) battery cable touches the frame or other grounded metal part of the generator set.

Insulated tools must be used when working in the vicinity of the batteries. Always remove the negative (–) cable first and reconnect last.

⚠ WARNING

Explosive fumes.

Arcing can ignite explosive fumes causing severe personal injury or death.

Make sure hydrogen from the battery, engine fuel and other explosive fumes are fully dissipated before working on the generator set.

⚠ WARNING

Working at heights.

Using the incorrect equipment when working at heights can result in severe personal injury or death.

Suitable equipment for performing these tasks must be used in accordance with the local guidelines and legislation. Failure to follow these instructions can result in severe personal injury or death.

⚠ WARNING

Access.

Using the generator set or part of as a means of access when attaching lifting shackles, chains, or other lifting aids, may damage the generator set, causing severe personal injury or death.

Do not use the generator set as a means of access. Failure to follow these instructions can result in severe personal injury or death.

⚠ WARNING

Exposed terminations.

Some panel internal components may have live exposed terminations even if the generator set is not running. Voltages are present which can cause electrical shock, resulting in personal injury or damage to equipment.

Isolate all external electrical supplies prior to access of the control panel.

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 off for safe working:

1. **Press the off mode switch on the generator set control panel.**
2. **As an additional precaution, press the Emergency Stop Button.**
3. **Isolate all supplies to the generator set.**
4. **Isolate the battery charger.**
5. **Disconnect the battery.**
6. **Remove the starter control wires.**
7. **A suitable warning plate stating 'Maintenance in Progress' should be displayed prominently.**

6.1 Locking the Generator Set Out of Service

⚠ WARNING

Explosive gases.

Explosive gases (given off during battery charging) may be present in the vicinity of the batteries. Ignition of battery gases can cause severe personal injury.

Make sure the area is well ventilated before disconnecting batteries.

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 Operator's engine specific manual. This manual contains specific equipment instructions that may differ from the standard generator set.

NOTICE

Before carrying out any maintenance, isolate all supplies to the generator set and any control panels. Render the set inoperative by disconnecting the plant battery.

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 11. PERIODIC MAINTENANCE SCHEDULE - ONE DAY TO ONE YEAR

Maintenance Items	See Engine Schedule	Daily or After 8 Hrs	Monthly or After 100 Hrs	6 Months or After 250 Hrs	1 Year
Perform maintenance tasks as specified using Daily or Hourly periods - whichever is sooner					
General set inspection	X[1]	X[2]			
Check engine oil level		X			
Check coolant level		X			
Check coolant heater(s)		X			
Check battery charging system			X		
Check all hardware (fittings, clamps, fasteners, etc.)			X		
Check battery electrolyte level			X		
Check generator air outlet			X		
Check radiator hoses for wear and cracks				X	
Test rupture basin leak detect switch					X[3]
Check drive belt	X[1]				
Check air cleaner (replace as necessary)	X[1]				
Drain fuel filter(s)	X[1]				

Check anti-freeze and DCA concentration	X[1]				
Replace engine oil and filter	X[1]				
Replace water coolant filter	X[1]				
Clean crankcase breather	X[1]				
Replace fuel filter	X[1]				
Clean cooling systems	X[1]				

1. Refer to Cummins QSX15 Series Engine Operation and Maintenance Manual for maintenance interval and/or procedure
2. Check for oil, fuel, coolant, and exhaust system leaks. Check exhaust system audibly and visually with the generator set running.
3. Check leak detect switch in sub-base fuel tank of optional enclosure, 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.

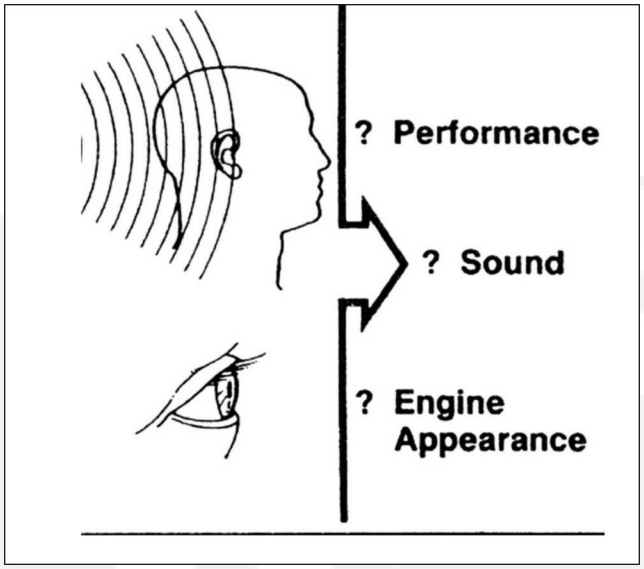


FIGURE 29. DAY-TO-DAY AWARENESS

Before starting the generator set, check the oil and coolant levels and look for:

- Leaks
- Loose or damaged parts
- Worn or damaged belts
- Any change in engine or 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.

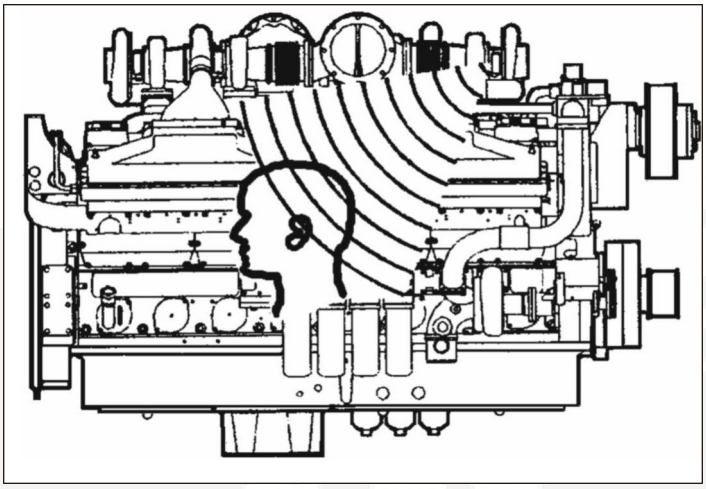


FIGURE 30. LOOK AND LISTEN FOR CHANGES IN PERFORMANCE

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

Scolding.

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.

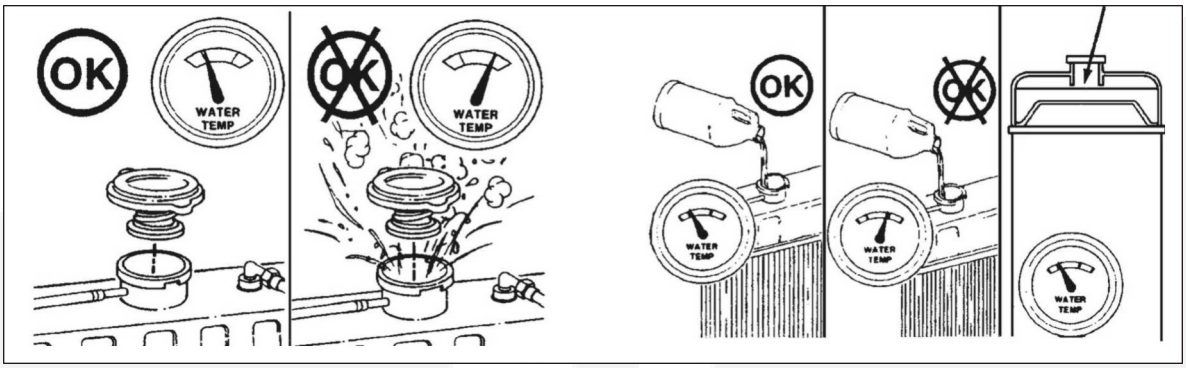


FIGURE 31. COOLANT LEVEL PROCEDURE

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

Fan blade damage.
Personal injury can result from a fan blade that has become damaged.
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).

Contact your authorized distributor if the fan is damaged.

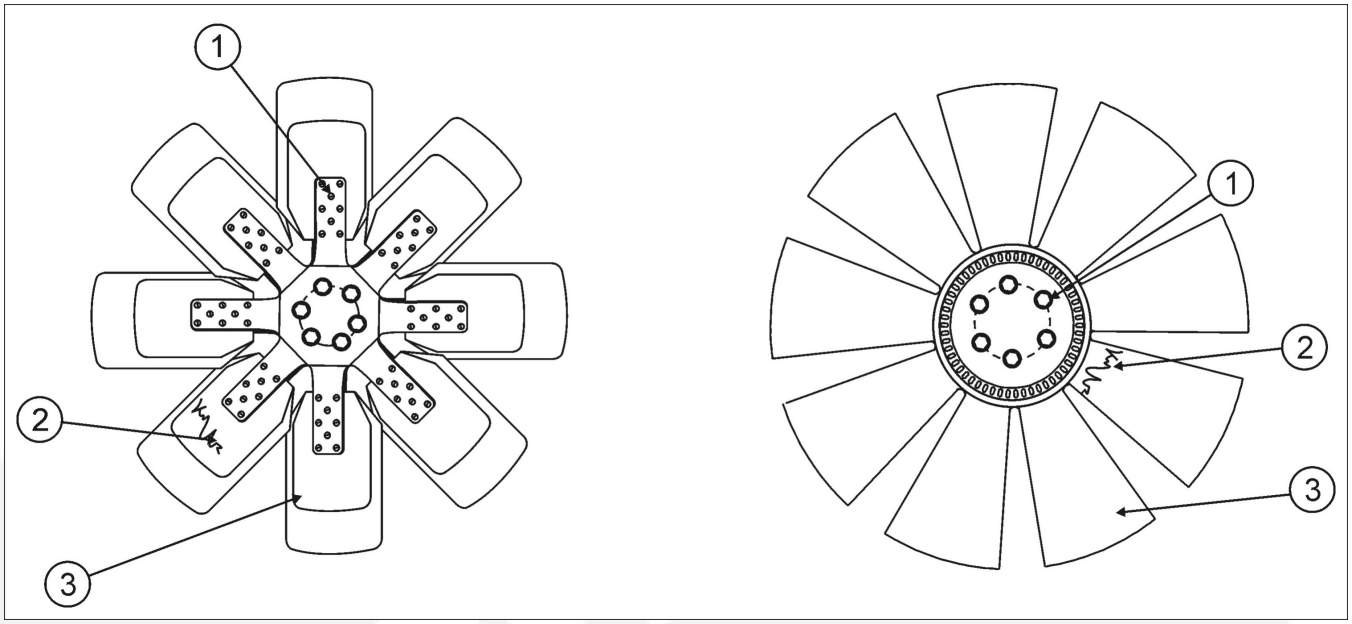


FIGURE 32. COOLING FAN INSPECTION

6.4.3 Drive Belt - Inspection

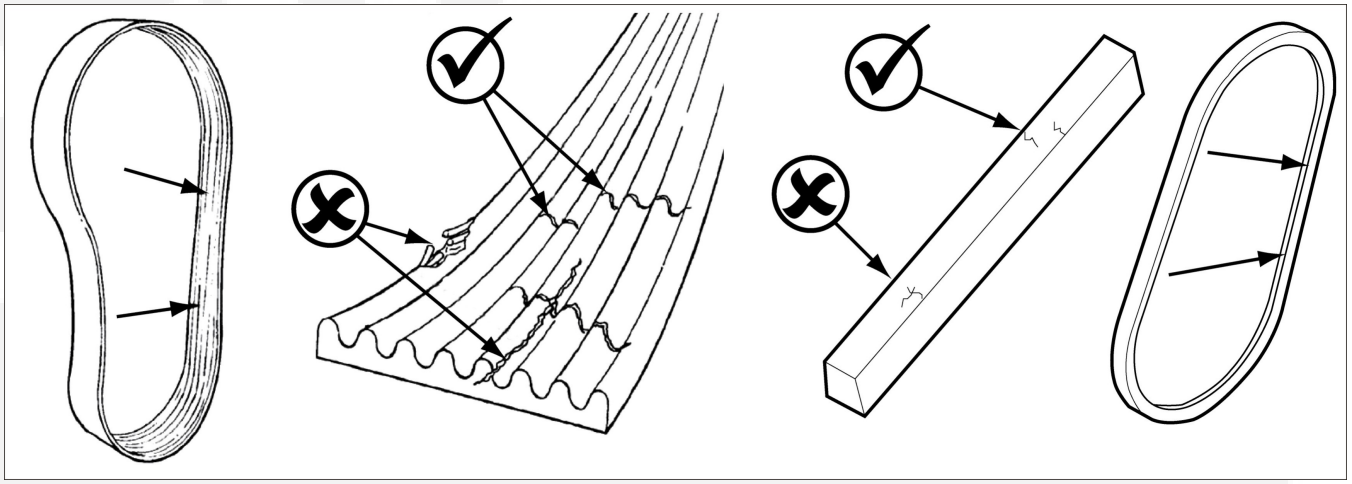


FIGURE 33. DRIVE BELT INSPECTION

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

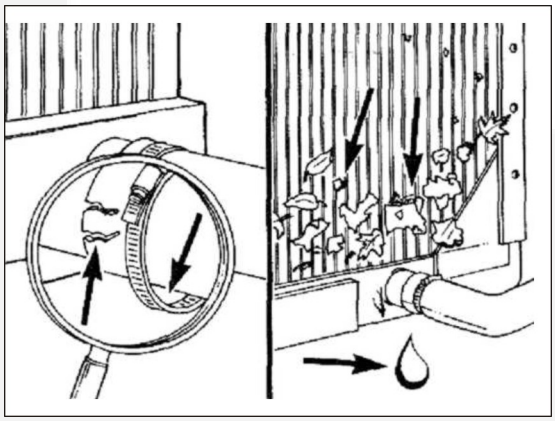


FIGURE 34. RADIATOR CHECK

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

Crankcase pressure.
Crankcase pressure can blow out hot oil and cause severe burns.
Do NOT check oil while the generator set is operating.

⚠ CAUTION

Skin infection.
Prolonged and repeated skin contact with used engine oils can cause skin disorders or other bodily injury.
Comply with all local health and safety regulations/codes when handling or disposing of used engine oil.

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.

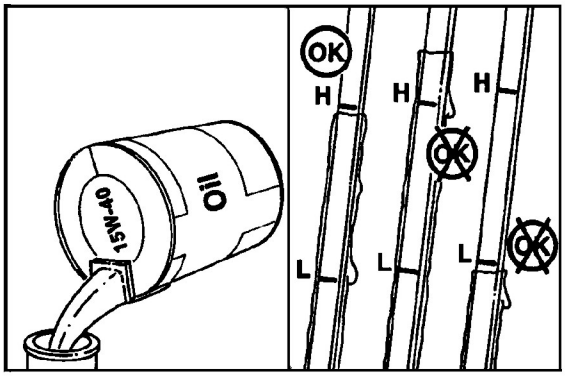


FIGURE 35. ENGINE OIL LEVEL CHECK

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 15W-40 multi-viscosity lubricating oil such as Cummins Premium Blue® or its equivalent. Consult your authorized distributor for the correct lubricating oil for your operating conditions.

6.6 Fuel System

⚠ WARNING

Fuel igntion.
Ignition of fuel can cause serious personal injury or death by fire or explosion.
DO NOT permit any flame, cigarette, or other igniter near the fuel system, or in areas sharing ventilation.

⚠ WARNING

Fuel mixtures.
Mixing gasoline or alcohol with diesel fuel, can cause an explosion which may 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.

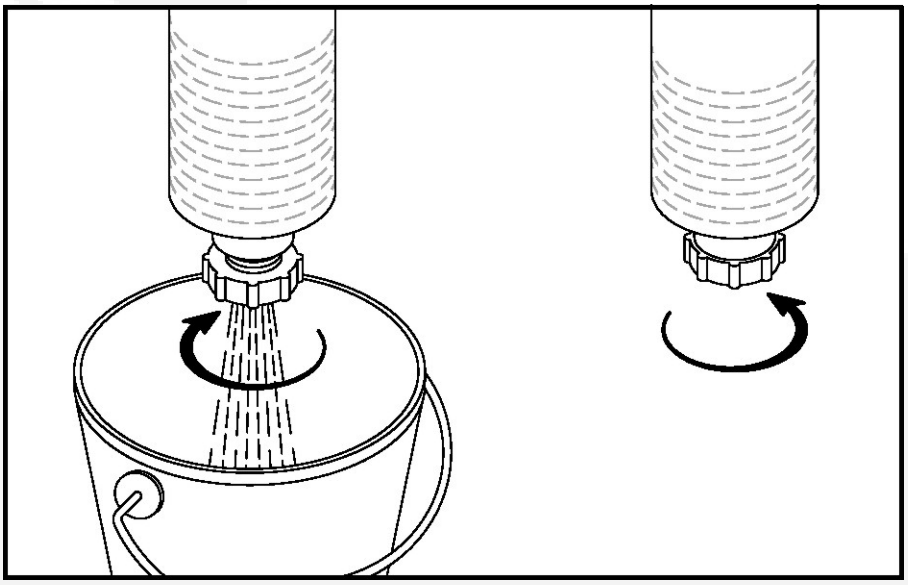


FIGURE 36. DRAINING THE FUEL/WATER SEPARATOR

6.7 Fuel System

⚠ WARNING

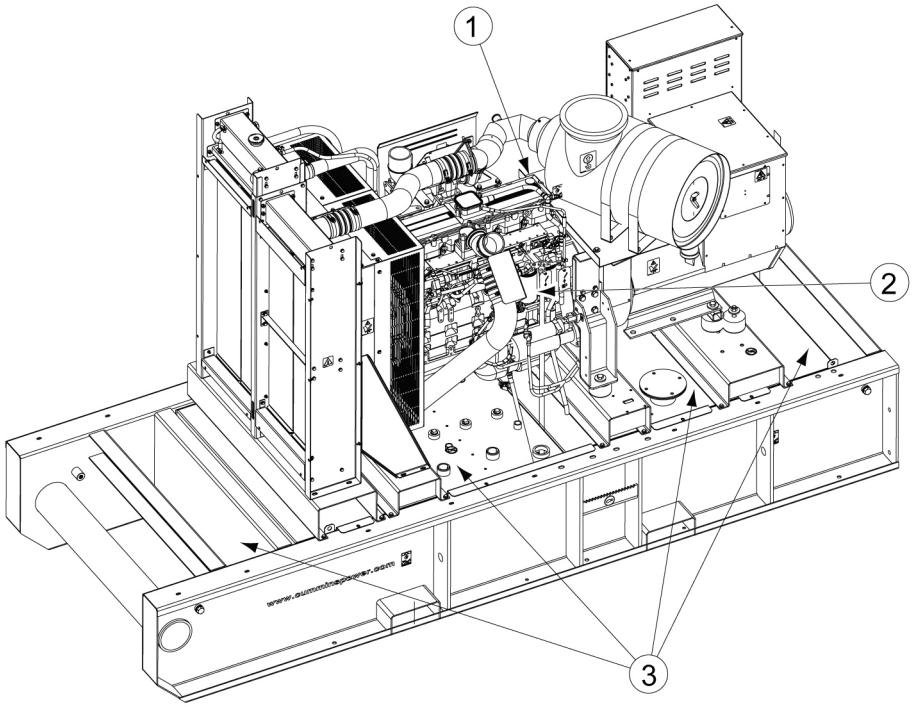
Fuel igntion.
Ignition of fuel can cause serious personal injury or death by fire or explosion.
DO NOT permit any flame, cigarette, or other igniter near the fuel system, or in areas sharing ventilation.

NOTICE

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

6.8 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 line with local health and safety regulations. Failure to perform this action may result in spillage of liquids likely to contaminate the surrounding area.



1	Oil Filler
2	Dip Stick
3	Containment Area

FIGURE 37. FLUID CONTAINMENT INSPECTION

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

6.9 Hoses and Fuel Lines - Check

⚠ WARNING

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

⚠ WARNING

Burns
Hot metal parts can cause serious burns.
To prevent serious burns, avoid contact with hot metal parts such as radiator, turbocharger and exhaust system.

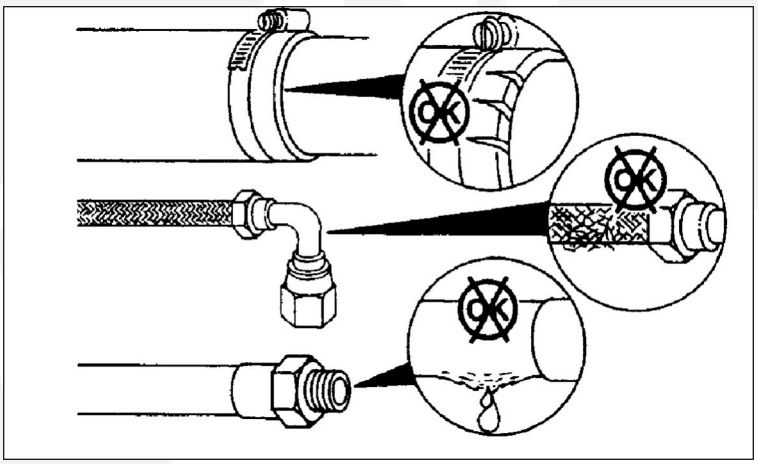


FIGURE 38. HOSES AND FUEL LINE INSPECTION

With the generator set operating, inspect the fuel lines, filters, and fittings for leaks. Check any flexible sections for cuts, cracks and abrasions and ensure 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 corrected immediately.

6.10 Air Intake System

6.10.1 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.

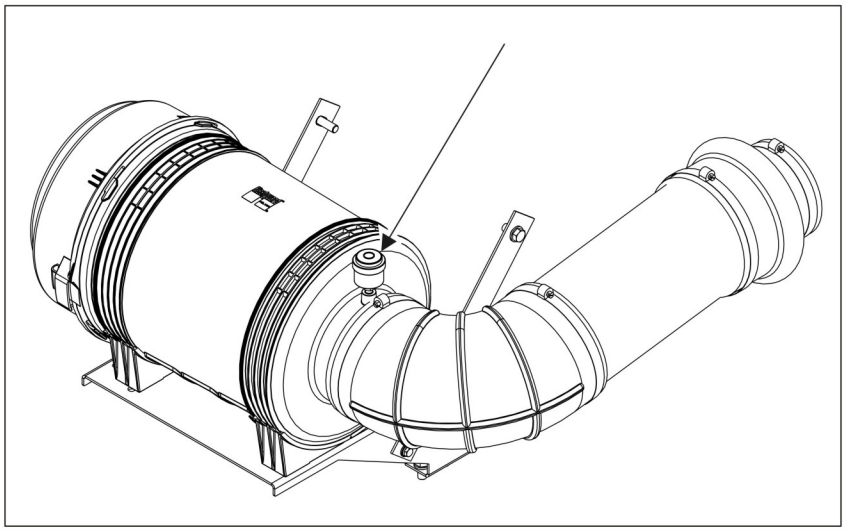


FIGURE 39. AIR CLEANER SERVICE INDICATOR

6.10.2 Normal Duty Air Cleaner

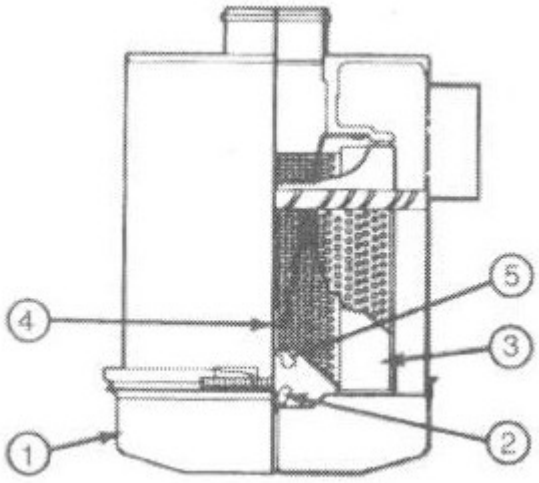
6.10.2.1 Air Cleaner Element Removal

Normal duty air cleaners combine centrifuge cleaning with element filtering before air enters the engine.

NOTICE
Holes, loose-end seals, dented sealing surfaces, corrosion of pipes, and other forms of damage render the air cleaner inoperative and require immediate element replacement or engine damage can occur.

NOTICE
Cummins Inc. does not recommend cleaning paper-type air cleaner elements. Elements that have been cleaned will clog, and airflow to the engine will be restricted.

1. Before disassembly, wipe dirt from the cover and the upper portion of the air cleaner.
2. Loosen the wing bolt (2) and remove the band clamp securing the dust pan (1).
3. Remove the dust shield (3) from the dust pan (1).
4. Clean the dust pan and shield.
5. Remove the wing nut (5) that secures the air cleaner element (4) in the air cleaner housing.
6. Inspect the rubber sealing washer on the wing nut.
7. Remove the dirty cleaner element (4). Dispose of the dirty element in accordance with local environmental agency requirements.

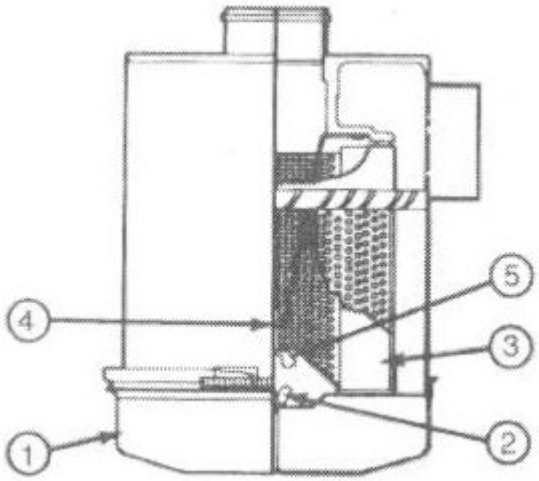


No.	Description	No.	Description
1	Dust Pan	4	Air Cleaner Element
2	Wing Bolt	5	Wing Nut
3	Dust Shield		

FIGURE 40. NORMAL DUTY AIR CLEANER

6.10.2.2 Air Cleaner Element Installation

1. Install the air cleaner element (4) in the air cleaner housing.
2. Inspect the rubber sealing washer and make sure it is in place under the wing nut (5).
3. Tighten the wing nut (5) that secures the element (4) in the air cleaner housing.
4. Assemble the dust shield (3) and the dust pan (1).
5. Position the dust shield (3) and dust pan (1) on the air cleaner housing and secure them with the band clamp wing bolt (2).



No.	Description	No.	Description
1	Dust Pan	4	Air Cleaner Element
2	Wing Bolt	5	Wing Nut
3	Dust Shield		

FIGURE 41. NORMAL DUTY AIR CLEANER

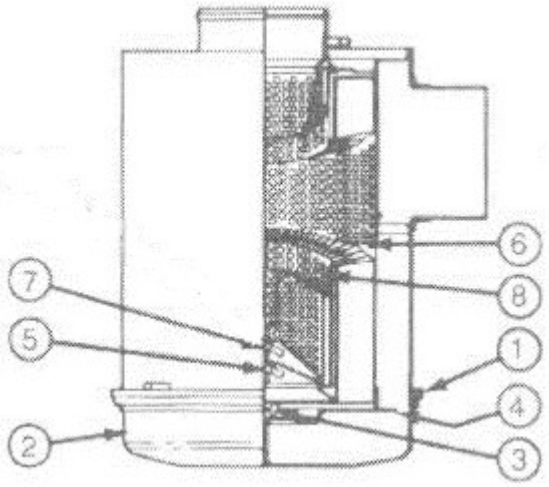
6.10.3 Heavy Duty Air Cleaner

6.10.3.1 Air Cleaner Element Removal

Heavy duty air cleaners combine centrifuge cleaning with element filtering before air enters the engine.

NOTICE
Cummins Inc. does not recommend cleaning paper-type air cleaner elements. Elements that have been cleaned will clog, and airflow to the engine will be restricted.

1. Before disassembly, wipe dirt from the cover and the upper portion of the air cleaner.
2. Loosen the wing bolt (1) and remove the band clamp securing the dust pan (2).
3. Remove the dust shield (4) from the dust pan (2).
4. Clean the dust pan and shield.
5. Loosen the wing bolt (3).
6. Remove the wing nut (5) that secures the air cleaner primary element (6) in the air cleaner housing.
7. Inspect the rubber sealing washer on the wing nut.
8. Remove the dirty cleaner element (6). If the inner safety element (8) is being replaced based upon high intake restriction, remove the wing nut (7) and replace the inner safety element. Dispose of the dirty element in accordance with local environmental agency requirements.

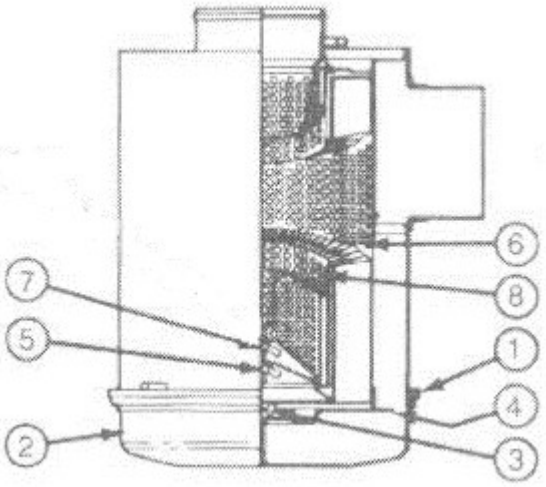


No.	Description	No.	Description
1	Wing Bolt	5	Wing Nut
2	Dust Pan	6	Air Cleaner Primary Element
3	Wing Nut	7	Wing Nut
4	Dust Shield	8	Air Cleaner Inner Safety Element

FIGURE 42. HEAVY DUTY AIR CLEANER

6.10.3.2 Air Cleaner Element Installation

1. If the inner safety element (8) is being replaced, install the safety element and secure it with the wing nut (7).
2. Check the seals.
3. Install the air cleaner primary element (6) in the air cleaner housing.
4. Inspect the rubber sealing washer on the wing nut (5).
5. Tighten the wing nut to sure the primary element in the air cleaner housing.
6. Install the dust shield (4) into the dust pan (2).
7. Install the dust shield and dust pan assembly and secure them using the band clamp and tighten the wing bolt (1).
8. Tighten the wing bolt (3).



No.	Description	No.	Description
1	Wing Bolt	5	Wing Nut
2	Dust Pan	6	Air Cleaner Primary Element
3	Wing Nut	7	Wing Nut
4	Dust Shield	8	Air Cleaner Inner Safety Element

FIGURE 43. HEAVY DUTY AIR CLEANER

6.10.3.3 Heavy Duty Air Cleaner Maintenance

There is a rubber breather tube on the bottom of each filter pre-cleaner that should be checked periodically to make sure it is free of dust and dirt.

Each filter pre-cleaner includes a primary and secondary element that is checked periodically to make sure they are clean. Refer to Periodic Maintenance Schedule table for additional information.

6.11 Exhaust System

⚠ WARNING

Hot exhaust components.

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

Inhalation of exhaust gases.

Inhalation of exhaust gases can result in serious personal injury or death.

Be sure deadly exhaust gas is piped outside and away from windows, doors or other inlets to buildings. Do not allow to accumulate in habitable areas.

⚠ WARNING

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

With the generator set operating, 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 ensure 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 corrected immediately.

6.12 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 by illuminating each of the indicator lamps in turn .

6.13 DC Electrical System

⚠ WARNING

Battery gases.
Ignition of explosive battery gases can cause severe personal injury.
Do not use naked flames, smoke, or cause sparks while servicing batteries.

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

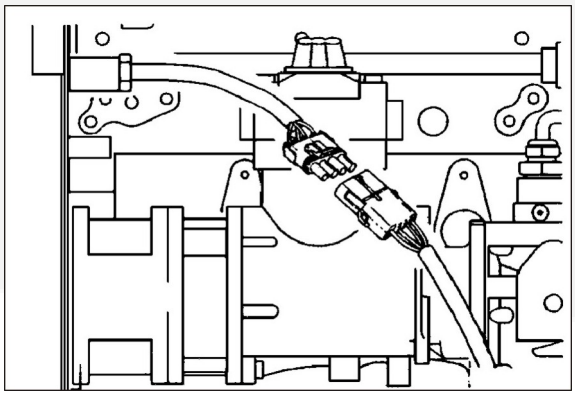


FIGURE 44. CHECK HARNESS CONNECTIONS

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 ensure 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.

6.14 Batteries

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

It is therefore vital that batteries are stored, commissioned, and maintained as detailed here. Reference should also be made to the Battery Manufacturer's instructions.

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.

6.14.1 Storage

Dry-charged batteries should be stored in a cool, dry place, upright and with the vent caps securely in place.

Filled and charged batteries must be stored in a cool, dry, well ventilated place. Make sure that the vent caps are securely screwed down, or pushed home.

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

6.14.2 Safety Precautions

The handling and proper use of batteries is not hazardous providing the correct precautions are observed and personnel are trained in their use.

6.14.2.1 General Precautions

⚠ WARNING

Arcing.
Laying tools or metal objects across the battery can cause arcing that may ignite battery gases causing explosions resulting in personal injury.
Never lay tools or metal objects across the top of the battery.

- 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 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.

6.14.2.2 Fire Hazard

NOTICE
Make sure that batteries are charged in a well ventilated area, away from naked flames and sparks.

NOTICE
During the charging of a battery, explosive gases are given off. Keep the battery well ventilated and away from naked flames and sparks. NO SMOKING.

NOTICE
Before disconnecting a battery, always remove power from the mains powered battery charger (where fitted) BEFORE disconnecting the charger leads.

NOTICE
When putting a battery into service on a generator set, connect the earth lead LAST; when removing the battery, disconnect the earth lead FIRST.

6.14.2.3 Fluid Hazard

⚠ WARNING
Electrolyte. ***If electrolyte is splashed on the skin or in the eyes can cause serious injury.*** ***Always wear an acid-proof protective apron, goggles and gloves when handling electrolyte. If electrolyte is splashed on the skin or in the eyes, flush the affected areas immediately with water and seek medical advice.***

⚠ CAUTION
Sulfuric acid. ***Adding undiluted sulfuric acid to a battery can cause a chemical reaction that may result in personal injury.*** ***Never add undiluted sulfuric acid to a battery.***

.

6.14.3 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 using the following steps:

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

6.14.3.1 Pre-Commissioning Procedure

1. Check for any mechanical damage to the battery case or terminals, and make sure that the battery is clean and dry.
2. Smear the battery terminals with petroleum jelly to prevent corrosion.
3. 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.

6.14.3.2 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 given in **Table 13 on page 101** (8.2 liters (2.2 gallons) per standard battery).
2. The filling operation must be completed in one operation.
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 in **Table 13 on page 101**.
4. After filling, the battery must be placed on a commissioning charge within one hour. Charging must take place before any load is placed on the battery.

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

6.14.3.3 Charging - Commissioning

1. Charge the battery for a minimum of four hours in order to ensure that the acid is sufficiently mixed within the battery. The charging period may need to be extended if the battery has been in storage.
2. When the generator set is running, check the charge alternator output using an induction ammeter.

6.14.3.4 Connecting the Battery to the Generator Set

1. A battery must not be fitted to a generator set without charge if the SG of the electrolyte has fallen below 1.240 during storage.
2. Battery hold-down bolts must be tight but not over tight.
3. Re-smear the terminals with petroleum jelly, if necessary.
4. Fit the vents firmly in position and ensure that the battery is clean and dry.

5. Verify correct polarity when connecting the battery to the set. Even momentary incorrect connection can cause damage to the electrical system. Connect the positive generator cable FIRST, followed by the negative ground, using an insulated wrench.
6. Terminal connections must be tight but not over tight.

6.14.4 Battery Maintenance

⚠ WARNING

Battery gases.
Ignition of explosive battery gases can cause severe personal injury.
Thoroughly ventilate battery area before working on the battery. Do not smoke while servicing batteries, or cause sparks or arcing that may ignite battery gases.

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. Discharge static electricity from body before touching batteries, 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, ensure that the vent caps are securely screwed down, or pushed home.
2. To avoid contamination of the battery, only clean it 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. Make sure the battery(s) are secured 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 75 for the maintenance interval.

6.14.4.1 Cleaning Batteries

⚠ WARNING

Electrolyte.

Electrolyte. is a dilute sulfuric acid that is harmful to the skin and eyes. Do not get the substance in your eyes or contact with skin.

Wear goggles, protective rubber gloves, and apron when servicing batteries.

In case of skin contact, immediately wash affected area with soap and water.

In case of eye contact, immediately flood eyes with large amounts of water for a minimum of fifteen minutes. Immediately call a physician.

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.

6.14.4.2 Charging

Where generator sets are used infrequently, batteries must be put on a monthly re-charge schedule to ensure that a fully charged condition is maintained.

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 cease to rise.

6.14.4.3 Trickle/Boost Charging (Option)

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

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 six months).

NOTICE

Batteries should not be left on Boost Charge for extended periods as this will result in excessive water consumption, 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 should arise, 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 eight 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 twelve 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.

6.14.5 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 some visible means of telling when the battery is discharged or approaching the end of its useful life.

6.14.5.1 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 (two to three hours) to assure a thorough mixing of water and electrolyte.

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 in **Table 13 on page 101** by the addition of distilled water only and recharge. Replace the vent plugs once filling is completed.

If the cell is low, check case for leaks.

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

6.14.5.2 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 vertical and take the reading.

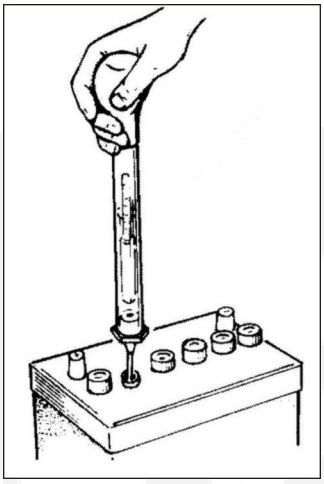


FIGURE 45. CHECKING SPECIFIC GRAVITY

6.14.5.3 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.

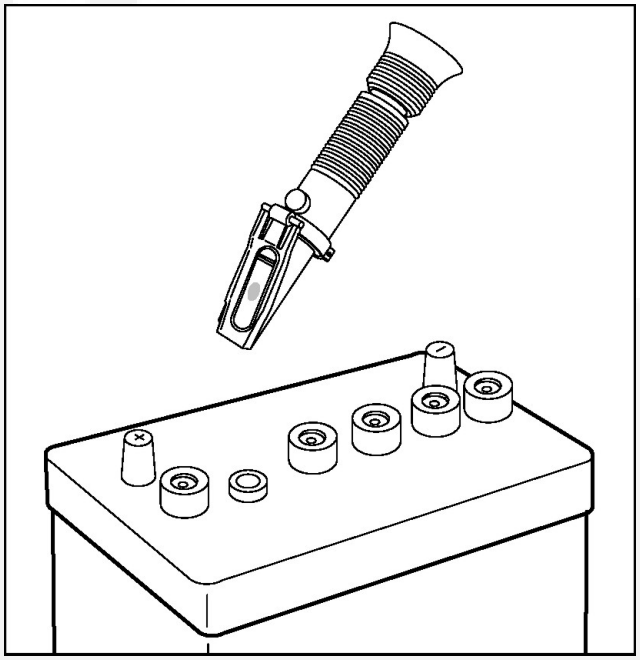


FIGURE 46. TYPICAL BATTERY ACID REFRACTOMETER

6.14.5.4 Specific Gravity Values for Batteries

A fully charged battery will have a corrected specific gravity of 1.260 at 77 ºF (25 ºC). Hold the hydrometer vertical and take the reading. Charge the battery if the reading is below 1.215.

TABLE 12. SPECIFIC GRAVITY

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

Table 12 shows the specific gravity (SG) of electrolyte, corrected to 77 ºF (25 ºC). Correct the SG reading for other temperatures by subtracting seven gravity points (0.007) for every 18 ºF (10 ºC) the electrolyte temperature is above 80 ºF (27 ºC). Apply the correction formula as follows:

1. For every 18 ºF (10 ºC) above 77 ºF (25 ºC), subtract 0.007 (7 points)
2. For every 18 ºF (10 ºC) below 77 ºF (25 ºC), add 0.007 (7 points)

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

6.14.6 Battery Replacement

⚠ WARNING

Incorrect battery disposal.
Burning the battery may cause an explosions Damage to the case will release electrolyte which is harmful to the skin and eyes and is also toxic.
Do not mutilate or burn the battery in a fire for 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 .

6.14.7 Electrolyte Levels and Bench Charging Rates

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

TABLE 13. 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

Battery Type	Electrolyte Level Above Plates (mm)	Bench Charging Rate (A/hour)		Battery Type	Electrolyte Level Above Plates (mm)	Bench Charging Rate (A/hour)
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
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

Battery Type	Electrolyte Level Above Plates (mm)	Bench Charging Rate (A/hour)		Battery Type	Electrolyte Level Above Plates (mm)	Bench Charging Rate (A/hour)
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.

6.14.8 Battery Fault Finding

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

TABLE 14. 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.

Symptom	Possible Fault	Remedy
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.

Refer to the control manual listed in the Related Literature section for control troubleshooting.

7.2 Safety Considerations

⚠ WARNING

Hazardous voltage.
High voltages are present when the generator set is running.
Do not open the output box while the generator set is running as the isolator switch will cause the generator set to shut down.

⚠ WARNING

Hazardous voltage.
Contacting high voltage components can cause severe personal injury or death by electrocution.
Keep the output box covers in place during troubleshooting. Only personnel trained and experienced in performing electrical servicing should carry out testing and/or adjustments.

⚠ WARNING

Battery gases.
Ignition of explosive battery gases can cause severe personal injury or death.
Arcing at battery terminals, light switch or other equipment, flame, pilot lights and sparks, can ignite battery gas. Do not smoke, or switch inspection light on or off near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.

⚠ WARNING

Accidental or remote starting.
Accidental starting of the generator set while working on it can cause severe personal injury or death.
Prevent accidental starting by disconnecting the starting battery cables (negative (–) first) using an insulated wrench and isolating all auxiliary supplies.

⚠ CAUTION

Exposed terminations.
Some panel internal components may have live exposed terminations even if the generator set is not running.
Isolate all external electrical supplies prior to access of the control panel.

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 **Section 6.1 on page 74**.

7.3 Fault Finding

⚠ WARNING

Troubleshooting procedures.
Troubleshooting procedures present hazards that can result in severe personal injury or death.
Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures.
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 - PCC 3201

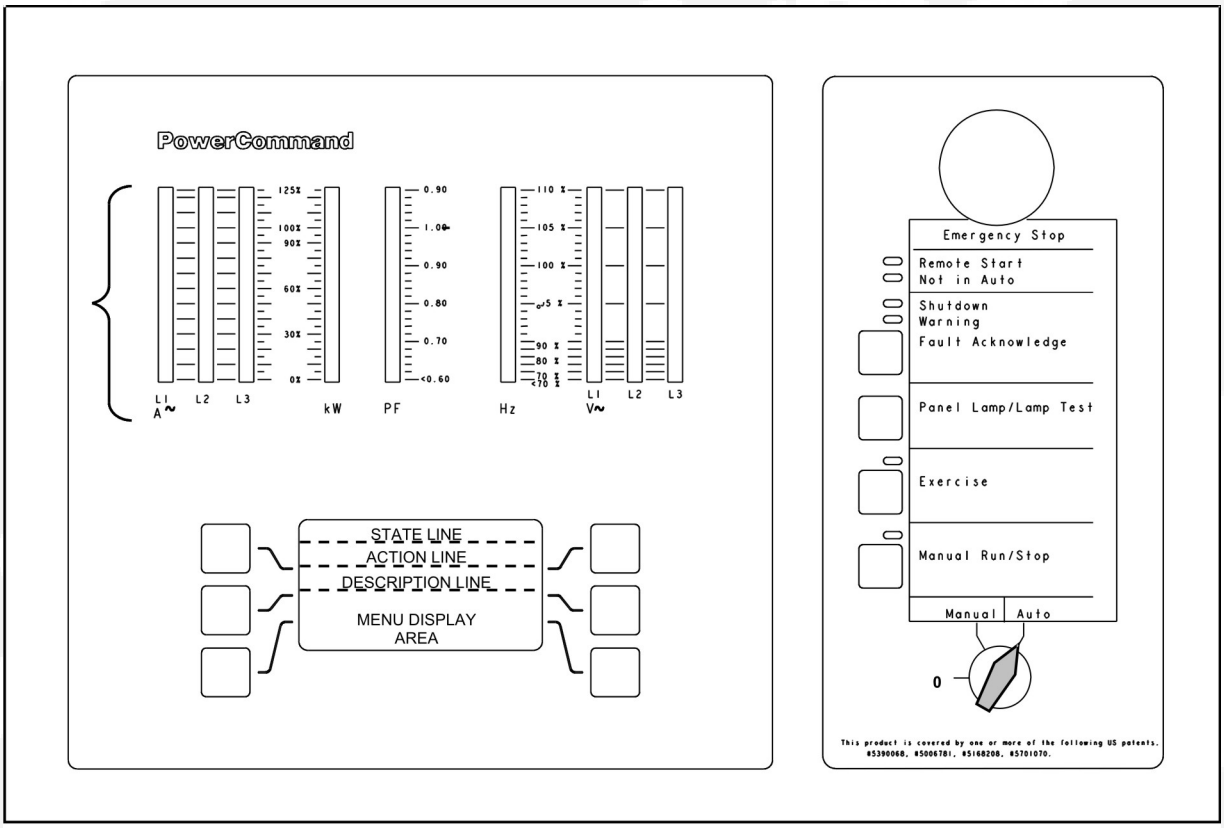


FIGURE 47. PCC 3201 CONTROL PANEL

7.4.1 Not in Auto

This red lamp flashes continuously when the O/Manual/Auto switch is not in the Auto position.

NOTICE
If the switch is in the Auto position and the lamp is still flashing, service is required.

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 turning the O/Manual/Auto switch to the O position, and pressing the Fault Acknowledge button. The generator set cannot be started when this lamp is on.

Dependent upon the specific fault that occurs, the engine may or may not shut down immediately. A fault that could cause engine damage, causes an immediate engine shutdown (bypasses engine cooldown sequence). All other faults would allow the engine to run during the cooldown sequence before engine shutdown. In this case, the Shutdown Status indicator blinks during the cooldown period.

7.4.3 Warning Status Indicator

This yellow lamp is lit whenever the control detects a warning condition. After the condition is corrected, warning indicators can be reset by pressing the Fault Acknowledge button. (It is **not** necessary to stop the generator set if the fault becomes inactive during generator set operation.) In auto mode, warning indicators can also be reset by cycling the remote reset input after the condition is corrected.

Some warnings remain active after the condition is corrected and the control reset button is pressed. This will require the generator set to be shut down to reset the warning indicator.

7.5 Fault/Status Codes - PCC 3201

7.5.1 Fault/Status Codes

⚠ WARNING

Troubleshooting procedures.

Troubleshooting procedures present hazards that can result in severe personal injury or death.

Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures

⚠ WARNING

Accidental or remote starting.

Accidental or remote starting of the generator set while working on it can cause severe personal injury or death.

Prevent accidental starting by disconnecting the starting battery leads (negative [–] first) and isolating all auxiliary supplies.

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 Reading Fault Codes

If the generator set contains the optional graphical display and a fault occurs, the fault code/message will be displayed in the display Description Line. If the control does not contain the graphical display, the fault code is read from the Warning and Shutdown status indicators.

After the fault is acknowledged and corrected, the recorded fault will be deleted from the control panel memory, but will remain in a data log to maintain a fault code history. The InPower service tool is required to view this data log.

7.5.2.1 Reading Fault Codes Using the Graphical Display (Optional)

The top three lines of the graphical display contain the following control information in the order described:

- State Line - modes of operation, such as Stopped, Time Delay To Start, Warm Up At Idle, and paralleling operations, such as Standby, Dead BUS Close, Synchronize, etc.
- Action Line - system actions, such as Warning, Derate, Shutdown Cool-down and Shutdown, and fault codes.
- Description Line - Fault code messages.

Refer to History/About Submenus section, which describes how to view fault codes using graphical display.

7.5.2.2 Reading Fault Codes Using Warning/Shutdown Indicators

If the Warning or Shutdown status indicator is lit, press and hold the Fault Acknowledge button and release after ten seconds or more. After ten seconds, the Shutdown lamp will begin to blink the active fault code(s) as follows.

The Warning lamp is used to indicate the start of a new code. The Warning lamp will remain on for 2 seconds, followed by the Shutdown lamp blinking the fault code. This sequence occurs three times for each code. The fourth flash of the Warning lamp indicates the beginning of the second fault code.

There are distinct pauses between repetitions of the code blink transmissions of the Shutdown lamp.

A three digit fault code is indicated by three sets of blinks separated by a two second pause. The first set corresponds to the hundreds position, the second to the tens position and the third to the ones digit. Example for Code No. 213:

Shutdown LED: blink-blink-pause-blink-pause-blink-blink-blink

Warning LED: blink (2 seconds)

The light will display the fault codes (active or inactive) in succession, starting with the most recent. Up to 32 (unacknowledged) fault codes can be stored in control panel memory.

To return the control to the most recent fault code, press and release the Fault Acknowledge button (less than one second) and repeat procedure.

When the fault code is acknowledged and the fault condition is corrected, the fault code will be removed from the LED fault log.

7.5.3 Fault Messages

A Fault message is an indicator of a Warning or Shutdown condition. It includes the 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.

7.5.4 Fault Acknowledgement

Shutdown faults must be acknowledged after the fault has been corrected. If in Auto or Manual mode, the control must be set to Stop mode (Off). Faults are cleared from the control panel display by pressing the Fault Acknowledge button.

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

NOTICE
Faults may also be acknowledged when in Auto mode and the Remote Start command is removed. Contact you authorized distributor for this option.

7.5.5 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.

7.5.6 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.

7.5.7 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).

7.5.8 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.

7.5.9 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.

7.5.10 Fault Codes - PCC 3201

Category	Code	Lamp	Displayed Message
A	115	Shutdown	Speed signal lost
B	122	Warning	Manifold air press sensor
B	123	Warning	Manifold air press sensor
C	124	Warning	High manifold air press
C	135	Warning	Oil pressure sensor high
C	141	Warning	Oil pressure sensor low
B	143	Warning	Low Oil Pressure
C	144	Warning	Coolant temperature sensor high
C	145	Warning	Coolant temperature sensor low
D	146	Warning	High coolant temperature
D	151	Shutdown	High coolant temperature
C	153	Warning	Manifold air temperature sensor high
C	154	Warning	Manifold air temperature sensor low
A	155	Shutdown	Manifold air temperature alarm
C	187	Warning	Sensor supply 2 OOR low
C	195	Warning	Coolant level sensor high
C	196	Warning	Coolant level sensor low
D	197	Warning	Low coolant level
C	212	Warning	Oil temperature sensor high
C	213	Warning	Oil temperature sensor low
C	221	Warning	Air pressure sensor high
C	222	Warning	Air pressure sensor low
C	223	Warning	Centinel driver low
C	224	Warning	Centinel driver high
C	227	Warning	Sensor supply 2 OOR high
A	228	Shutdown	Low coolant pressure
C	231	Warning	Coolant pressure sensor high
C	232	Warning	Coolant pressure sensor low
A	234	Shutdown	Overspeed

Category	Code	Lamp	Displayed Message
D	235	Shutdown	Low coolant level
C	238	Warning	Sensor supply 3 OOR low
C	245	Warning	Fan control sensor low
C	263	Warning	Fuel temperature sensor high
C	265	Warning	Fuel temperature sensor low
C	266	Warning	High fuel temperature
C	271	Warning	Fuel pump press sensor low
C	272	Warning	Fuel pump press sensor high
B	285	Warning	J1939 PGN timeout error
B	286	Warning	J1939 configuration error
C	322	Warning	Injector cylinder 1 open
C	323	Warning	Injector cylinder 5 open
C	324	Warning	Injector cylinder 3 open
C	325	Warning	Injector cylinder 6 open
C	331	Warning	Injector cylinder 2 open
C	332	Warning	Injector cylinder 4 open
A	342	Shutdown	ECM calibration error
B	343	Warning	Internal ECM error
B	351	Warning	Bad injector power supply
C	352	Warning	Sensor supply 1 OOR low
C	386	Warning	Sensor supply 1 OOR high
A	415	Shutdown	Low oil pressure
B	421	Warning	High oil temperature
C	427	Warning	CAN degraded
D	441	Warning	Low battery voltage
D	442	Warning	High battery voltage
B	449	Warning	High fuel supply pressure
B	451	Warning	Fuel rail pressure sensor
B	452	Warning	Fuel rail pressure sensor
B	488	Warning	High intake manifold temperature
B	546	Warning	Fuel pressure sensor high
B	547	Warning	Fuel pressure sensor low
A	556	Shutdown	High blowby pressure
B	559	Warning	Low fuel supply pressure
A	586	Shutdown	Run/Stop switch
A	587	Shutdown	Run/Stop switch

Category	Code	Lamp	Displayed Message
A	599	Shutdown	Auxilary Shutdown
D	611	Warning	Engine hot
B	689	Warning	Crank shaft sensor
C	697	Warning	ECM temperature sensor OOR high
C	698	Warning	ECM temperature sensor OOR low
B	731	Warning	Cam/Crank misalignment
A	781	Shutdown	CAN datalink failed
A	783	Shutdown	Manifold temperature error
B	1121	Warning	Failed to disconnect
A	1135	Shutdown	J1939 datalink update error
C	1219	Warning	Utility CB tripped
C	1222	Warning	Power transfer not in auto
C	1223	Warning	Utility frequency sensor
C	1224	Warning	Generator over voltage sensor
C	1225	Warning	Generator under voltage sensor
E	1243	Warning	Engine derate
D	1244	Shutdown	Engine normal shutdown
D	1245	Shutdown	Engine shutdown
B	1248	Warning	Engine warning
A	1257	Shutdown	ECM identification error
E	1311	Shutdown/Warning	Cable access door open
E	1312	Shutdown/Warning	Customer Input #2
E	1313	Shutdown/Warning	Network Fault 1
E	1314	Shutdown/Warning	Network Fault 2
E	1315	Shutdown/Warning	Network Fault 3
E	1316	Shutdown/Warning	Network Fault 4
E	1317	Shutdown/Warning	Low fuel level
E	1318	Shutdown/Warning	Rupture basin
B	1319	Warning	High alternator temperature
C	1321	Warning	Common warning driver
A	1322	Shutdown	Load governor kW setpoint OOR high
A	1323	Shutdown	Load governor kW setpoint OOR low
B	1324	Warning	Load governor kVAR OOR high

Category	Code	Lamp	Displayed Message
B	1325	Warning	Load governor kVAR OOR low
B	1326	Warning	Backup starter disconnect
A	1327	Shutdown	Load governor kW analog OOR
D	1328	Warning	Genset CB tripped
B	1329	Warning	AVR DC power failure
A	1331	Shutdown	AVR driver shorted
A	1332	Shutdown	Manual switch OOR low
A	1333	Shutdown	Manual switch OOR high
A	1334	Shutdown	Critical scaler OOR
B	1335	Shutdown	Non critical scaler OOR
E	1337	NONE	Network wink
E	1341	Shutdown	Load demand stop
A	1342	Shutdown	Slot 0 card
A	1343	Shutdown	Slot 1 card
A	1345	Shutdown	Slot 3 card
A	1346	Shutdown	Slot 4 incorrect
C	1351	Warning	Slot 4/network enabled
B	1357	Warning	Low oil level
B	1362	Warning	High oil filter pressure
B	1363	Warning	Low manifold pressure
C	1376	Warning	Cam/Crank data incorrect
C	1377	Warning	Post-oil filter pressure sensor
C	1378	Warning	Post-oil filter pressure sensor
C	1414	Warning	Run relay contact
C	1415	Warning	Run relay driver
D	1416	Warning	Fail to shutdown
D	1417	Warning	Power down error
C	1424	Warning	High side driver
C	1427	Warning	Overspeed relay driver
C	1428	Warning	LOP shutdown relay driver
C	1429	Warning	HET shutdown relay driver
C	1431	Warning	LOP warning relay driver
C	1432	Warning	HET warning relay driver
D	1433	Shutdown	Emergency stop - local
D	1434	Shutdown	Emergency stop - remote
D	1435	Warning	Engine cold

Category	Code	Lamp	Displayed Message
A	1437	Shutdown	E-stop path fuse blown
D	1438	Warning	Fail to crank
D	1439	Warning	Fuel level low in day
D	1441	Warning	Fuel level low in main
B	1444	Warning	kW overload
A	1445	Shutdown	Alternator short circuit
A	1446	Shutdown	AC output voltage is high
A	1447	Shutdown	AC output voltage is low
A	1448	Shutdown	AC output frequency low
A	1449	Warning	AC output frequency high
B	1451	Warning	Gen/Bus voltage differ
A	1452	Shutdown	Gen CB failed to close
A	1453	Shutdown	Gen CB failed to open
C	1454	Warning	Gen CB position contact
A	1455	Warning	Util CB contact
E	1456	Warning	Bus out of range
E	1457	Warning	Fail to synchronize
E	1458	Warning	Phase rotation
A	1459	Shutdown	Reverse kW
A	1461	Shutdown	Loss of field
B	1462	Warning	High ground current
E	1463	None	Not in Auto
E	1464	None	Load dump
E	1465	None	Ready to load
C	1466	Warning	Modem failure
C	1467	Warning	Unable to connect modem
C	1468	Warning	Network error
B	1471	Warning	High current
A	1472	Shutdown	Overcurrent
A	1473	Shutdown	Watchdog failure
A	1474	Shutdown	Software version mismatch
C	1475	Warning	First start backup
C	1476	Warning	LonWorks card
C	1477	Warning	Crank relay contact
C	1478	Warning	Crank relay driver
A	1481	Shutdown	AVR driver open
E	1483	None	Common alarm status
A	1485	Shutdown	EFC driver shorted

Category	Code	Lamp	Displayed Message
A	1486	Warning	ECF driver open
C	1487	Warning	Auto acknowledge driver
C	1488	Warning	Warning LED driver
C	1489	Warning	Shutdown LED driver
C	1491	Warning	Ready to load relay driver
C	1492	Warning	Load dump relay driver
C	1493	Warning	Display control driver
C	1494	Warning	Modem power relay driver
C	1495	Warning	Common shutdown 2 driver
C	1496	Warning	Auto mode relay driver
C	1497	Warning	Manual run LED driver
C	1498	Warning	Exercise run LED driver
C	1499	Warning	Remote start LED driver
B	1548	Warning	Injector cylinder 7 open
B	1549	Warning	Injector cylinder 8 open
B	1551	Warning	Injector cylinder 10 open
B	1552	Warning	Injector cylinder 11 open
B	1553	Warning	Injector cylinder 12 open
B	1554	Warning	Injector cylinder 13 open
B	1555	Warning	Injector cylinder 14 open
B	1556	Warning	Injector cylinder 15 open
B	1557	Warning	Injector cylinder 16 open
B	1558	Warning	Injector cylinder 17 open
B	1559	Warning	Injector cylinder 18 open
B	1622	Warning	Injector cylinder 9 open
C	1843	Warning	Blowby pressure sensor
C	1844	Warning	Blowby pressure sensor
C	1845	Warning	H_20 in fuel sensor low
C	1846	Warning	H_20 in fuel sensor high
D	1847	Shutdown	High coolant temperature
D	1852	Warning	High H_20 in fuel
D	1891	Warning	Change oil and filter
C	1978	Warning	Load/speed bias sensor high
A	1992	Shutdown	Overspeed
C	2111	Warning	Aftercooler temperature sensor
C	2112	Warning	Aftercooler temperature sensor

Category	Code	Lamp	Displayed Message
B	2113	Warning	High aftercooler temperature
A	2114	Shutdown	High aftercooler temperature
C	2185	Warning	Sensor supply 4 OOR high
C	2186	Warning	Sensory supply 4 OOR low
B	2215	Warning	Low fuel supply pressure
B	2261	Warning	High fuel supply pressure
B	2262	Warning	Low fuel supply pressure
C	2265	Warning	Fuel lift pump sensor high
C	2266	Warning	Fuel lift pump sensor low
B	2311	Warning	Fuel injector control error
C	2331	Warning	Utility under voltage sensor
C	2358	Warning	Utility over voltage sensor
C	2377	Warning	Fan control sensor high
C	2396	Warning	Utility circuit breaker failed to close
C	2397	Warning	Utility circuit breaker failed to open
D	2545	Warning	Keyswitch reset required

7.5.11 Warning and Shutdown Codes

⚠ WARNING

Troubleshooting procedures.

Troubleshooting procedures present hazards that can result in severe personal injury or death.

Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures.

7.5.11.1 Code 146 - High Coolant Temp Warning

Corrective Action: Indicates the engine is operating near cooling system capacity. Increase in load or higher ambient temperature may cause a High Coolant Temp (151) shutdown. Review 151 correction list for other possible causes.

7.5.11.2 Code 151 - High Coolant Temp Alarm

Corrective Action: 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. Check the coolant level and replenish if low. Look for coolant leaks and repair if necessary.
2. Check for obstructions to cooling airflow and correct as necessary.
3. Check fan belt and repair or tighten if necessary.
4. Check the blower fan and circulation pumps on remote radiator installations.

5. Reset the control and restart after locating and correcting the problem.

7.5.11.3 Code 197 - Low Coolant Level

Corrective Action: Indicates engine coolant level has fallen to an unacceptable level. If the generator is powering critical loads and cannot be shut down, wait until the next shutdown period, and then follow **235 Coolant Level Alarm** procedure. If the engine can be stopped, follow **235** procedure.

7.5.11.4 Code 235 - Low Coolant Level

Corrective Action: Indicates engine coolant level has fallen below the alarm trip point. Allow the engine to cool down completely before proceeding.

1. Check the coolant level sight glass at LTA top tank. Replenish if low.
2. Look for possible coolant leakage points and repair if necessary.
3. Reset the control and restart after locating and correcting the problem.

7.5.11.5 Code 359 - Engine Failed to Start

Corrective Action: Indicates a possible fault with the control or starting system. Check for the following conditions:

1. Poor battery cable connections. Clean the battery cable terminals and tighten all connections.
2. Discharged or defective battery. Recharge or replace the battery.

7.5.11.6 Code 441 - Low Battery Voltage

Corrective Action: Indicates battery voltage is below 24 VDC.

1. Discharged or defective battery. Check the battery charger fuse. Recharge or replace the battery.
2. Poor battery cable connections. Clean the battery cable terminals and tighten all connections.
3. Check engine DC alternator. Replace the engine DC alternator if normal battery charging voltage (24 to 26 VDC) is not obtained.
4. Check the float level if applicable (raise float level).

7.5.11.7 Code 442 - High Battery Voltage

Corrective Action: Indicates battery voltage exceeds 32 VDC.

- Check the float level on the battery charger, if applicable. Lower float level if necessary).
- Check the engine DC alternator. Replace the engine DC alternator if normal battery charging voltage (24 to 26 VDC) is not obtained.

7.5.11.8 Code 611 - Engine Hot

Corrective Action: Indicates that an engine hot shutdown has occurred (cooldown timers were bypassed). This condition will occur when the operator presses the **Emergency Switch** or moves the **O/Manual/Auto** switch to the **O** (Off) position before the generator set completes the cooldown operation. (The generator set should run at 10% or less load for 3 minutes before engine shutdown.) This type of shutdown should be avoided. It can cause possible loss of performance and engine damage.

7.5.11.9 Code 1311 through 1318 - Customer Defined Fault

Corrective Action: When any one of these customer defined inputs is detected by the control, the corresponding fault message is displayed. The nature of the fault is an optional customer selection. These fault functions can be programmed to initiate a shutdown or warning as indicated by the **Warning** or **Shutdown** lamp.

NOTICE
Customer fault messages are editable. The message displayed for the code shown (1311 through 1318) is determined by the customer.

7.5.11.10 Code 1416 - Failed to Shutdown

Corrective Action: Status indicates that the **Fault Bypass** mode is enabled and that a critical shutdown fault has occurred. In this mode, the generator set ignores the majority of system shutdown faults. The purpose of this mode is to satisfy local code requirements where necessary.

NOTICE
The InPower service tool is required to enable/disable the Fault Bypass mode.

7.5.11.11 Code 1417 - Power Down Error

Corrective Action: Indicates that the control can not power down due to some unknown condition. Possible drain on battery. Contact an authorized service center for service.

7.5.11.12 Code 1433/1434 - Emergency Stop - Local/ Emergency Stop - Remote

Corrective Action: Indicates local or remote Emergency Stop. Emergency Stop shutdown status can be reset only at the local control panel.

To reset the local/remote Emergency Stop button:

1. Pull the button out.
2. Move the O/Manual/Auto switch to O (Off).
3. Press the front panel Fault Acknowledge button.
4. Return O/Manual/Auto switch to desired position.

7.5.11.13 Code 1435 - Engine Cold

Corrective Action: Indicates engine coolant heater is not operating or is not circulating coolant. The generator set is in standby mode but is not operating. A warning occurs when the engine jacket water coolant temperature is 70° F (21° C) or lower.

NOTICE
In applications where the ambient temperature falls below 40° F (45° C), Low Coolant Temp may be indicated even though the coolant heaters are operating.

Check for the following conditions:

1. Make sure both ball valves in heater coolant lines are open.
2. The coolant heater not connected to power supply. Check for a blown fuse or disconnected heater cord and correct as required.
3. Check for low jacket water coolant level and replenish if required. Look for possible coolant leaks and repair as required.

7.5.11.14 Code 1438 - Fail to Crank

Corrective Action: Indicates possible fault with control or starting system. Check for the following conditions:

- Poor battery cable connections. Clean the battery cable terminals and tighten all connections.
- Discharged or defective battery. Recharge or replace the battery.

7.5.11.15 Code 1439 - Fuel Level Low in Day

Corrective Action: Indicates fuel supply is running low. Check fuel supply and replenish as required.

7.5.11.16 Code 1441 - Fuel Level Low in Main

Corrective Action: Indicates fuel supply is running low. Check fuel supply and replenish as required.

7.6 Line Circuit Breaker

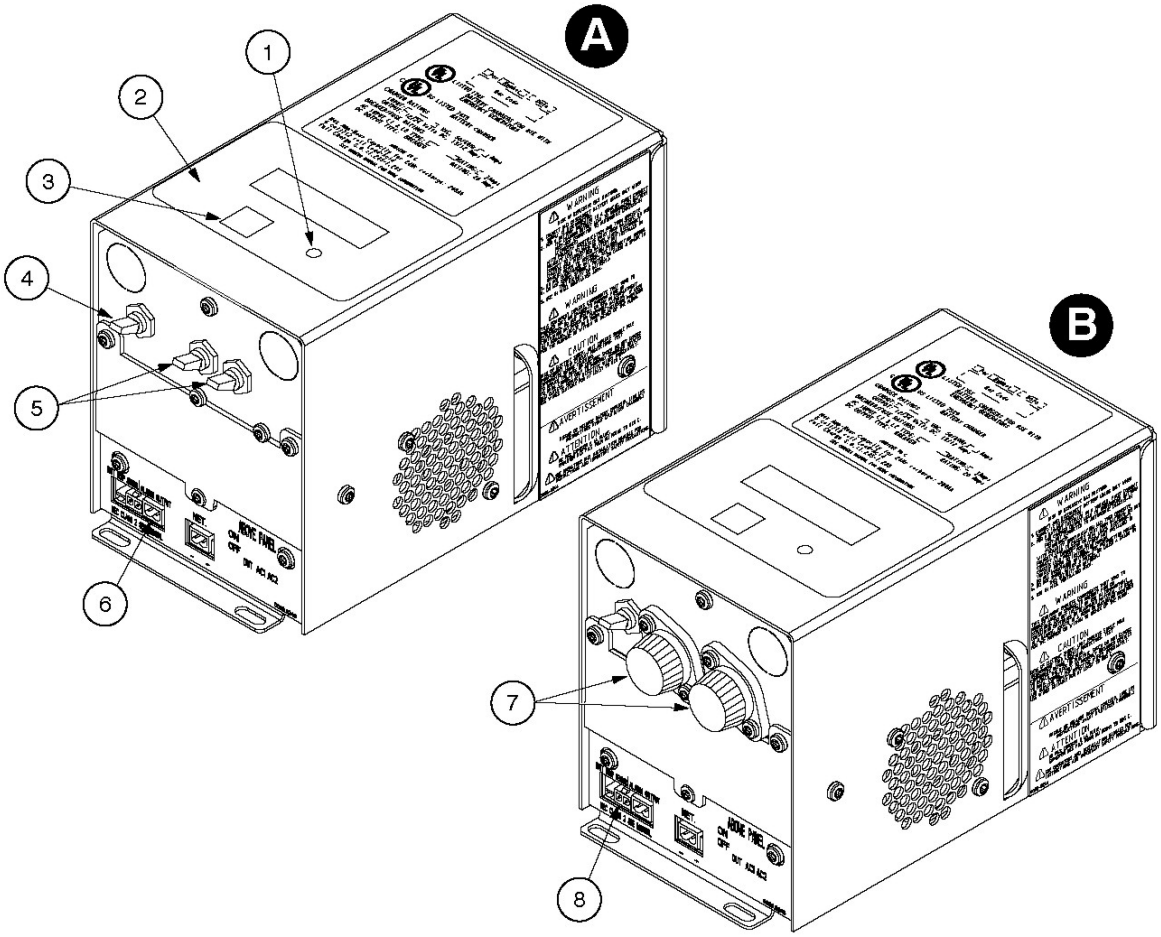
A line circuit breaker is mounted in the generator output box. If the load exceeds the circuit breaker current rating, the line circuit breaker will open, preventing the generator from being overloaded. If the circuit breaker trips, locate the source of the overload and correct as necessary. Manually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

8 Battery Charger

8.1 PowerCommand Battery Charger - 15 Amp at 12 Volt and 12 Amp at 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.



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

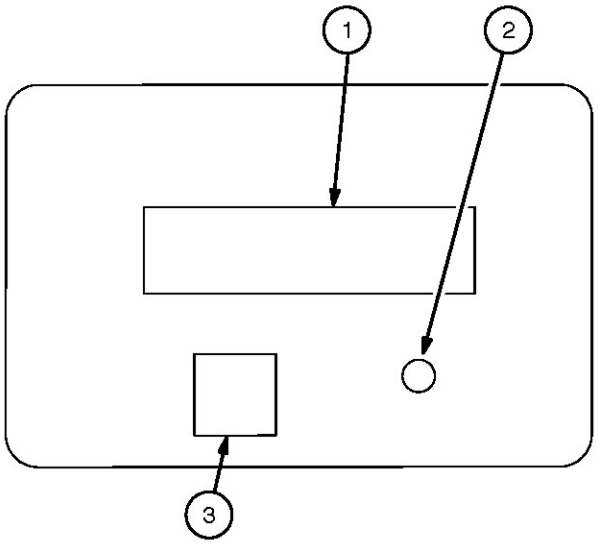
FIGURE 48. 15/12-AMP POWERCOMMAND BATTERY CHARGERS

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 49. 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]).

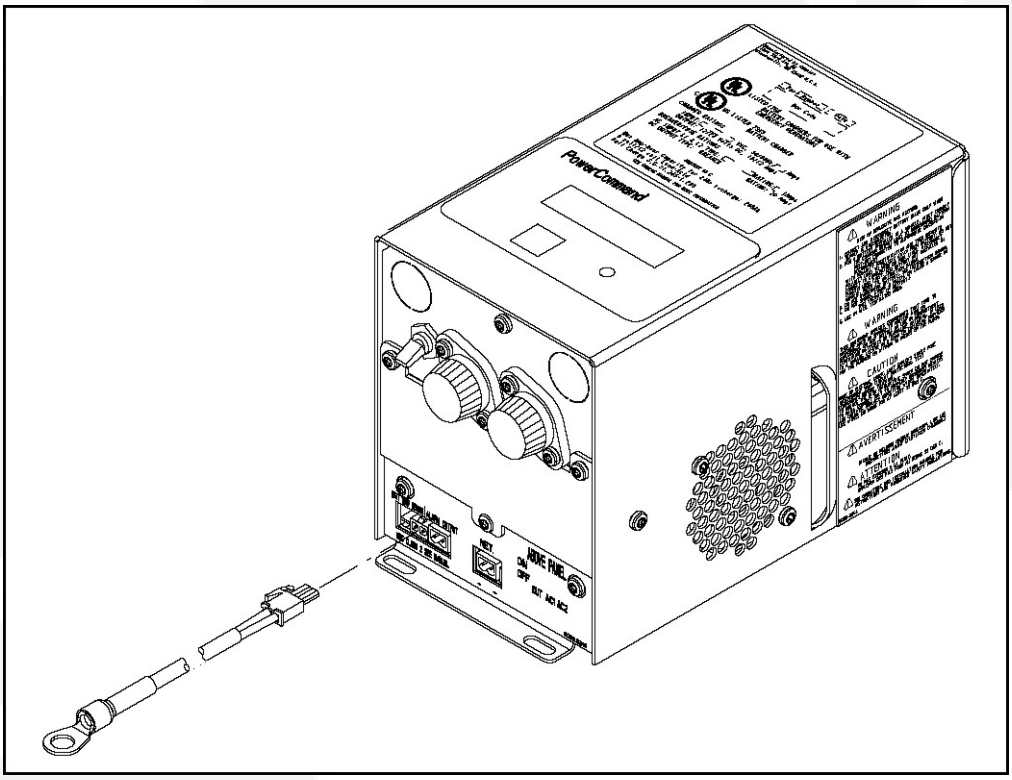


FIGURE 50. TEMPERATURE SENSOR

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	35A/1/2, Erandawana Pune 411 038 India
Phone +55 11 2186 4195 Fax +55 11 2186 4729	Phone +86 10 5902 3000 Fax +86 10 5902 3199	Phone +91 020 6602 7525 Fax +91 020 6602 8090
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 your nearest Cummins Power Generation distributor. To locate your local Cummins Power Generation distributor, refer to **www.cumminspower.com** and select Distributor Locator. When contacting your distributor, always supply the complete model, specification, and serial number as shown on the nameplate.

9.1.1 Locating Your Distributor

In North America

Telephone +1 800 888 6626 (this is an automated service for touch-tone phones only) to contact the nearest Cummins Power Generation distributor in the United States or Canada. By selecting Option 1 (press 1), you will be automatically connected to the distributor nearest you.

If you are unable to contact a distributor using the automated service, consult the Yellow Pages. Typically, our distributors are listed under:

GENERATORS – ELECTRIC or

ENGINES – GASOLINE OR DIESEL

If you have difficulty arranging service or resolving an issue, please contact the Service Manager at the nearest Cummins Power Generation distributor for assistance.

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

Outside North America

If you are outside North America, refer to **www.cumminspower.com** and select Distributor Locator, or send an email to ask.powergen@cummins.com.

www.cumminspower.com